national highways

A27

Arundel Bypass

Preliminary Environmental Information Report

Volume 2b

11 January 2022 – 8 March 2022

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About this report

Thank you for taking part in our statutory public consultation on the proposed A27 Arundel Bypass Scheme. This consultation is an important step towards delivering the Scheme, which will bring many benefits to local communities and the region's economy, whilst making journeys quicker and safer, and freeing Arundel town and neighbouring communities from congestion.

To inform this consultation, we have prepared a suite of information which you can find on National Highway's website (www.nationalhighways.co.uk/our-work/south-east/a27-arundel-bypass), and which includes this Preliminary Environmental Information Report (PEI Report). This report is set out in four volumes and describes the environmental setting of the Scheme and our preliminary assessments of the Scheme's potential significant environmental effects as described below:

Volume 1 - PEI Report Non-Technical Summary (NTS), a short summary which uses non-technical language.

Volume 2 - PEI Report, a detailed technical report (in two parts), which introduces the Scheme and describes its details, the alternatives considered, and the approach taken for the environmental assessment. The PEI Report presents and then summarises the preliminary assessment of the likely significant environmental effects of the Scheme as well as considers the potential inter-relationships between the topics covered, and between the Scheme and other developments in the surrounding area.

Volume 3 – PEI Report Figures, which provide further information in the form of figures to support the initial findings presented in Volume 2.

Volume 4 – PEI Report Technical Appendices, which provide further information in the form of technical information (in three parts) to support the initial findings presented in Volume 2.

Each volume's Contents Page lists all the topics discussed. Due to their size, Volume 2 is presented in two parts (2a and 2b) and Volume 4 is presented in three parts (4a, 4b and 4c). It should be noted that those topics that are not included in the individual sub-volumes are greyed out.

This report should be read alongside the other supporting consultation materials such as the consultation brochure, which will explain where you can find more details regarding the Scheme and how to provide your comments.

This consultation is an important opportunity for you to share your comments on the Scheme ahead of submission of our Development Consent Order application, which is expected to happen later in 2022. We'd like to hear what you think, so please share any ideas, local knowledge or concerns that you may have. Your feedback to this consultation is important and will continue to help shape the design of the Scheme.

Table of contents

Those items below that are highlighted in Grey do not form part of this volume.

5. Air Quality

5.1 Introduction

5.1.1 This chapter considers the potential effects of Scheme construction and operation on air quality. The assessment has been prepared in accordance with *DMRB LA 105 – Air Quality* (Ref 5-1).

5.1.2 There may be interrelationships related to the potential effects on the air quality receptors and other disciplines. Reference should also be made in particular to the following chapters:

a. Chapter 8: Biodiversity

b. Chapter 11: Noise and Vibration

c. Chapter 12: Population and Human Health

5.1.3 The *EIA Scoping Report* contained within Appendix 1-A, determined that a 'detailed' level of assessment is required with regard to air quality and this level of assessment will be undertaken for the EIA and reported within the ES that will be submitted with the DCO application.

5.1.4 A preliminary assessment has been undertaken and reported herein. The objectives of the assessment are to:

a. Identify relevant receptors to represent locations where people are likely to be present, based on potential impacts of air quality on human health and designated ecological sites.

b. Estimate pollutant concentrations at these sensitive receptors so as to assess the local operational air quality effects for the Scheme, focusing on key road traffic pollutants – nitrogen dioxide (NO_2) and particulate matter (PM_{10} – particulate matter particles with diameters that are 10 micrometres and smaller) for human health, nitrogen oxides (NO_X) and nitrogen deposition for ecological sites.

c. Compare baseline air quality modelling predictions and baseline air quality monitoring data against relevant *Air Quality Strategy* (AQS) (Ref 5-2) objectives so as to provide confidence in and verification of the model results.

d. Consider the rate of improvement in air quality over time as cleaner road vehicles enter the national vehicle fleet.

e. Determine the magnitude of change (impact) in pollutant concentrations as a result of the operation of the Scheme.

Ref 5-1 Highways England (2019) Design Manual for Roads and Bridges LA 105 – Air Quality.
Ref 5-2 Department for Environment, Food and Rural Affairs in partnership with the Scottish Executive, Welsh Assembly Government and Department of the Environment Northern Ireland (2007). The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (Volume 1)

f. Determine the significance of the effects on air quality due to the operation of the Scheme. Preliminary information on compliance with European Union (EU) Limit values and effects during the Scheme construction phase is also presented.

5.1.5 The following legislation, planning policy and planning practice guidance is of direct relevance to the assessment of air quality:

a. *The Ambient Air Quality and Cleaner Air for Europe Directive 2008/50/EC* (‘*The Air Quality Directive’*) (Ref 5-3)

b. *Part IV of the Environment Act 1995* (Ref 5-4)

c. *Air Quality Standards Regulations 2010* (Ref 5-5)

d. *Air Quality (Amendment of Domestic Regulations) (EU Exit) Regulations 2019* (Ref 5-6)

e. *Environment Act 2021* (Ref 5-7)

f. *Defra National Air Quality Strategy* (AQS) (Ref 5-8)

g. *Defra Clean Air Strategy* (Ref 5-9)

h. *Defra Compliance Assessment Summary* (Ref 5-10)

i. *NPSNN* (Ref 1-7)

j. *NPPF* (Ref 1-8)

k. *PPG* for Air Quality (Ref 5-11)

l. *The UK Plan for Tackling Roadside NO_2 Concentrations* (Ref 5-12)

m. *Defra Supplement to the UK plan for tackling roadside nitrogen dioxide concentrations* (Ref 5-13)

n. *National Highways ‘Our strategy to improve air quality’* (Ref 5-14)

Ref 5-3 Council Directive on Ambient Air Quality and Cleaner Air for Europe (2008/50/EC). European Parliament and Council of the European Union (2008).
Ref 5-4 Environment Act 1995. The Stationery Office (1995).
Ref 5-5 Air Quality Standard Regulations 2010. The Stationery Office (2010).
Ref 5-6 The Air Quality (Amendment of Domestic Regulations) (EU Exit) Regulations 2019. The Stationery Office (2019)
Ref 5-7 Environment Act 2021. The Stationery Office (2021).
Ref 5-8 The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (Volume 1). Department for Environment, Food and Rural Affairs in partnership with the Scottish Executive, Welsh Assembly Government and Department of the Environment Northern Ireland (2007).
Ref 5-9 Clean Air Strategy 2019. Department for Environment, Food and Rural Affairs (2019).
Ref 5-10 Air Pollution in the UK 2018 Compliance Assessment Summary. Department for Environment, Food and Rural Affairs (2019).
Ref 5-11 Planning Practice Guidance: Air quality. Ministry of Housing, Communities & Local Government (2019).
Ref 5-12 UK plan for tackling roadside nitrogen dioxide concentrations: detailed plan. Department for Environment, Food and Rural Affairs (2017).
Ref 5-13 Supplement to the UK plan for tackling roadside nitrogen dioxide concentrations. Department for Environment, Food and Rural Affairs (2018).
Ref 5-14 Our strategy to improve air quality. Highways England (2017).

5.1.6 The Environment Act (Ref 5-7) was published in late 2021. Following this the Government will bring forward a consultation on $PM_{2.5}$ targets. This consultation will take place by October 2022 with the targets set thereafter. Therefore, at this time National Highway's Schemes will continue to be assessed in line with the existing air quality objectives and limits as applicable and in accordance with current legislation in compliance with the *NPSNN*.

5.1.7 A further review of the relevant listed legislation and policy will be provided within the ES Chapter, alongside consideration of local planning policy documents.

5.2 Stakeholder engagement

5.2.1 Initial consultation regarding air quality matters has been undertaken with ADC, WSCC, SDNPA, AWC, CDC and HDC via the *EIA Scoping Report*. The following aspects have been discussed in relation to the Scheme:

a. Construction compounds
b. Construction phase diversion routes
c. Construction phase Heavy Goods Vehicles (HGVs)
d. Construction phase mitigation
e. The air quality assessment study area and proximity with Air Quality Management Areas (AQMAs)
f. Monitoring data
g. Data sources for background concentrations
h. Pollutants considered within the air quality assessment
i. Assessment of future air quality and assumed improvements – particularly in reference to long-term trends
j. Use of detailed modelling techniques
k. National Highways air quality guidance (*DMRB LA 105* (Ref 5-1))

5.2.2 In addition, subsequent to the formal scoping process, virtual meetings were held with ADC, WSCC, SDNPA, AWC, CDC and HDC to discuss scoping responses and to agree site locations for a new Scheme-specific air quality monitoring survey of NO_2, which will be used to inform dispersion model verification for the ES.

5.3 Assessment assumptions and limitations

5.3.1 The detailed air quality assessment to be presented in the ES will be based on detailed traffic modelling data which is currently being prepared. In this PEI Report, we have described potential areas expected to experience increases/decreases in pollutant concentrations based on dispersion modelling predictions using fixed demand traffic flows taken from a

strategic traffic model. These were provided as part of the development of the preliminary design for statutory consultation.

5.3.2 For the PEI Report, the available traffic forecasts used are “fixed trip” assignments, which means the total level of demand does not change. The traffic model forecasts changes in travel times, congestion and flows (due to re-routing), but does not take account of changes in the level of travel demand, which is sometimes called induced traffic. Induced traffic is caused by travellers changing their choice of destination, frequency of travel or the time at which they undertake their journey.

5.3.3 For the air quality assessment to be reported in the ES, traffic data will be used as generated by the traffic model which will include a component called a Variable Demand Model (VDM). This model will forecast demand changes in response to the opening of the Scheme, which is a representation of induced traffic responses. This could lead to increases or decreases in traffic flows on some links of approximately ±15%, the potential impact of which is considered further in relation to the predictions described within this PEI Report in *Section 5.8* of this chapter. The traffic flow changes are likely to be greatest in areas where the congestion relief is the greatest.

5.3.4 Air quality monitoring data has been obtained from local authorities and a previous Scheme-specific study from 2015, within the defined PEI Report study area. The local operational air quality assessment uses the latest Defra local air quality management tools and guidance, the ADMS Roads dispersion model and National Highways’ tools and guidance available at the time the assessment was undertaken, with the predictions having been checked against the local air quality monitoring data.

5.3.5 Within this PEI Report, the operational air quality assessment focuses on the immediate area along and around the Scheme, as well as key areas of potential worsening in pollutant concentrations due to the attraction of traffic to the A27 corridor at the Worthing Grove Lodge/Lyons Farm AQMA, and at areas of potentially significant beneficial changes in air quality at Storrington and Arundel. The study area for the ES will be defined when updated traffic modelling data is available, and may differ from that considered within this PEI Report. Whilst this PEI Report has aimed to consider all areas where impacts on air quality could occur due to the Scheme, there remains a risk that areas not considered within this PEI Report may be subject to changes in air quality when the assessment of road traffic impacts is updated for the ES Chapter. Further detail is provided within *Section 5.8* of this PEI Report.

5.3.6 At this stage, details in relation to construction vehicles, the construction schedule, associated construction activities and detailed plant equipment requirements are not yet available. Therefore, a qualitative discussion of potential construction air quality impacts associated with these sources is provided in this chapter based on the typical construction activities anticipated for a scheme of this type and scale.

5.3.7 A detailed assessment of the construction phase air impacts will be undertaken as part of the EIA and reported in the ES.

5.4 Study area

5.4.1 The assessment of construction phase traffic effects (typically HGV assessment and traffic management assessment) and operational phase traffic effects (local operational assessment) uses a study area of 200 m around road sections likely to be affected by the Scheme. This is due to the effect of pollutants from road traffic reducing with distance from the point of release, and beyond 200 m these are likely to have reduced to a concentration equivalent to background concentrations, as outlined within *DMRB LA 105* (Ref 5-1).

5.4.2 Individual sensitive receptors (within or outside AQMAs) are studied in the local operational assessment at distances of up to 200 m. The air quality study area for the local operational assessment considers the Scheme, and those routes where the Scheme is predicted to have an impact. Affected road links (individually modelled sections of road) have been identified by comparing traffic data with the Scheme (Do Something) and without the Scheme (Do Minimum) against the local air quality screening criteria presented in *DMRB LA 105* (Ref 5-1), which are:

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

b. Heavy Duty Vehicles (HDV) (vehicles greater than 3.5 tonnes, including buses and coaches) flows will change by 200 AADT or more; or

c. A change in speed band; or

d. A change in road alignment by 5 m or more.

5.4.3 These criteria are used to identify whether significant changes in air quality might occur. If a criterion is not met or exceeded, then a significant change in air quality is not anticipated. However, if a criterion is met, this does not automatically mean a significant air quality effect is anticipated, but that further evaluation is required to understand the potential for significant effects.

5.4.4 On the basis of the current status of the traffic data available (see paragraph 5.3.2), a proportionate approach to the reporting of air quality effects has been adopted whereby increases and decreases in concentrations are described in relation to potential exceedances of air quality objective values. The discussion of results focusses on receptors where there is a change in traffic that would result in a deterioration of air quality, or where a beneficial change in traffic has been identified which could lead to a significant beneficial impact where existing air quality is poor.

5.4.5 For this preliminary assessment, areas anticipated to experience beneficial air quality changes where baseline concentrations are already below the objective value, have not been considered as they are not anticipated to

influence the overall significance of air quality effects resulting from the Scheme.

5.4.6 All areas that meet the DMRB screening criteria for air quality as outlined in paragraph 5.4.2 and within the Traffic Reliability Area (TRA) will be considered in full as part of the EIA and reported in the ES. As outlined within paragraph 5.3.5, this may include additional areas not currently considered within this PEI Report.

5.4.7 The air quality assessment has focussed on those following areas where a change in operational traffic meeting the traffic screening criteria identified above occurs, including:

a. The immediate area alongside the A27 bypass route.

b. The immediate area along the existing A27 being bypassed and adjoining roads.

c. The immediate area around the existing A27 east and west of the Scheme route between Shoreham-by-Sea and Chichester and adjoining roads where there are increases in flow with the scheme in operation.

d. In areas where the Scheme could result in beneficial changes to air quality as a result of re-routing through the wider network causing reductions in flow, including the AQMA in Storrington (Horsham AQMA No1).

5.4.8 Additional links are included in the local operational air quality model where the additional emissions from these areas or links are required to describe pollutant concentrations at sensitive receptor locations along affected roads. This has been carried out with regard to sensitive receptors along affected routes and adjacent to the Scheme.

5.4.9 The aforementioned screening criteria will be used when considering construction phase traffic impacts as part of the EIA and reported in the ES.

5.5 Baseline conditions

5.5.1 Existing baseline air quality data and sensitivity receptor data for the study area have been gathered from the following sources:

a. Boundaries of AQMAs (Ref 5-15).

b. Local Authority monitoring data (Ref 5-16, Ref 5-17, Ref 5-18, Ref 5-19, Ref 5-20).

Ref 5-15 Department of Environment, Food and Rural Affairs (2021) The 2021 AQMA dataset
Ref 5-16 Adur District Council (2020). 2020 Air Quality Annual Status Report (ASR). September 2020.
Ref 5-17 Arun District Council (2020). 2020 Air Quality Annual Status Report (ASR). June 2020.
Ref 5-18 Chichester District Council (2020). 2020 Air Quality Annual Status Report (ASR). June 2020.
Ref 5-19 Horsham District Council (2020). 2020 Air Quality Annual Status Report (ASR) for Horsham District Council. June 2020.
Ref 5-20 Worthing Borough Council (2020). 2020 Air Quality Annual Status Report (ASR). September 2020.

c. Scheme-specific National Highways' monitoring data from 2015 (Ref 5-21).

d. Defra Pollution Climate Mapping (PCM) Model GIS data for the latest available year (Ref 5-22).

e. Defra air pollution background concentration maps (Ref 5-23).

f. Locations of human health receptors (residential properties, schools, hospitals and elderly care homes) from Ordnance Survey (OS) base mapping (Ref 5-24 and Ref 5-25).

g. Boundaries of relevant designated ecological sites (Ref 5-26).

5.5.2 There are two AQMAs within the study area; namely the Worthing Grove Lodge/Lyons Farm AQMA and the Horsham AQMA No1 in Storrington (Ref 5-27).

5.5.3 Information on areas exceeding EU limit value thresholds (40 µg/m^3 for annual mean NO_2) is available from Defra's PCM Model (Ref 5-22). This model provides 'road contributed' concentrations of pollutants, including annual mean NO_2. Based on 2018 roadside NO_2 concentrations modelled by the Defra PCM model, no links exceeding 40 µg/m^3 are present within the study area.

5.5.4 Estimates of background pollutant concentrations in the UK are available for 0.6 mile (1 km) grid squares throughout the UK up to the year 2030, based on baseline data available for 2018. 2018 is the earliest year for which the mapped background concentrations are available.

5.5.5 In accordance with LAQM.TG(16) (Ref 5-28), as modelled national background maps are used in the assessment, the 2018 mapped data was compared to local background monitoring data to check they are representative of the area.

5.5.6 The comparison of these background maps to the background monitoring data showed that concentrations modelled in the national background maps are in line with local background monitoring for 2015, and so no further adjustment of the background map concentrations was undertaken.

5.5.7 The 2018 background concentrations for NO_2 and PM_{10} for the grid squares through which the Scheme corridor passes are all below the relevant air

Ref 5-21 Highways England (2019). A27 Arundel Bypass Environmental Assessment Report. Appendices 5.1 to 5.10. August 2019
Ref 5-22 Defra (2020) NO_2 projection data (2018 reference year).
Ref 5-23 Department for Environment, Food and Rural Affairs (2021). 2018-based background maps for NO_X, NO_2, PM_{10} and $PM_{2.5}$
Ref 5-24 Ordnance Survey (2020) MasterMap
Ref 5-25 Ordnance Survey (2020) AddressBase
Ref 5-26 Natural England (2020). MAGIC
Ref 5-27 Department of Environment, Food and Rural Affairs (2021) Defra AQMA Dataset. April, 2021.
Ref 5-28 Department for Environment, Food and Rural Affairs (2018). Local Air Quality Management Technical Guidance (TG16).

quality objectives. The 2018 background concentrations for NO_2 range from 7.0 µg/m^3 to 18.1 µg/m^3, whilst PM_{10} concentrations range from 11.4 µg/m^3 to 18.0 µg/m^3, which are all well below the annual mean objective values for NO_2 and PM_{10} of 40 µg/m^3.

5.5.8 Defra background mapping for 2027 was applied for the forecast year of Scheme opening, with the same sectors of motorways, trunk roads and A roads within each grid square removed, to avoid double counting of emission sources being included within the dispersion modelling. In 2027, background NO_2 concentrations range from 5.3 µg/m^3 to 13.7 µg/m^3, whilst background PM_{10} concentrations range from 10.2 µg/m^3 to 16.7 µg/m^3.

5.5.9 A Scheme-specific NO_2 diffusion tube survey was undertaken at locations in close proximity to the Scheme and within the surrounding road network during 2015. The findings of this survey at locations considered within this assessment are presented in Table 5-1.

Table 5-1 National Highways Diffusion Tube Monitoring Results (µg/m^3)

Site ID	OS Grid Ref		2015 Annual mean NO_2 concentration (µg/m^3)
	X	Y	
A27Ar_001_0116	506632	105686	29.2
A27Ar_002_0116	506596	105736	26.6
A27Ar_004_0116	506041	105688	27.0
A27Ar_006_0116	504713	105833	35.4
A27Ar_007_0116	504315	105891	18.2
A27Ar_009_0116	502343	106546	30.3
A27Ar_010_0116	502204	106718	20.8
A27Ar_011_0116	502155	106762	20.9
A27Ar_012_0116	501810	107180	19.6
A27Ar_013_0116	502033	106900	22.1
A27Ar_014_0116	501746	107192	15.8
A27Ar_015_0116	501650	106644	29.4
A27Ar_017_0116	501538	106749	22.3

A page correction was made on 20/01/22 to rectify OS grid references within Table 5-1.

Site ID	OS Grid Ref		2015 Annual mean NO_2 concentration (µg/m^3)
	X	Y	
A27Ar_018_0116	501293	106869	27.4
A27Ar_019_0116	501416	106912	32.0
A27Ar_020_0116	501024	107053	53.9
A27Ar_021_0116	500602	107068	27.9
A27Ar_022_0116	500176	107212	34.5
A27Ar_023_0116	497084	106799	23.2
A27Ar_026_0116	498840	107364	24.0
A27Ar_028_0116	495470	106963	18.2
A27Ar_029_0116	501245	106736	27.6
A27Ar_033_0116	511848	105782	21.0
A27Ar_035_0116	512512	105770	26.4
A27Ar_036_0116	513392	105557	31.6
A27Ar_037_0116	513026	106380	26.3
A27Ar_038_0116	511911	105342	19.6
A27Ar_040_0116	501284	106913	49.8
A27Ar_041_0116	501315	106901	46.7
A27Ar_042_0116	501403	106928	28.5
A27Ar_043_0116	501416	106912	39.4
A27Ar_044_0116	501458	106817	25.7
A27Ar_046_0116	495089	107111	34.9
A27Ar_049_0116	501326	106880	39.0

5.5.10 The monitored concentrations shown in Table 5-1 suggest that, in the majority of areas, existing annual mean NO_2 concentrations at kerbside and roadside locations in the air quality study area and adjacent to the existing A27 are below the annual mean AQS objective (40 µg/m^3).

A page correction was made on 20/01/22 to rectify OS grid references within Table 5-1.

5.5.11 At three monitoring sites (one located at the kerbside less than 0.5 m from the road edge, and two located within 2 m of the road edge) along A27 Chichester Road, near to the roundabout with Arundel Relief Road and Ford Road in Arundel, NO_2 concentrations monitored during 2015 were above the NO_2 annual mean objective (40 µg/m^3). An additional two sites near to this roundabout (one located at the kerbside less than 0.5 m from the road edge, and one located 2 m from the road edge) were close to the objective value, with measured concentrations above 39 µg/m^3.

5.5.12 Continuous air quality monitoring and passive diffusion tube monitoring is ongoing at specific sites within the areas administered by Adur District Council, Chichester District Council, Horsham District Council and Worthing Borough Council.

5.5.13 Table 5-2 and Table 5-3 present continuous and passive (NO_2 diffusion tube) monitoring data from local authority monitoring campaigns that are considered within this assessment.

A page correction was made on 20/01/22 to rectify OS grid references within Table 5-1.

Table 5-2 Local Authority passive NO_2 monitoring results (µg/m^3)

Site ID	OS Grid Ref		Site Name	Site Type	2015 Annual mean NO_2 concentration (µg/m^3)
	X	Y			
2	503439	103364	Litt02	Roadside	25.8
8	500306	104391	Ford08	Roadside	17.1
N8	513236	104651	Littlehampton Road	Roadside	28.2
6N	515190	105122	Gainsborough Avenue	Roadside	38.0
N5	514495	105022	First Avenue	Roadside	28.8
N18A	515315	105141	Kinnall Court, Upper Brighton Road	Suburban	21.6
N24	515151	105109	152 Upper Brighton Road	Roadside	22.4
N25	513845	105199	Warren Court House	Suburban	20.7
N29	515014	105099	Downlands Parade	Roadside	33.5
N30A	514183	104948	Grove Lodge Cottages	Roadside	66.1
N35	514272	104963	30 Upper Brighton Road House	Roadside	29.9
N39	514088	104907	SW of Roundabout at Grove Lodge	Roadside	31.1
N43	514203	104983	23 Upper Brighton Road	Suburban	21.2

A page correction was made on 20/01/22 to rectify OS grid references within Table 5-2.

Site ID	OS Grid Ref		Site Name	Site Type	2015 Annual mean NO_2 concentration ($\mu g/m^3$)
	X	Y			
N45	514127	105063	11 Hill Barn Lane	Suburban	16.0
S12	517731	105505	Broadstone Lane, Lancing	Roadside	30.1
S13	517291	105550	Upper Brighton Road, Sompting	Roadside	35.5
6	502337	106556	Arun06	Roadside	31.4
16	502354	106527	Arun16	Roadside	18.1
N53	513278	105623	Offington Corner	Roadside	29.0
S11	518832	105588	Lancing Manor, Lancing	Roadside	33.0
5	501805	107185	Arun05	Roadside	17.1
14	501320	106901	Arun14	Roadside	28.2
Storrington6	508396	114447	1-4 Holly Court, Pulborough Rd, Storrington	Roadside	21.7
Storrington7	508338	114374	The Willows, Amberley Rd, Storrington	Roadside	20.5
Storrington11n	508521	114363	53 West Street, Storrington (Post Office)	Roadside	37.8

A page correction was made on 20/01/22 to rectify OS grid references within Table 5-2.

Site ID	OS Grid Ref		Site Name	Site Type	2015 Annual mean NO_2 concentration ($\mu g/m^3$)
	X	Y			
Storrington18n	508210	114342	20 Amberley Rd, Storrington (Barges End)	Roadside	16.4
Storrington1	508960	114270	Manleys Hill, Storr Duplicate	Roadside	39.2
Storrington3	508934	114298	3 School Hill, Storrington	Roadside	27.7
Storrington4	508831	114273	22 High Street, Storrington	Roadside	36.1
Storrington5	508742	114286	2 West Street, Storrington (Post Office)	Roadside	23.5
Storrington12n	508596	114326	3 Rectory Cottage Storrington	Roadside	25.8
Storrington13n	508669	114307	18 West Street, Storrington	Roadside	27.5
Storrington14n	509341	114143	Cobden, Manleys Hill, Storrington	Roadside	23.2
Storrington16n	508969	114355	Mill Parade, Waitrose Car Park, Storrington	Roadside	23.1

A page correction was made on 20/01/22 to rectify OS grid references within Table 5-2.

Table 5-3 Local Authority NO_2 continuous monitoring results ($\mu g/m^3$)

Site ID	OS Grid Ref		Site Name	Site Type	2015 Annual mean NO_2 concentration ($\mu g/m^3$)
	X	Y			
HO4	509087	114198	Storrington AURN	Roadside	21.4
WT2	514184	104964	Grove Lodge	Roadside	37.4

A page correction was made on 20/01/22 to rectify OS grid references within Table 5-3.

5.5.14 The Local Authority monitored NO_2 concentrations shown in Table 5-2 and Table 5-3 suggest that most existing annual mean NO_2 concentrations at kerbside and roadside locations in the air quality study area and adjacent to the existing A27 are well below the annual mean AQS objective (40 µg/m^3). There was one exceedance of the AQS objective within the Worthing Grove Lodge/Lyons Farm AQMA in 2015, and one other location above 39 µg/m^3 on Manleys Hill, Storrington.

5.5.15 Concentrations of $PM_{2.5}$ were not monitored within the study area in 2015. However, local authority $PM_{2.5}$ monitoring data is available for 2018. Monitoring results for $PM_{2.5}$ in 2018 are presented within Table 5-4.

Table 5-4 Local Authority $PM_{2.5}$ continuous monitoring results (µg/m^3)

Site ID	OS Grid Ref		Site Name	Site Type	2018 Annual mean PM2.5 concentration (µg/m3)
	X	Y			
WT2	514184	104964	Grove Lodge	Roadside	10

5.5.16 The monitored concentration of $PM_{2.5}$ is well below the annual mean AQS objective (25 µg/m^3).

5.5.17 Considering the relevant pollutants and comparing these against AQS objectives, the following is concluded:

a. National assessments have demonstrated that there is no risk of carbon monoxide, 1,3-butadiene, benzene, lead and sulphur dioxide concentrations exceeding the relevant UK AQS objectives due to emissions from traffic anywhere in the UK. As such, these pollutants have not been considered further as they are very unlikely to be present at levels which would represent potential significant effects due to the Scheme.

b. For particulate matter (PM_{10}), local authorities within the air quality study area have not identified a risk of exceedances for PM_{10}.

c. For the hourly mean NO_2 UK AQS objective, local authorities within the air quality study area have not identified a risk of objective exceedance, so the hourly mean for this pollutant is not considered as part of the air quality assessment in terms of having potential for significant effects due to the Scheme.

5.5.18 On this basis, changes to the annual average NO_2 concentrations are the focus of the air quality assessment for public exposure (i.e., residential properties), whilst predicted changes to the concentrations of PM_{10} are also considered.

A page correction was made on 20/01/22 to rectify OS grid references within Table 5-4.

5.5.19 Designated ecological sites in the air quality study area include Sites of Special Scientific Interest (SSSIs), Local Nature Reserves (LNR), Local Wildlife Sites (LWS), Ancient Woodlands (AWs) and Veteran Trees which contain features which are sensitive to air pollutants – such sites are summarised in Table 5-5. Site relevant critical loads, maximum nitrogen deposition rates and maximum NOx concentrations within these designated sites are also presented, which indicate that baseline critical loads for nitrogen deposition may be exceeded at the majority of designated sites, with the exception of Adur Estuary SSSI and Lancing Ring LNR. The critical level for NOx for the protection of vegetation (30 µg/m^3) is unlikely to be exceeded at all sites (Ref 5-29).

Ref 5-29 UK Centre for Ecology and Hydrology (2020). Air Pollution Information Services.
A page correction was made on 20/01/22 to rectify OS grid references within Table 5-4.

Table 5-5 Ecological designated sites

Site Name	X	Y	Relevant nitrogen critical load class	Critical load (kg N/ha/yr)[a]	Avg. nitrogen deposition (kg N/ha/yr)[b]	Max. NO_x concentration ($\mu g/m^3$)
Slindon Wood Ancient Woodland	495100	107168	Broadleaved, Mixed and Yew Woodland	10	22.12	15.9
Unnamed Ancient Woodland at Slindon Common	496367	107252	Broadleaved, Mixed and Yew Woodland	10	22.12	13.3
Potwell Copse Ancient Woodland	496466	106814	Broadleaved, Mixed and Yew Woodland	10	22.12	14.5
Unnamed Ancient Woodland by Slindon Church of England (C of E) Primary School	496754	107893	Broadleaved, Mixed and Yew Woodland	10	22.12	13.3
Unnamed Ancient Woodland East of Yapton Lane	497470	106771	Broadleaved, Mixed and Yew Woodland	10	22.12	14.3
Great Deans Ancient Woodland	497542	106906	Broadleaved, Mixed and Yew Woodland	10	22.12	14.3
Dane's Wood Ancient Woodland	497486	106849	Broadleaved, Mixed and Yew Woodland	10	22.12	14.3
Goblestubbs Copse Ancient Woodland	498600	107339	Broadleaved, Mixed and Yew Woodland	10	22.12	13.1
Paine's Wood Ancient Woodland	499306	107393	Broadleaved, Mixed and Yew Woodland	10	22.12	12.8

Site Name	X	Y	Relevant nitrogen critical load class	Critical load (kg N/ha/yr)[a]	Avg. nitrogen deposition (kg N/ha/yr)[b]	Max. NO_x concentration ($\mu g/m^3$)
The Waterwoods Ancient Woodland	500872	107090	Broadleaved, Mixed and Yew Woodland	10	23.24	13.0
Rocks Copse Ancient Woodland	501280	106894	Broadleaved, Mixed and Yew Woodland	10	23.24	13.7
Arundel Park Ancient Woodland	501457	107491	Broadleaved, Mixed and Yew Woodland	10	23.24	13.0
Mill & Castle Hanger Ancient Woodland	501959	107271	Broadleaved, Mixed and Yew Woodland	10	23.24	13.0
Batworthpark Plantation Ancient Woodland	502745	106287	Broadleaved, Mixed and Yew Woodland	10	23.24	13.9
Stubbs Copse Ancient Woodland	503546	105754	Broadleaved, Mixed and Yew Woodland	10	23.24	14.2
Stubbs Copse Ancient Woodland	503572	105774	Broadleaved, Mixed and Yew Woodland	10	23.24	14.2
Westlands Copse Ancient Woodland	503781	105752	Broadleaved, Mixed and Yew Woodland	10	23.24	14.2
Poling Copse Ancient Woodland/LWS	504571	105881	Broadleaved, Mixed and Yew Woodland	10	23.24	14.2
Charlow Furze Field Ancient Woodland	505825	105706	Broadleaved, Mixed and Yew Woodland	10	20.02	14.1
Grooms Copse Ancient Woodland	507964	105114	Broadleaved, Mixed and Yew Woodland	10	20.02	14.6
Potlands Copse Ancient Woodland	509232	105483	Broadleaved, Mixed and Yew Woodland	10	20.02	15.3

Site Name	X	Y	Relevant nitrogen critical load class	Critical load (kg N/ha/yr)[a]	Avg. nitrogen deposition (kg N/ha/yr)[b]	Max. NO_x concentration ($\mu g/m^3$)
Clapham Common Ancient Woodland	509967	105772	Broadleaved, Mixed and Yew Woodland	10	20.02	15.3
Goring Wood Ancient Woodland	509931	105692	Broadleaved, Mixed and Yew Woodland	10	20.02	15.3
Clapham Wood Ancient Woodland	509274	106088	Broadleaved, Mixed and Yew Woodland	10	20.02	12.7
Church Copse Ancient Woodland	509377	106558	Broadleaved, Mixed and Yew Woodland	10	20.02	12.7
Unnamed Ancient Woodland south of Long Furlong	510078	107323	Broadleaved, Mixed and Yew Woodland	10	23.66	11.9
Unnamed Ancient Woodland south of Long Furlong	520392	107917	Broadleaved, Mixed and Yew Woodland	10	23.66	14.2
Lancing Ring LNR	518879	105816	Calcerous Grassland	15	14	19.2
Adur Estuary SSSI	520753	106454	Saltmarsh	20	14.4	20.2
Adur Estuary SSSI	520695	106411	Saltmarsh	20	14.4	20.2
Binsted Wood Complex LWS	497654	106537	Broadleaved, Mixed and Yew Woodland	10	22.12	14.3
Dane's Wood, Shillbridge Wood Ancient Woodland	497271	107529	Broadleaved, Mixed and Yew Woodland	10	22.12	14.3
Widewater Lagoon LNR	519507	104053	Saltmarsh and Coastal Vegetated Shingle	8	11.2	14.2

Site Name	X	Y	Relevant nitrogen critical load class	Critical load (kg N/ha/yr)[a]	Avg. nitrogen deposition (kg N/ha/yr)[b]	Max. NO_x concentration ($\mu g/m^3$)
The White House Coppice Ancient Woodland	510242	104718	Broadleaved, Mixed and Yew Woodland	10	20.58	13.2
Unnamed Ancient Woodland East of Titnore Lane	509901	105247	Broadleaved, Mixed and Yew Woodland	10	20.02	15.3
Unnamed Ancient Woodland West of Titnore Lane	509850	105205	Broadleaved, Mixed and Yew Woodland	10	20.02	15.3
Veteran Tree 1	495119	107341	Broadleaved, Mixed and Yew Woodland	10	22.12	15.9
Veteran Tree 2	495139	107351	Broadleaved, Mixed and Yew Woodland	10	22.12	15.9
Veteran Tree 3	497472	107179	Broadleaved, Mixed and Yew Woodland	10	22.12	12.8
Veteran Tree 4	499232	105538	Broadleaved, Mixed and Yew Woodland	10	22.12	11.3
Veteran Tree 5	498088	105871	Broadleaved, Mixed and Yew Woodland	10	22.12	11.5
Veteran Tree 6	497648	106301	Broadleaved, Mixed and Yew Woodland	10	22.12	14.3
Veteran Tree 7	498237	106006	Broadleaved, Mixed and Yew Woodland	10	22.12	11.8

Site Name	X	Y	Relevant nitrogen critical load class	Critical load (kg N/ha/yr)[a]	Avg. nitrogen deposition (kg N/ha/yr)[b]	Max. NO_x concentration ($\mu g/m^3$)
Veteran Tree 8	500138	105691	Broadleaved, Mixed and Yew Woodland	10	23.24	11.5
Veteran Tree 9	501778	107291	Broadleaved, Mixed and Yew Woodland	10	23.24	13.0
Veteran Tree 10	509398	105701	Broadleaved, Mixed and Yew Woodland	10	20.02	15.3
Veteran Tree 11	518738	105721	Broadleaved, Mixed and Yew Woodland	10	23.52	19.2
Veteran Tree 12	514078	104901	Broadleaved, Mixed and Yew Woodland	10	20.58	19.1
Veteran Tree 13	495029	105361	Broadleaved, Mixed and Yew Woodland	10	22.12	12.4

Relevant nitrogen critical load class, critical load, max. nitrogen deposition rate and max. NO_x concentration data taken from Air Pollution Information System website (Ref 5-15).

[a] Taken from 'Indicative values within nutrient nitrogen critical load ranges for use in air pollution impact assessments'

[b] These data are the most recent available from the APIS website and are a 3-year mean for the period 2017-19.

5.6 Potential impacts

5.6.1 Prior to implementation of the mitigation, the Scheme has the potential to significantly affect local air quality (positively or negatively), both during construction and once in operation, in the following ways:

a. There could be increased emissions of dust during construction of the Scheme from dust-raising activities on site (e.g., earthworks, drainage works, stockpiles/storage, movement of vehicles, etc).

b. There could be emissions to air associated with Non-Road Mobile Machinery (NRMM) undertaking construction works.

c. 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.

d. Once operational, air quality changes may result due to changes in vehicle activity (flows, speeds and composition) as a result of the Scheme.

e. Changes in the distances between sources of emissions and air quality sensitive receptors due to the Scheme could affect local air quality.

5.6.2 There could be significant adverse air quality effects during the construction of the Scheme in relation to construction dust and NRMM and vehicle emissions. However, any impacts on human health related to air quality would be temporary (i.e. restricted to the period of the construction works only) and could be suitably minimised by the application of industry standard mitigation measures (refer to *Section 5.7*). Designated ecological sites are also potential sensitive receptors. However, due to the construction mitigation measures that would be utilised, significant effects are not expected. However, these potential effects will be considered further within the assessment to be presented in the ES.

5.7 Design, mitigation and enhancement measures

Construction

5.7.1 During the construction of the Scheme, changes in air quality might occur due to dust emissions from construction activity, emissions from site plant equipment and HGVs and also from changes in traffic flows along the Scheme and wider road network with traffic management in place.

5.7.2 A first iteration EMP will be prepared which will include a range of industry standard practice construction phase dust mitigation measures (see examples in paragraph 5.7.3 below) required during all works where adverse effects on sensitive receptors might occur.

5.7.3 The above construction activities will be mitigated using standard mitigation measures such as those within Institute of Air Quality Management (IAQM)

guidance on the assessment of dust from demolition and construction (Ref 5-30), for example:

a. Develop and implement a series of dust management measures and monitoring measures (e.g., visual inspections).

b. Fully enclose site or specific operations where there is a high risk of dust production and the site is active for an extensive period.

c. All construction plant to use fuel equivalent to Ultra-Low Sulphur Diesel (ULSD) where possible.

d. Vehicles entering and leaving sites to be covered to prevent escape of materials during transport.

e. Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site), where reasonably practicable.

5.7.4 Where standard mitigation measures may not be sufficient to minimise emissions of dust alone, additional mitigation measures will be proposed as required (e.g., re-vegetate earthworks and exposed areas/soil stockpiles to stabilise surfaces as soon as practicable, use Hessian, mulches or trackifiers where it is not possible to re-vegetate or cover with topsoil, increase frequency of monitoring to ensure that impacts are captured and mitigated effectively). Such measures will be confirmed in the EMP.

5.7.5 It is currently unknown whether a concrete batching plant would be required during construction. Should the need for such a facility be identified, the location of the batching plant would be determined in consultation with stakeholders and provided for within the DCO application.

Operation

5.7.6 The Scheme design inherently minimises operational phase air quality impacts by:

a. Diverting vehicles onto the Scheme route, instead of the existing A27 through Arundel and other east-west routes such as through Storrington.

b. Reducing congestion and its consequential air quality effects.

c. Reducing the speed limit at the Western tie-in end of the Scheme from 70 mph to 50 mph, which in turn reduces emissions rates due to slower moving traffic.

5.8 Assessment of effects

5.8.1 The Scheme's air quality effects have been assessed following consideration of the potential impacts outlined in *Section 5.6* and the mitigation measures detailed in *Section 5.7*.

Ref 5-30 Institute for Air Quality Management (IAQM) (2016) Assessment of dust from demolition and construction. Version 1.1. construction-dust-2014.pdf (iaqm.co.uk)

Construction phase dust assessment

5.8.2 There is a risk of temporary adverse impacts from dust emissions to occur at sensitive receptors located close to the Scheme during the construction works. The locations with the greatest numbers of receptors within 200 m of the proposed construction works are:

a. Properties around the Causeway Roundabout and Chichester Road

b. North-east Fontwell

c. Binsted Lane

d. Yapton Lane and Avisford Grange

e. Broad Green Cottages

f. Crossbush, and the intersection of Poling Street and the A27.

5.8.3 In these locations, site-specific mitigation measures, in addition to standard mitigation measures, may be required to avoid significant temporary effects on air quality (e.g., monitoring and stakeholder engagement plan). These measures will be set out as needed within the EMP for the Scheme.

5.8.4 Adoption of such measures will minimise the risk of significant adverse dust effects and statutory nuisance issues during Scheme construction.

Construction phase HGV assessment

5.8.5 The criterion for an affected route in relation to construction HGV traffic is a change of more than 200 HGVs per day. Where HGV movements are below this threshold, significant changes in air quality are not considered likely. However, where HGV movements are above 200 per day, there is a potential for air quality impacts to occur and so further assessment is required. Detailed information on likely HGV movements is not currently available and so it has not been possible to consider these impacts through detailed modelling as part of this PEI Report. However, due to the nature of the Scheme, large amounts of materials would be required which would need to be transported to/from site. Therefore, there is a risk that the transportation of construction materials and/or waste materials causes a deterioration in air quality along defined transport routes. A particular concern relates to material transportation to and from site along routes within AQMAs or other locations with sensitive receptors close to these routes.

5.8.6 A haul road is expected to be constructed along the entire Scheme length, to the north of the mainline. The majority of construction traffic would enter at either end of the Scheme to minimise the use of country roads.

5.8.7 Further work will be undertaken to characterise air quality impacts from material transportation within the EIA if construction phase estimated HGV numbers are above the DMRB criteria for an extended period (i.e., more than 24 months). The further work will be undertaken at the ES stage, to consider whether there are any impacts on air quality from HGV

movements that are not captured within this PEI Report as information on HGV movements becomes available.

5.8.8 Until further assessment can be undertaken for the construction phase HGV traffic, there remains a risk that there could be changes in air quality that could worsen air quality and therefore a potential likely significant effect cannot be ruled out at this stage. This will be confirmed in the ES.

Construction phase traffic management assessment

5.8.9 The Scheme would require works to the existing road network, e.g., Crossbush Junction Roundabout, the A27 around Slindon Common, Tye Lane and the A27 alignment next to Copse Lane. Traffic management would be in place to minimise traffic re-routing throughout the Scheme construction phase. However, it is not currently known to what extent traffic re-routing may take place during this period, and the potential knock-on air quality implications. As such, further air quality work will be required and reported in the ES taking account of traffic re-routing patterns, to consider whether there are any impacts on air quality from construction phase traffic management that are not captured within this PEI Report.

5.8.10 Until further assessment can be undertaken for the construction phase traffic management, there remains a risk that there could be changes in air quality that could worsen air quality requiring an evaluation of whether predicted effects are potentially significant.

Local operational air quality assessment

5.8.11 The anticipated concentrations and changes in annual mean NO_2 and PM_{10} during the Scheme operational phase, along with the number of days' exceedance of the 24-hour PM_{10} objective are discussed in this section.

5.8.12 All the locations that have been modelled within the study area are predicted to meet relevant AQS objectives for all the above pollutants. The highest predicted annual mean NO_2 concentration was less than 32µg/m^3. This is partly because air quality is already good in the immediate area around the Scheme and because further improvements in air quality are expected in the Scheme's opening year due to improvements in background concentrations and reductions in emissions from vehicles as cleaner vehicles enter the fleet.

5.8.13 As predicted concentrations are well below the NO_2 annual mean objective value, even with an additional 15% traffic flow added to the A27 corridor to account for traffic data uncertainties (see paragraph 5.3.3), predicted NO_2 concentrations would likely remain below the objective value for NO_2 and therefore not be significant. The modelling being completed for the ES Chapter using updated traffic data will address the uncertainty in traffic flow along the A27 corridor.

5.8.14 The Scheme bypasses Arundel which would result in notable reductions in traffic along the bypassed section of the A284 and roads connecting to the Ford Road Roundabout. This is expected to result in an improvement in air quality for those sensitive receptors in the Arundel area.

5.8.15 The Storrington area is expected to experience an improvement in air quality as a result of a reduction in traffic on the A283 to the north of the Scheme.

5.8.16 At the realigned Crossbush Junction/Interchange there is a small number of residential properties to the north-east. These sensitive receptors are not expected to experience a significant adverse air quality effect from increased traffic at the junction, as predicted concentrations remain below the relevant objective values for NO_2 and PM_{10}.

5.8.17 Residential properties within 200 m of the western tie-in of the Scheme between Avisford and Fontwell are also not expected to experience a significant adverse air quality effect from the increase in traffic flows, as concentrations remain below the relevant objective values for NO_2 and PM_{10}.

5.8.18 Sensitive receptors within the Worthing Grove Lodge/Lyons Farm AQMA are not predicted to be significantly adversely affected by the Scheme, despite an increase in traffic in this area, as concentrations remain below the relevant objective values for NO_2 and PM_{10}.

5.8.19 Sensitive receptors between Fontwell and Crossbush that are within 200 m of the A27 Scheme route are not expected to experience a significant adverse air quality effect due to increases in traffic as a result of the Scheme, as concentrations remain below the relevant objective values for NO_2 and PM_{10}.

5.8.20 Routes expected to experience an increase in traffic flows which may cause an increase in pollutant concentrations, albeit not to concentrations above the annual mean air quality objectives for NO_2 and PM_{10} of 40 µg/m^3, include:

a. A27, from Lancing to Crossbush
b. A27, west of Avisford to Chichester
c. A27 through the Worthing Grove Lodge/Lyons Farm AQMA, and the A2031 and A2032 in Worthing
d. West Hampnett Road in Chichester, and Chichester Bypass
e. A284, from Crossbush to Lyminster
f. Lyminster Bypass/Fitzalan Link
g. Long Furlong, north of the A27/A280 junction

5.8.21 Traffic flows are expected to reduce, and therefore air quality improvements are expected, along the following routes:

a. Arundel Relief Road and Chichester Road
b. Shellbridge Road/B2132, north of Slindon Common
c. A259 from Chichester to Worthing
d. A29/B2139/A283 around Storrington, north of the A27

e. B2159 and B2166, south-east of Chichester to Longford Road in Bognor Regis

Ecosystems assessment

5.8.22 Traffic flows along roads close to the following designated ecosystem sites are expected to reduce and therefore reductions in NOx and nitrogen deposition are expected:

a. Great Deans Ancient Woodland
b. Dane's Wood Ancient Woodland
c. Goblestubbs Copse Ancient Woodland
d. Paine's Wood Ancient Woodland
e. The Waterwoods Ancient Woodland
f. Rocks Copse Ancient Woodland
g. Mill & Castle Ancient Woodland
h. Batworthpark Plantation Ancient Woodland
i. Dane's Wood, Shillbridge Wood Ancient Woodland

5.8.23 Traffic flows along roads close to the following designated ecosystem sites are expected to increase and therefore increases in NOx and nitrogen deposition are expected:

a. Adur Estuary SSSI
b. Binsted Wood Complex LWS
c. Slindon Wood Ancient Woodland
d. Potwell Copse Ancient Woodland
e. Stubbs Copse Ancient Woodland
f. Westlands Copse Ancient Woodland
g. Poling Copse Ancient Woodland/LWS
h. Charlow Furze Field Ancient Woodland
i. Grooms Copse Ancient Woodland
j. Potlands Copse Ancient Woodland
k. Clapham Common Ancient Woodland
l. Goring Wood Ancient Woodland
m. Clapham Wood Ancient Woodland
n. Widewater Lagoon LNR
o. The White House Coppice Ancient Woodland
p. Unnamed Ancient Woodland East of Titnore Lane
q. Unnamed Ancient Woodland West of Titnore Lane

5.8.24 Those designated ecosystems with increases in concentrations of NO_X and rates of nitrogen deposition will be subject to further air quality assessment and biodiversity assessment, as required, and reported in the ES. Current predictions of air quality effects indicate that the change in deposition with and without the Scheme are greater than 1% of the lower critical load at the following sites:

a. Adur Estuary SSSI
b. Unnamed Ancient Woodland east of Yapton Lane
c. Slindon Wood Ancient Woodland
d. Goblestubbs Copse Ancient Woodland
e. The Waterwoods Ancient Woodland
f. Rocks Copse Ancient Woodland
g. Stubbs Copse Ancient Woodland
h. Poling Copse Ancient Woodland/LWS
i. Unnamed Ancient Woodland south of Long Furlong
j. Batworth Park Plantation Ancient Woodland

5.8.25 In line with *DMRB LA 105*, a biodiversity expert has reviewed the NO_X and rates of nitrogen deposition predictions to determine the significance of effects on ecological sites. At the majority of sites this review has determined that whilst the increase in nitrogen deposition due to the Scheme would exceed 1% of the critical load at the roadside, at no point does it exceed the DMRB threshold for significance of 0.4 kgN/ha/yr. Therefore, although the largest change is not so small as to be imperceptible, in accordance with *DMRB LA 105* a conclusion of no significant effect has been made.

5.8.26 However, at Veteran Tree 6, the review has determined that the predicted nitrogen deposition due to the Scheme would exceed 1% of the critical load and also exceed the DMRB threshold for significance of 0.4 kgN/ha/yr. Further details can be found in *Chapter 8: Biodiversity*.

5.8.27 Following the completion of the air quality assessment work described in this chapter, an approach to consider ammonia has recently been developed by National Highways. This method will be implemented for the Scheme as part of the preparation of the ES. This may increase the potential for significant adverse effects at biodiversity sites.

Operational impacts – local air quality compliance risk assessment

5.8.28 The results of the local air quality operational assessment have been used to determine compliance risks with the EU Air Quality Directive, as this has been given effect within UK domestic legislation, amongst others including the Air Quality Standards Regulations 2010 and the Air Quality

(Amendment of Domestic Regulations) (EU Exit) Regulations 2019, during Scheme operation.

5.8.29 A comparison between the outcome of the local air quality operational assessment and those road links reported as being non-compliant with the limit value for NO_2 by Defra has found that there are no areas anticipated to be non-compliant with the limit value within the air quality study area for the Scheme in the opening year of 2027 whether or not the Scheme goes ahead.

5.8.30 This indicates that there is no risk of non-compliance with the EU Air Quality Directive for the Scheme and thus an Air Quality Action Plan (AQAP) is not expected to be required. The compliance risk assessment will be updated and reported in the ES.

Summary of preliminary air quality assessment

5.8.31 All the locations that have been considered in relation to human health within the PEI Report air quality study area are predicted to meet relevant air quality objectives for all relevant pollutants, and changes in air quality as a result of the Scheme are not expected to change this situation. Therefore, on the basis of the criteria presented in DMRB, with mitigation the Scheme is not likely to result in any significant adverse effects due to changes in air quality.

5.8.32 Preliminary construction assessment:

a. With the implementation of the applicable mitigation measures, no likely significant air quality effects are anticipated. The potential for air quality impacts from construction phase traffic will be confirmed within the ES Chapter. However, until further assessment can be undertaken for the construction phase traffic management and construction HGVs, there remains a risk that there could be changes in air quality that could worsen air quality requiring an evaluation of whether predicted effects are potentially significant.

5.8.33 Preliminary operational assessment:

a. No likely significant air quality effects are anticipated. The potential for air quality impacts during operation will be confirmed within the ES Chapter.

b. Air quality is likely to be improved through Arundel and Storrington once the Scheme is in use.

c. Air quality is likely to be adversely affected along the A27 through Worthing, and alongside the new bypass corridor.

d. At the vast majority of sites, air quality effects on biodiversity are not anticipated to be significant, although further details relating to one Veteran Tree 6 are presented within *Chapter 8: Biodiversity*.

5.8.34 In summary, based on the preliminary assessment outlined above, whilst it is considered unlikely at this stage that potentially significant effects on air

quality could occur, there is potential for significant effects to result from the construction of the Scheme subject to further assessment. A summary of this potentially significant effect is reported below in Table 5-6.

5.9 Scheme options

5.9.1 As described in *Chapter 2: The Scheme*, options are still being considered for the potential reprovision of Avisford Park Golf Club. In addition, a potential alternative option from the current proposed alignment where the Scheme passes between Avisford Park, the new housing development at Avisford Grange and the existing Yapton Lane is being considered. This would raise the vertical alignment of the Scheme, with an offline Yapton Lane overbridge. The sections below discuss these in turn and outline whether adopting either of these would change anything stated in the preceding baseline conditions, potential impacts and assessment of effects and consider the potential for different effects of the options.

Options for Avisford Park Golf Club reprovision

Option 1: 9 hole golf course with driving range or practice facilities

5.9.2 The reprovision of an amended golf course is unlikely to result in any changes to the assessment as presented above, or change the preliminary conclusions in terms of the potential for likely significant air quality effects as it would not impact the alignment or receptors considered for the air quality assessment. Therefore, concentrations predicted at all receptors are anticipated to remain below the objective value for NO_2.

Option 2: Replacement 18 hole golf course

5.9.3 Full reprovision of the existing golf course would not result in any changes to the assessment as presented above, or change the preliminary conclusions in terms of the potential for likely significant air quality effects, as it would not impact the alignment or receptors considered for the air quality assessment. Concentrations predicted at all receptors are anticipated to remain below the objective value for NO_2. Therefore, Option 2 is not considered to be different from Option 1 with regard to the potential for air quality impacts.

Option for raised vertical alignment with offline Yapton Lane overbridge

5.9.4 This option is considered to be a minimal change against the current proposed alignment in respect of air quality and would not result in any changes to the preliminary assessment presented above. The preliminary conclusions in terms of the potential for likely significant air quality effects therefore remains the same for this option and the current proposed alignment, as modelling completed as part of a sensitivity test scenario predicts that concentrations would remain below the objective values for NO_2 and PM_{10} at the receptors within 200 m of the re-alignment of Yapton Lane.

Table 5-6 Summary of potential significant effects

Receptor	Scheme impact	Potential significant effects (following embedded mitigation)	Further mitigation to be explored
Residential properties and designated ecosystems	Reallocation and management of traffic required for construction activity. Use of the local road network by HGVs.	Temporary adverse effect on residential properties (NO_2) and designated ecosystems (nitrogen deposition)	Once further information is available, the risk of likely significant air quality effects can be evaluated and appropriate mitigation relating to traffic management or HGVs can be developed if required.

6. Cultural Heritage

6.1 Introduction

6.1.1 This chapter addresses the likely significant effects of the construction and operation of the Scheme on cultural heritage, following the methodology set out in *DMRB LA 104* (Ref 4-1) and *LA 106 Cultural heritage assessment* (Ref 6-1).

6.1.2 Cultural heritage includes historic monuments, historic groups of buildings and/or historic sites, including archaeological remains, built heritage and the historic landscape. This chapter considers the historic evolution of the landscape and the potential Scheme effects on the significance and settings of heritage assets. The likely change to the present-day landscape and views and effects to the landscape character areas is addressed within *Chapter 7: Landscape and Visual*. The latter includes changes to the landscape character, views and effects from the SDNP.

6.1.3 There may be interrelationships between the potential effects on cultural heritage and other disciplines. Therefore, also refer to the following chapters:

a. Chapter 7: Landscape and Visual

b. Chapter 9: Geology and Soils

c. Chapter 11: Noise and Vibration

d. Chapter 13: Road Drainage and Water Environment

6.1.4 The likely change to the present-day landscape and views and effects to the landscape character areas is addressed within *Chapter 7: Landscape and Visual*. The latter includes changes to the landscape character, views and effects from the SDNP.

6.1.5 The historic baseline for the Scheme will be submitted with the ES. It will include consideration of designated and non-designated heritage assets and provide a statement on their significance. The baseline will be informed by the results of archaeological fieldwork which is ongoing and full results will be presented in the ES. This chapter is based on this emerging baseline and outlines the likely mitigations that may be required. The significance of designated assets is considered within the PEI Report, but that of the non-designated assets will be fully assessed within the ES once the results of the cultural heritage surveys have been completed. A summary of the baseline is reported below, and relevant heritage assets are shown in Figures 6-1 to 6-3.

6.1.6 As discussed in *Chapter 1: Introduction*, the primary basis for deciding whether or not to grant a Development Consent Order (DCO) is the *NPSNN* (Ref 1-7) which, at sections 4 and 5, sets out policies to guide how

Ref 6-1 Design Manual for Roads and Bridges: LA 106 Cultural heritage assessment (Revision 1). Highways England (2020).

DCO applications will be decided and how the impacts of national networks infrastructure should be considered. Table 6-1 identifies the *NPSNN* policies relevant to the cultural heritage assessment.

Table 6-1 NPSNN policies relevant to cultural heritage

Relevant NPSNN paragraph reference	Requirement of the National Policy Statement for National Networks (NPSNN) (Paraphrased)
5.124	Non-designated assets of archaeological interest that are demonstrably of equivalent significance to scheduled monuments should be considered subject to the policies for designated heritage assets.
5.125	The Secretary of State should also consider the impacts on other non-designated heritage assets.
5.126-5.127	An assessment of any likely significant heritage impacts of the proposed project as part of the EIA. The applicant should include an appropriate desk-based assessment and, where necessary, undertake a field evaluation.
5.131	When considering the impact of a proposed development on the significance of a designated heritage asset, the Secretary of State should give great weight to the asset's conservation. The more important the asset, the greater the weight should be.
5.133	Where the proposed development will lead to substantial harm to or total loss of significance of a designated heritage asset, the Secretary of State should refuse consent unless it can be demonstrated that the substantial harm or loss of significance is necessary in order to deliver substantial public benefits which outweigh that loss or harm.
5.134	Where the proposed development will lead to less than substantial harm to the significance of a designated heritage asset, this harm should be weighed against the public benefits of the proposal, including securing its optimum viable use.
5.135	Not all elements of a World Heritage Site or Conservation Area will necessarily contribute to its significance. The Secretary of State should treat the loss of a building (or other element) that makes a positive contribution to the site's significance either as substantial harm or less than

Relevant NPSNN paragraph reference	Requirement of the National Policy Statement for National Networks (NPSNN) (Paraphrased)
	substantial harm, as appropriate, taking into account the relative significance of the elements affected and their contribution to the significance of the Conservation Area or World Heritage Site as a whole.
5.137	Applicants should look for opportunities for new development within Conservation Areas and World Heritage Sites, and within the setting of heritage assets, to enhance or better reveal their significance.
5.140	Requirement to record and advance understanding of a heritage asset's significance prior to it being lost if this loss is justified.
5.142	Consider requirements to ensure that appropriate procedures are in place for the identification and treatment of yet undiscovered heritage assets with archaeological interest discovered during construction.
5.144-5.146	The applicant should undertake an assessment of any likely significant landscape and visual impacts in the EIA […] The applicant's assessment should include significant effects during construction of the project and/or its operation on landscape components and landscape character (including historic landscape characterisation).

6.1.7 Other relevant policies and guidance have been considered as part of the cultural heritage assessment where these have informed: the identification of assets and resources and their value; the assessment methodology; the potential for significant environmental effects; and required mitigation. Relevant policies and guidance are considered in the sections below:

National Planning Policy

a. *NPPF* (Ref 1-8), with particular reference to Section 16 Conserving and Enhancing the Historic Environment (MHCLG, 2021).

b. In accordance with the *NPPF*, the *NPSNN* policies relating to the applicant's assessment are the primary source of policy guidance regarding this assessment. The *NPPF* was revised in 2021, but the requirements which relate to this assessment have not substantively changed, and the *2014 NPSNN* remains the primary source of policy guidance.

National Guidance

a. *PPG* (Ref 1-9).

b. *Historic Environment Good Practice Advice in Planning Note 2 (GPA2). Managing Significance in Decision Taking in the Historic Environment. Historic England* (Historic England, 2015).

c. *Historic Environment Good Practice Advice in Planning Note 3 (GPA3). The Setting of Heritage Assets (2nd edition).* (Historic England, 2017).

Local Planning Policy

a. *The Arun Local Plan 2011 – 2031* (adopted 2018) (Ref 1-12) with particular reference to its strategic objective and polices related to heritage and conservation, HER SP1 (designated heritage assets), HER DM1 (listed buildings), HER DM6 (presumption in favour of the preservation of scheduled and other nationally important monuments and archaeological remains), Paragraph 16.4.12 (conservation areas) and Section 16.7 (archaeological remains).

b. *South Downs Local Plan 2014 – 33* (adopted 2019) (Ref 1-13), which sets out the polices that all planning applications should adhere to within the National Park, particularly Strategic Policy SD12.

c. *Walberton Neighbourhood Development Plan 2019 – 2031* (adopted 2021) (Ref 6-2) sets out local plan polices addressing Conservation Areas and Areas of Special Character (VE 4), Buildings and Structures of Special Character (VE5), Archaeology (VE11) and Distinctive Views and Vistas (VE11).

6.2 Stakeholder engagement

6.2.1 Stakeholders for the Scheme include statutory consultees, land managers, landowners, heritage interest groups and local communities. In addition to the statutory consultation process, there will be ongoing engagement with statutory consultees, such as ADC and WSCC, to steer the development of the Scheme in terms of heritage considerations.

6.2.2 *EIA Scoping Opinion* (Appendix 1-B) responses regarding cultural heritage have been received from the Planning Inspectorate, the relevant planning authorities of ADC, WSCC and SDNPA, the local civil authority of Walberton Parish Council, and Historic England as the Government's advisors on the historic environment. This PEI Report seeks to address some of these responses; whilst others will be addressed in full in the ES once the baseline data and the Scheme designs are fully developed.

6.2.3 Initial consultation has been undertaken with Historic England and the heritage and landscape officers at ADC, WSCC or their representatives and the SDNPA. The purpose of this has been to discuss and agree to a

Ref 6-2 Walberton Neighbourhood Development Plan 2019-2031. Walberton Parish Council (2021)

suitable approach to the assessment of the historic landscape and the setting of heritage assets.

6.2.4 Consultation has also been undertaken with Historic England and WSCC to agree a programme of geoarchaeological, geophysical and archaeological investigations.

6.2.5 The DCO submission will be accompanied by a specification setting out the agreed mitigation strategy for cultural heritage as well as Statements of Common Ground with relevant stakeholders, including WSCC, ADC, SDNPA, and Historic England.

6.2.6 Viewpoints to inform the potential impacts to cultural heritage assets have been discussed with the relevant stakeholders and agreed. Further viewpoints may be integrated into the ES as a result of statutory consultation.

6.3 Assessment assumptions and limitations

6.3.1 This preliminary assessment is based on baseline and Scheme design information available at the time of writing this PEI Report. A full assessment is being undertaken and will be reported in the ES.

6.3.2 For the purpose of this PEI Report, the study areas are defined as extending from the route of the Scheme, as per the *EIA Scoping Report* contained within Appendix 1-A. It is not expected that this will result in the identification of any additional effects beyond those identified in this PEI Report.

6.3.3 Archaeological surveys are currently being undertaken to inform the baseline and impact assessment, the results of which will be reported in the ES. These surveys comprise site walkovers, monitoring and logging of geotechnical investigations, geophysical surveys (detailed magnetometry and Electrical Resistivity Tomography (ERT)) and trial trenching, the location of which have been, or will be, agreed with WSCC and Historic England. The information gathered to date using available sources outlined in *Section 6.5* is considered sufficient to provide the basis for the preliminary assessment set out in this chapter.

6.4 Study area

6.4.1 *DMRB LA 106* (Ref 6-2) requires assessments to define a study area according to the sensitivity of the receiving environment and the potential impacts of the project. The study area for designated and non-designated cultural heritage assets as well as for the wider historic landscape used in this PEI Report extends to 1 km from the Scheme (Figures 6-1 and 6-2). This takes into consideration the surrounding landscape and the likelihood of impacts to the setting of the heritage assets located within. It is also considered sufficient to inform on the likelihood of encountering previously unknown archaeology within the Scheme limits.

6.4.2 A flexible approach has been taken to the identification of high-value assets (designated assets of Grade I and II* and Scheduled Monuments), beyond the 1 km study area, which may be impacted by the Scheme through changes to their setting, taking into consideration the increased significance of these assets and the increased potential for their setting to be influenced by change, over larger distances (Figure 6-3). This area has been informed by the Zone of Theoretical Visibility (ZTV) presented in *Chapter 7: Landscape and Visual*. This study area reflects the Scheme and the surrounding environment over which it is reasonably thought effects will occur.

6.4.3 The study area includes sections of the existing A27, which will be de-trunked as part of the Scheme.

6.5 Baseline conditions

Baseline data sources

6.5.1 The following sources of information have been reviewed to define the cultural heritage baseline:

a. The National Heritage List for England (NHLE).

b. The West Sussex Historic Environment Record (WSHER), including the Sussex Historic Landscape Characterisation (SHLC).

c. National Mapping Programme (NMP) and other aerial photographic sources.

d. Historic cartographic sources.

e. Relevant primary and secondary sources.

f. Published and unpublished reports from archaeological investigations.

g. Open Light Detection and Ranging (LiDAR) data obtained from the Environment Agency accessed through their online portal (Ref 6-3) as well as new topographic data obtained for the Scheme.

h. South East Research Framework Resource Assessment and Research Agendas (Ref 6-4).

6.5.2 These data sources are being augmented by an ongoing programme of non-intrusive and intrusive field investigations as detailed in paragraph 6.3.3, the results of which will be detailed in and incorporated into the ES.

Overview

6.5.3 There are a total of 20 scheduled monuments within 5 km of the Scheme, six of which are within 1 km of the Scheme. The nearest scheduled monument is the Tortington Augustinian Priory and Ponds (NHLE 1021459; A6), located approximately 150 m north of the Scheme. Arundel Castle

Ref 6-3 https://environment.data.gov.uk/DefraDataDownload/?Mode=survey
Ref 6-4 Kent County Council, 2019, South East Research Framework

(NHLE 1012500; A1), Goblestubbs Copse Earthworks (NHLE1005895; A2), Madehurst Woods Earthworks (NHLE 1003736; A3) and Maison Dieu (NHLE 1005865; A4), are all located north of the existing A27 and the Scheme. The Ringwork 400 m NNW of Batworthpark House (NHLE 1012177; A5) is located approximately 950 m north-east of the eastern extent of the Scheme.

6.5.4 There are 275 listed buildings within 1 km of the Scheme (Figure 6-1). The majority of these assets are located within the town of Arundel (202 listed buildings). Of the remaining 73 listed buildings outside Arundel, the majority are listed at Grade II and are located within the surrounding villages, settlements or as isolated buildings, such as farmhouses. There is one building listed at Grade I (Parish Church of St Mary, Walberton NHLE 1274629; BH12) and four buildings listed at Grade II* (Walberton House NHLE 1222531 BH93, Priory Farmhouse NHLE 1034405 BH7, Tortington Priory Barn to the north of Priory Farm NHLE 1221996 BH92 and the Church of St Mary's, Binsted NHLE 1274877 BH22).

6.5.5 Within Arundel itself, there are 11 highly graded listed buildings, including six at Grade II* and five at Grade I. Notable among these is the Grade I listed Arundel Castle, which is also a scheduled monument and set within a Grade II* Registered Park and Garden (RPG). The remaining listed buildings within Arundel are Grade II.

6.5.6 The Grade II* Arundel Castle RPG is the only RPG within 1 km of the Scheme and lies just north of the existing A27 within the town of Arundel.

6.5.7 There are five conservation areas located within the study area. These include conservation areas at Slindon and Lyminster and two in Walberton (Walberton Green and Walberton Village). There is also a conservation area in Arundel, encompassing the area to the south of the River Arun.

6.5.8 There is a large number of non-designated heritage assets within the study area. A minority of these heritage assets are non-designated historic buildings, but most are archaeological in character, including upstanding monuments and buried archaeological remains.

6.5.9 A summary of the cultural heritage baseline is presented below. The full baseline will be included as part of the ES.

Palaeolithic (c. 1,000,000 – 9,000 BC)

6.5.10 The Solent Basin West Sussex Coastal Plain has been recognised by archaeologists as an area rich in Palaeolithic remains. The River Arun has a number of raised beaches and fluvial sequences that are the primary sedimentary contexts for the region's Lower and Middle Palaeolithic archaeology. The River Arun has several terrace outcrops covering chalk bedrock and is covered by a brickearth landscape. In West Sussex, the only substantial area of Head gravel is located in the South Downs slip between Arundel and Emsworth; this deposit can be up to 5 m thick and seals raised beach and marine littoral deposits.

6.5.11 No Palaeolithic assets have been recorded within the Scheme footprint or study area, but the Scheme crosses the inferred location of the Adlingbourne Raised Beach and that of the Brighton-Norton Raised Beach and associated deposits. These have the potential to hold sealed Pleistocene deposits in primary deposition contexts, which could be of national geoarchaeological, palaeoenvironmental, and/or archaeological interest.

6.5.12 More widely, evidence of Palaeolithic activity has been recorded across the study area, with seven hand axes located at various locations, including Avisford Park immediately north of the Scheme, at Stubbs Copse approximately 455 m north of the Scheme, at Arundel approximately 425 m north of the Scheme, and at Slindon Pit approximately 935 m north of the Scheme. Although the exact provenance of these finds is unknown, they are concentrated in the vicinity of the assumed location of the Adlingbourne Raised Beach deposits. It is therefore possible that they may have been recovered from primary contexts.

Mesolithic (c. 9,000 – 4,000 BC)

6.5.13 Two important Mesolithic sites have been previously identified within the study area; these are located at Slindon Park approximately 875 m north of the existing A27, and at Avisford Park approximately 100 m north of the Scheme. However, no Mesolithic remains are recorded within the Scheme footprint itself.

Neolithic (c. 4,000 – 2,500 BC)

6.5.14 Evidence for early prehistoric activity is limited within the study area and consists of three Neolithic hand axes. One was found at Slindon approximately 1 m north of the Scheme, a second at Walberton Farm approximately 590 m south of the Scheme, and one at Crossbush approximately 855 m east of the Scheme. More recently a scatter of possible Neolithic material was recorded at Avisford Grange, approximately 50 m south of the Scheme.

Bronze Age (c. 2,500 – 700 BC)

6.5.15 The middle of the second millennium BC marked the start of permanent settlements across the Weald, with the characteristic roundhouse structure becoming the dominant type of dwelling for this period. The archaeological record highlights a move to domestication of animals and permanent settlement, with nucleated settlements beginning to be established (Ref 6-5).

6.5.16 An urned cremation burial of possible Bronze Age date has recently been uncovered at the Avisford Grange housing development approximately 50 m south of the Scheme. Further remains of Bronze Age date have been recorded, but the excavation report was not accessible at the time of

Ref 6-5 Champion, T. 2019. Middle Bronze Age to Iron Age. In South-East Research Framework. Kent County Council. Available online at:

writing. In addition, two barrows, a number of ditches and other earthworks of likely Bronze Age date have been recorded throughout the study area.

Iron Age (c. 700 BC – AD 43)

6.5.17 Occupation during the Iron Age continued in the form of nucleated settlements, however, during this period, hillforts became more prominent, with examples visible at Torberry, the Trundle, Cissbury and the Caburn (Ref 6-6). Although there is limited data for Iron Age settlement within West Sussex, there are known settlements at Wickhurst Green and Broadbridge Heath (Ref 6-7). There are, however, extensive earthworks in the vicinity of the Scheme which are likely to be of Iron Age date. These remain poorly understood, but highlight an extensive prehistoric landscape extending from the South Downs into the coastal plain.

6.5.18 Several Iron Age sites are recorded in close proximity to the Scheme. One of these consists of an enclosure, which crosses the existing A27 and may relate to the extensive scheduled prehistoric earthworks at Goblestubbs Copse. Other Iron Age remains in proximity to the Scheme include a settlement located approximately 210 m north of the Scheme, an enclosure identified at Binsted approximately 20 m south of the Scheme, a further enclosure identified approximately 320 m north of the existing A27, and two ditches and a cobbled trackway recorded at Avisford Grange approximately 50 m south of the Scheme. Further evidence of Iron Age occupation is likely to have been recorded in excavations at Avisford Grange for which no report is yet available. Similarly, a prehistoric to Roman rectilinear enclosure has been identified at Walberton approximately 300 m north of the Scheme. Lastly, the scheduled remains of Madehurst Woods comprise a large linear earthwork denoted by a bank and ditch extending approximately 1 km north of the existing A27.

6.5.19 Further evidence of Iron Age activity is recorded in the form of field systems of prehistoric or Roman date located at various locations north of the Scheme, as well as several Iron Age pottery findspots recovered at Slindon Common and Walberton. An undated prehistoric flint scatter and a flint arrowhead of likely Iron Age date were also recorded approximately 700 m south of the Scheme.

6.5.20 Undated evidence of possible Iron Age date within the study area includes a series of banks and ditches approximately 720 m north of the Scheme, 1 km north of the Scheme, 900 m north of the existing A27 and approximately 860 m north of the existing A27. Intercutting earthworks identified at Rewell Wood are probably prehistoric rectangular enclosures and span an area of approximately 2 km^2 to the north of the existing A27.

Ref 6-6 Champion, T. 2019. Middle Bronze Age to Iron Age. In South-East Research Framework. Kent County Council. Available online at:
Ref 6-7 Margetts, A 2018. Wealdbæra: excavations at Wickhurst Green, Broadbridge Heath and the landscape of the West Central Weald. Portslade

6.5.21 A large linear bank and ditch, referred to as the Binsted linear earthwork, start just south of the existing A27 and continues south, ending at Avisford Park Golf Club. It has previously been associated with the Madehurst Woods earthworks, although not securely linked. South of the existing A27, the ditch is visible on LiDAR and extends on a south-eastern alignment, passing through several fields. It survives well in the field and woodland immediately south of the existing A27, but despite earlier suggestions that it may extend past the Church of St Mary's, Binsted and into the Scheme footprint, it appears to gradually disappear from LiDAR data between Hundredhouse Copse and Binsted Lane. Several archaeological investigations have been carried out on the ditch, including a test pit within the upper fill of a ditch at Church Lane, which recovered Norman pottery, and a test trench across the presumed location of the ditch which failed to identify the presence of the earthworks.

Roman (AD 43 – 410)

6.5.22 Chichester is the most significant Roman settlement in the area and Arundel is located along the road that connected Chichester to Brighton (Ref 6-8). A section of this road crosses the Scheme north of the A27 where it meets Tye Lane.

6.5.23 Settlement patterns within West Sussex are uneven, with settlements located predominantly along the coastal plains. The largest settlement in the area was Chichester, which acted as a trading post for the southern area and was linked by an arterial network of roads to London, Bath and the north. Whilst settlements were sporadic within West Sussex, aerial photography has identified many Roman farmsteads across the region, with large farmsteads located at Pulborough, Southwick and Angmering.

6.5.24 Two large villa sites are located within the study area, including one at Arundel, approximately 300 m north of the existing A27, and a second at Walberton approximately 440 m south of the Scheme. Other settlements have been identified across the study area, with one at Goose Green, Slindon Common, Slindon, Arundel and at Walberton. A potential small settlement has been hypothesised at Crossbush, with several ditches, hearths and pottery suggesting the presence of such a settlement to the east of the Scheme. A banked enclosure of possible Roman date was also identified at Goblestubbs Copse.

6.5.25 A possible Romano-British Field system has been identified approximately 130 m north of the existing A27 and at Arundel Park.

6.5.26 Across the study area, several Roman findspots have been identified at Broomhurst Farm, Arundel, Walberton, Crossbush, Tortington, Newlands House, Tarrant Street, Fontwell and Danes Wood. A cist burial was recorded at Avisford.

Ref 6-8 I. Margery 1973. Roman Roads in Britain.

Early medieval (410 – 1066)

6.5.27 A number of early medieval assets have been identified within the study area, the most prominent of which form features of the scheduled Arundel Castle. Earthworks surrounding Arundel Castle have been identified as a potential Anglo-Saxon burh.

6.5.28 Equally significant are the scheduled remains of Ringwork 400 m NNW of Batworth Park, which have been interpreted as a short-lived ringwork of the very early Norman period, dating from the period immediately after the Norman Conquest and before the foundation of the nearby castle at Arundel in 1069/70.

6.5.29 Other early medieval assets in the study area include a pre-conquest grave slab taken from Arundel Castle embedded in the wall of a shop approximately 520 m south of the existing A27, and a pre-Conquest gable located in the vicarage gardens approximately 520 m south of the existing A27. Although their provenance is uncertain, they indicate an Anglo-Saxon presence beyond the immediate vicinity of Arundel and Batworth Park.

Medieval (1066 – 1540)

6.5.30 The Norman Conquest instigated sweeping societal changes with the new Norman conquerors occupying positions of power and consolidating their military hold over the local population by building castles and defensive structures. Settlement patterns across West Sussex during this period were dispersed, with small hamlets, villages and farmsteads interspersed by field systems, in part caused by a population decline in the 15th century that can be attributed to new opportunities for the population causing them to move away.

6.5.31 By 1086, the town of Arundel was under the dominion of the lords of the Rapes of Sussex, becoming economically prosperous until it stalled from the 14th century onwards. As part of the Anglo-Saxon burgh, the town contains defences originally built in the early medieval period; these were extended and maintained in the post Norman period. The earthworks at Little Park contained a mixture of early medieval and later medieval pottery suggesting it was in use over a wide time period. Medieval defences of the town were only built of earth.

6.5.32 Many of the small settlements surrounding Arundel were established and settled in the medieval period. Binsted expanded in the medieval period with the southern half of the parish called Hoelan, meaning ‘projecting ridge of land’. It likely became a centre for pottery making during the medieval period, with the surname Potte in the 15th century known to have been common here. Several pottery kilns have been previously identified where the junction of Binsted Lane meets the lane from Walberton.

6.5.33 The rural but well settled medieval landscape is well attested archaeologically by evidence of medieval activity recorded at Tortington, Batford, Walberton, Binsted, Goblestubbs Copse and Arundel.

6.5.34 Tortington appears to have been a particularly important settlement given its proximity to Arundel and its association with a number of ecclesiastical orders. The site of Blackfriars (formerly Maison Dieu or the Holy Trinity Hospital) which was founded in 1380 and located approximately 350 m north-east of the Scheme, and the remains Tortington Augustinian Priory located immediately north of the Scheme (both of which are scheduled), and the medieval hospital of St James located within Arundel itself, indicate strong ties to the town of Arundel and its rural hinterland.

6.5.35 Several medieval parks are recorded within the study area at Walberton, Batworth, Tortington and Arundel. A 'medieval parkscape' is recorded at Brookfield.

6.5.36 Other medieval features include earthworks at Tortington, lynchets, fishponds, ridge and furrow, a hollow way and a trackway. Isolated finds include pottery and masonry fragments.

Post-medieval (1540 – 1900)

6.5.37 During the post-medieval period in West Sussex, patterns of settlement and trade continued from the medieval period, particularly in the early post-medieval period. The largest change was the gradual move to increased urbanisation, with the old market towns in West Sussex such as Arundel and Chichester enlarging and becoming centres of local trade and industry. Arundel itself expanded in the post-medieval industrial expansion, with the population rising gradually throughout the 16th to 19th centuries. Expansion of the town started in the 17th century, and by the later part of the 18th century much of the central area of the town was built, reflecting contemporary prosperity.

6.5.38 Across Binsted, Tortington, Walberton and Slindon, the post-medieval period saw the agricultural landscape alter, with the open fields becoming increasingly enclosed by the 17th century and nearly fully enclosed by the 19th century. Much like the rest of West Sussex and the wider region of south east England, the area surrounding the Scheme is dominated by 18th century parliamentary enclosures. Very little evidence of the medieval field systems survives today.

6.5.39 A regional shift from agrarian and pastoral activities towards industries, and in particular brickmaking, is reflected throughout the study area. Evidence of such post-medieval industry survives primarily as kilns and brickworks, although there is extensive indirect evidence of the industry present in the form of place names and clay pits. Two lime and tile kilns are located at Slindon and a number of kilns have been recorded north of Binsted. The 1846 tithe map shows a brickyard in a field approximately 430 m south of the Scheme and a brickworks located approximately 30 m south of the Scheme. Records of two other lime kilns are found on OS mapping, adjacent to the Scheme. A kiln is shown at Chichester Road, approximately 120 m north of the existing A27, and at Crossbush. A brickworks was mentioned on a lease of 1732 north west of Arundel and a second brickworks is said to be located approximately 700 m west of the Scheme.

Two further brickworks are shown on the 1875 OS map adjacent to the Scheme.

6.5.40 Evidence of clay extraction and quarrying is found across the study area, with four quarry pits located at Slindon. Three gravel and clay extraction pits are located at Walberton. Numerous anomalies identified in the LiDAR data are likely to be quarries, borrow pits or extraction pits of post-medieval date.

6.5.41 Closer to Arundel, evidence of quarry and chalk pits has been previously recorded in at least a dozen locations north of the existing A27, concentrated between Arundel and Slindon.

6.5.42 Other former sites of industrial buildings that have been demolished, have been recorded close to Arundel including an oil cake mill, a malthouse, and the Swallow Brewery in Arundel.

6.5.43 The 1888 OS maps of Arundel, Walberton and Slindon show a mostly rural landscape with clusters of industrial activity. The town of Arundel is small and nucleated, but industrialisation is evidenced by the new railway line running along the eastern edge of the town and several factories and mills present to the south west of Arundel, just south of the existing A27.

6.5.44 Agricultural activities are attested by two windmills located at Walberton, a third windmill located at Arundel, and a fourth located at Lyminster.

6.5.45 Earthworks which include trackways, enclosures, field systems and other agricultural features dating to the post-medieval period have been noted across the study area through a mixture of archaeological investigation, LiDAR surveys and aerial photography.

6.5.46 A number of barns and farmsteads dating to the 18th and 19th centuries are recorded in historic maps throughout the study area. Many of these farmsteads remain both extant and in use today and form part of the post-medieval agricultural landscape that dominates the study area.

6.5.47 Other archaeological remains of interest include the foundations of Binsted Parish offices recorded during an archaeological excavation and located approximately 20 m south of the Scheme.

6.5.48 The Scheme also crosses the southern extent of Avisford Park, a large, landscaped parkland once associated with Avisford Hotel and now converted to a golf course.

6.5.49 A LiDAR survey was undertaken in 2021 across the Scheme; this survey indicated that there were several earthworks crossing through the Scheme as follows:

a. In the fields between Tortington Lane and the River Arun, several bank and ditches have been recorded crossing through the Scheme. These are likely field boundaries or potentially a former road to Tortington Priory.

b. Adjacent to the east of the River Arun is a series of evenly spaced, linear features on a north-west to south-east alignment. These have been identified as probable ridge and furrow.

c. A system of late 19th and early 20th century flood embankments have been identified along the eastern edge of the flood plain, and within the Scheme through LiDAR survey.

Modern (1900 – present)

6.5.50 The county of Sussex played a strategic part in the defence of Britain during World War II. Anti-invasion defences were built along the south coast, with inland anti-tank 'stop' lines. Its airfields were crucial to defence during the Battle of Britain. As such, much of the archaeological evidence from the 20th century still visible across the county relates to World War II.

6.5.51 Infantry posts are visible at five locations within the study area, all of which lie approximately 900 m north of the existing A27, to the north of the town of Arundel.

6.5.52 A World War II air raid shelter is located at the village of Tortington, approximately 850 m south of the Scheme.

6.6 Potential impacts

6.6.1 The construction and operation of the Scheme would result in a range of changes to the historic environment. These changes could produce potential impacts on individual heritage assets, or groups, including both designated and non-designated assets. These impacts may be positive, negative or a combination of both depending on the nature and scale of the change and the asset affected.

6.6.2 Construction impacts are those associated with the construction of the Scheme, including the presence of the infrastructure and embedded mitigation once constructed. Operational impacts are restricted to those resulting from the use and maintenance of the road once built.

6.6.3 Impacts are considered in terms of whether they are direct (as a direct consequence of the Scheme) or indirect (such as changes in the viability of assets as a result of severed access); temporary or permanent; and in terms of their duration (short-term, medium-term, long-term). Impacts on the settings of individual heritage assets and groups of assets would arise both due to the construction and/or operation of the Scheme.

Construction impacts

6.6.4 Construction of the Scheme may potentially impact heritage assets in a number of ways, for example:

a. Partial or total removal of heritage assets, including archaeological remains, within the proposed carriageway alignment and other areas of proposed intrusive ground and excavation works such as routing of

services and utilities, drainage ponds, landscaping, vegetation clearance, soil removal and other areas required for mitigation.

b. Partial or total removal of archaeological deposits in areas of construction compounds, vehicle parking, worksites, borrow pits, haul roads and other infrastructure associated with construction.

c. Demolition of existing structures, including structures or buildings with historic interest.

d. Partial or total removal of archaeological deposits in areas of piling. Deposit warping and desiccation associated with changes to the hydrological regime.

e. Compaction of archaeological deposits by temporary haul roads and construction traffic and equipment, construction compounds and associated facilities, soil and material storage areas.

f. Compaction of archaeological deposits beneath Scheme earthworks.

g. Temporary and permanent effects on the settings of heritage assets, including changes to the physical surroundings of a heritage asset; changes to the appreciation of the sense of place of an asset; changes which affect the viability of a heritage asset; visual intrusion; lighting and dark skies; noise and vibration; air quality; severance and access.

Operational impacts

6.6.5 Operation of the Scheme could result in physical impacts to an historic asset through vibration caused by moving traffic. In addition, operational impacts may affect the significance of heritage assets through their setting. This includes visual intrusion into their setting and/or increased noise which is appreciable within their setting. Setting impacts may commence during the construction of the Scheme and may continue during operation.

6.6.6 Operational impacts also include those associated with removal of traffic from the existing A27 as part of its de-trunking. These impacts would be permanent.

6.7 Design, mitigation and enhancement measures

6.7.1 Where practicable, measures to avoid or minimise direct impacts on heritage assets have been integrated within the Scheme design. Measures to conserve or enhance the setting of heritage assets have also been embedded in the design and set out below. Detailed design of structures and landscaping is ongoing; therefore, this document has taken a worst-case approach to assessment, with refinement to follow in the assessment which will be reported in the ES.

6.7.2 The crossing of the River Arun has been designed with due regard to the topography of the river valley and the importance of views from heritage assets, particularly within Arundel. A viaduct has been chosen over an embankment to enable views through the structure, to avoid severance

within the landscape and to minimise impact to the archaeological resource. The detailed design of the viaduct structure is being developed and will be assessed in full within the ES.

6.7.3 Where the Scheme runs close to the Grade II* listed Church of St Mary's (NHLE 1274877 BH22), Binsted, the Scheme alignment has been designed to a reduced vertical alignment to reduce visual intrusion. In addition, the proposed landscaping has been carefully designed to balance the desire to limit views of the Scheme with the need to preserve the open setting of the Church of St Mary's, Binsted.

6.7.4 The need to protect heritage assets and their settings has also been taken into account in the development of the draft Environmental Masterplan, including ecological and landscape mitigation proposals and the design of green bridges to maintain connectivity in the landscape. Opportunities to enhance the historic environment and introduce heritage-specific mitigation to limit impacts will be further developed during the design process, where appropriate and feasible.

6.7.5 Archaeological evaluations are being designed in consultation with WSCC and Historic England to confirm the presence and value of any archaeological remains within the Scheme alignment and where intrusive activities are planned. These investigations are being undertaken to inform the impact assessment and do not constitute mitigation for any potential impacts due to the Scheme in and of themselves.

6.7.6 However, where adverse impacts are suggested, the archaeological evaluations will inform a suitable mitigation strategy or a change in the design, comprising either retention of the archaeological remains by design, or a programme of archaeological investigation and recording proportionate to the level of impact and the value of the assets affected. Archaeological mitigation investigations might include archaeological excavations, recording, reporting, publication and dissemination to local communities, the wider general public and academics. The archaeological mitigation strategy will be designed and agreed with WSCC (for non-designated and designated assets) and Historic England (for designated assets).

6.7.7 Standard measures will be implemented within the first iteration EMP submitted as part of the DCO. The EMP will include a range of measures to avoid and mitigate potential impacts on heritage assets, including measures to be put in place to ensure the protection of heritage assets in close proximity to the construction works and defining a 'chance find protocol' to set out the process required to deal with unexpected archaeological remains uncovered during construction. The EMP will also include details of the defined archaeological mitigation strategy.

6.7.8 A Community Information (Archaeology) Action Plan (CIAAP) will be developed to disseminate accessible information on the processes and results of ongoing archaeological surveys, showcasing discoveries arising from the investigations. Audiences would include members of the public, families, schools and heritage stakeholders. The CIAAP will enable

engagement at both the evaluation and mitigation fieldwork stages. The programme would form part of the Scheme's wider communication strategy. A range of activities will be developed, selected based on advice from consultees and community groups. It is anticipated that activities would involve updates in any Scheme newsletter/website; guided site tours and site open days subject to health, safety and access considerations; pop-up exhibitions and artefact handling sessions; local and online public talks and lectures.

6.7.9 Embedded mitigation has also been proposed to limit impacts during operation of the Scheme. These focus on measures to reduce noise intrusion into the setting of heritage assets. Noise barriers have been included where appropriate, and where they are not likely to introduce a new visual impact. Where barriers are not appropriate very low noise surfacing has been incorporated into the design. This approach has been used specifically where the Scheme passes the Church of St Mary's, Binsted. Additional measures at this location include a speed reduction to 50 mph.

6.8 Assessment of likely significant effects

Construction impacts

6.8.1 Construction of the Scheme, including the main carriageway, viaduct, new junctions and road realignments, would result in physical impacts on a small number of known cultural heritage assets as well as on the historic landscape. Within this section, the Asset Number assigned to each heritage asset is outlined in brackets.

6.8.2 A number of non-designated assets may be entirely removed or truncated (partially removed) by the intrusive activities of the Scheme and associated construction activities such as topsoil storage, spoil deposition, compound locations or mitigation activities. The significance of effect will be guided by the extent of loss and the value of the asset, both of which are subject to further assessment and will be reported in the ES. Those known assets that may be significantly affected are reported below:

a. Removal of remains of Mesolithic site at Avisford Park (A20).

b. Truncation or removal of non-designated Iron Age earthworks (A32).

c. Truncation or removal of remains associated with the non-designated Roman Villa at Blacksmith's Corner, Walberton (A52).

d. Truncation of a non-designated section of the Chichester to Arundel Roman Road (A71).

e. Truncation or removal of non-designated medieval pits (A98) and kilns (A145).

f. Truncation or removal of non-designated remains associated with the remains of a possible medieval park at Tortington (A90).

g. Truncation of non-designated medieval ridge and furrow identified in aerial photographs and LiDAR data (A100, A249, A252).

h. Truncation or removal of non-designated remains of a medieval moated site (A93).

i. Truncation or removal of non-designated remains of possible house platforms indicative of the possible presence of a deserted medieval village (A99).

j. Truncation of non-designated remains post-medieval remains and industrial activities (A143).

k. Truncation of non-designated post-medieval field boundaries identified in aerial photographs and LiDAR data (A247).

l. Truncation of non-designated undated earthworks identified in aerial photographs and LiDAR data (A192, A193, A242, A243, A244, A245, A246).

m. Truncation of non-designated ditch and embankment that may relate to scheduled remains to the north (A217).

n. Truncation of probable flood defences and other drainage features within the Arun valley identified in aerial photographs and LiDAR data (A248, A250).

o. Truncation or removal of non-designated post-medieval house platforms (A251) and lynchets (A96, A134) identified in aerial photographs and LiDAR data.

6.8.3 There are unlikely to be impacts on known find spots, which consist of archaeological assets that were previously recorded and entirely removed from their find locations (A54, A103, A65).

6.8.4 There is also a potential for significant effects during construction of the Scheme on previously unrecorded paleoenvironmental and archaeological remains dating to all the prehistoric periods as well as to the Roman, medieval and post-medieval periods.

6.8.5 There are no plans to demolish Morley's Croft (Grade II listed building; NHLE 1222201 BH67) as part of the construction of the Scheme. Should construction unavoidably require this building to be demolished, it is likely that its loss would be considered a significant adverse environmental effect. Any change in construction requirements will be addressed within the ES.

6.8.6 The construction of the Scheme would introduce new infrastructure and changes to the setting of heritage assets leading to potential significant effects based on the values defined in *DMRB LA 104*, including:

a. Arundel Castle (scheduled monument; NHLE 1012500; A1), (Grade I listed building; NHLE 1027926; BH17) (Grade II* Registered Park and Garden (NHLE 1000170; very high value).

b. Tortington Priory (scheduled monument; NHLE 1021459; A6; high value)

c. Church of St Andrew, Ford (Grade I listed building; NHLE 1233989; BH9; high value).

d. Avisford Park Hotel (Grade II listed building; NHLE 1222534; BH41; high value).

e. Swiss Cottage (Grade II listed building; NHLE 1222535; BH78; high value).

f. Beam Ends (Grade II listed building; NHLE 1222465; BH32; high value)

g. The Glebe House, Binsted (Grade II listed building; NHLE 1221993; BH82; high value).

h. Church of St Mary's, Binsted (Grade II* listed building; NHLE 1274877; BH22; high value).

i. Meadow Lodge (Grade II listed building; NHLE 1274878; BH63; high value).

j. Morleys Croft (Grade II listed building; NHLE 1222201; BH67; high value).

k. The Thatched Cottage (Grade II listed building, NHLE 1274880; BH91; high value).

l. Tortington Priory Barn, to the north of Priory Farm (Grade II* listed building; NHLE 1221996; BH92; high value).

m. Windmill, Fitzalan Road (Grade II listed building NHLE 1353714; BH94; high value).

n. The Camillia Hotel (Grade II listed building; NHLE 1027602; BH79 high value).

6.8.7 It should be noted changes to the setting of some of these assets have the potential to cause significant adverse effects to their significance due to the proximity of the Scheme in conjunction with the sensitivity of the setting. This includes the Church of St Mary's, Binsted due to its highly designated status as a Grade II* listed building and Morley's Croft, which lies within the draft Order Limits. The Scheme has been designed to minimise these impacts as far as practicable and is subject to further refinement.

6.8.8 Construction activities have the potential to have a temporary adverse effect on the settings of heritage assets along the route as a result of potential noise, dust, vibration and visual intrusion. Design measures to limit these potential impacts will be further explored and incorporated in the Scheme design, alongside those which will be included in the first iteration EMP, which will be submitted as part of the DCO.

6.8.9 The establishment of construction compounds would have a temporary adverse effect on the setting of some heritage assets for the duration of the

works. Construction compound locations would be situated to reduce impacts on the settings of heritage assets where practicable.

6.8.10 The Scheme and related construction activities would have the potential to cause permanent adverse effects on the significance of the historic landscape. The following landscapes have been identified as being sensitive to change and are likely to be impacted by the Scheme; however, at this stage it is unknown whether these would be significant:

a. Severance of the Avisford Park historic landscape and remaining Avisford Park (A137).

b. Severance of the medieval to post-medieval dispersed historic landscape of the Binsted.

c. Severance of the Tortington medieval landscape.

d. Degradation of the Arundel medieval landscape.

6.8.11 It is not anticipated that construction activities planned as part of the de-trunking of the existing A27 would result in changes to the setting of heritage assets during this phase of the works, which could result in significant effects.

Operational impacts

6.8.12 The Scheme would bring benefits to a number of heritage assets as a result of the de-trunking of the existing A27 between Yapton Lane and Lyminster Road. The existing A27 runs to the south of Arundel in close proximity to the heritage assets within the settlement, including Arundel Castle (Scheduled Monument NHLE 1012500 A1; Grade I listed building NHLE 1027926 BH17; Grade II* RPG NHLE 1000170); alongside one Scheduled Monument; four Grade I listed buildings; four Grade II* listed buildings and 182 Grade II listed buildings.

6.8.13 The existing A27 continues to run west, past a group of listed buildings at Park Farm (NHLE 1353713 (BH205), 1027936 (BH204) and 1247969 (BH206)) and through the SDNP, passing close to the scheduled remains of Goblestubbs Copse earthworks (NHLE 1005895; A2).

6.8.14 The Scheme would have beneficial effects on all these assets, reducing the visual intrusion of moving traffic and associated noise. These effects may be significant and will be further assessed within the ES.

6.8.15 The Scheme would have some adverse effects on the setting of prominent heritage assets within Arundel, specifically Arundel Castle and Arundel Conservation Area due to the visibility of moving traffic on the proposed viaduct over the Arun floodplain. Such setting effects are not anticipated to be significant; however, this will be assessed further in the ES.

6.8.16 The proximity of the Scheme to assets along Binsted Lane is likely to result in adverse operational effects due to the introduction of noise impacts. The inclusion of low noise surfacing and a reduced speed limit has reduced these potential adverse effects on the Grade II* listed Church of St Mary's

(NHLE 1274877; BH22), Binsted; however, there is the potential for these to remain and will be addressed further in the ES. Without further design refinement, particularly of the Binsted Rife crossing, there is the potential for these effects to be significant.

Summary of preliminary assessment

6.8.17 Construction and operation of the Scheme would result in a number of likely permanent adverse significant effects to cultural heritage assets through alterations to their setting, the truncation and removal of archaeological remains and severance of historic landscapes. Conversely, the Scheme would deliver benefits to the historic environment in Arundel as a result of the de-trunking of the existing A27.

6.8.18 The preliminary assessment indicates significant permanent adverse effects on cultural heritage assets including listed buildings due to changes to their setting, the loss of a number of non-designated archaeological remains and impacts to the historic landscape.

6.8.19 Further design work, following public consultation, will optimise the Scheme design to minimise direct physical impacts, where practicable and minimise the visual intrusion of new infrastructure on the setting of heritage assets. Further reductions are anticipated as a result of the implementation of the EMP and the CIAAP.

6.8.20 Based on the preliminary assessment outlined above, there is potential for significant effects to result from the construction and/or operation of the Scheme. A summary of these potentially significant effects is reported below in Table 6-2.

6.9 Scheme options

6.9.1 As described in *Chapter 2: The Scheme*, options are still being considered for the potential reprovision of Avisford Park Golf Club. In addition, a potential alternative option from the current proposed alignment where the Scheme passes between Avisford Park, the new housing development at Avisford Grange and the existing Yapton Lane is being considered. This would raise the vertical alignment of the Scheme, with an offline Yapton Lane overbridge. The sections below discuss these in turn and outline whether adopting either of these would change anything stated in the preceding baseline conditions, potential impacts and assessment of effects sections and consider the potential for different effects of the options.

Options for Avisford Park Golf Club reprovision

Option 1: 9 hole golf course with driving range or practice facilities

6.9.2 The reprovision of an amended golf course is unlikely to result in any changes to the information already provided in the baseline conditions, potential impacts and assessment of effects sections of this chapter as the assessment has already considered the full extent of the draft Order Limits, which this option is within. Furthermore, changes to the layout of the

existing golf course are unlikely to result in additional impacts to the cultural heritage resource.

Option 2: Replacement 18 hole golf course

6.9.3 Full reprovision of the existing golf course would not result in any changes to the information already provided in the baseline conditions, potential impacts and assessment of effects sections of this chapter as the assessment has already considered the full extent of the draft Order Limits, which this option is within.

6.9.4 Previously recorded archaeological assets that may be impacted by this option include non-designated kilns (A145) and non-designated Iron Age earthworks (A32). However, following the results of archaeological trial trenching it is likely that further non-designated assets will be identified in this area which could alter which option may be preferred.

6.9.5 Church Farmhouse, Binsted Lane (NHLE 1222198; BH46; Grade II listed building; high value) may be subject to significant effects from this option through changes to its setting. This would be subject to the design of any golf course reprovision in this area.

6.9.6 As a result, Option 2 would result in greater impacts to both the designated and non-designated cultural heritage resource.

Option for raised vertical alignment with offline Yapton Lane overbridge

6.9.7 This option is considered unlikely to result in any changes to the baseline conditions, potential impacts and assessment of effects outlined in this chapter for the current proposed alignment. If this option was taken forward then the Scheme would be more visually prominent than the current proposed alignment due to the elevated nature of the offline Yapton Lane overbridge. However the change in height is unlikely to increase the impact of the presence of the Scheme within the setting of the heritage assets to an extent which increases the significance of effect. Therefore, preliminary conclusions in terms of the potential for likely significant environmental effects remain the same for this option and the current proposed alignment.

Table 6-2 Summary of potential significant effects

Receptor	Scheme impact	Potential significant effects (following embedded mitigation)	Further mitigation to be explored
Tortington Priory (scheduled Monument NHLE 1021459; A6)	Construction - presence of the Scheme within the setting of the asset	Permanent adverse effects associated with the erosion of the setting of the asset	After the implementation of the EMP, no further mitigation is likely to be available.
Goblestubbs Copse earthworks (Scheduled Monument NHLE 1005895; A2)	Operation - de-trunking of the existing A27	Permanent beneficial effect from removal of traffic from the setting of the asset during operation of the Scheme	No further mitigation is required.
Arundel Castle (scheduled monument; NHLE 1012500; A1), (Grade I listed building; NHLE 1027926; BH17) (Grade II* Registered Park and Garden (NHLE 1000170)	Construction - presence of the Scheme within the setting of the asset	Permanent adverse effects associated with the visibility of the Scheme within the landscape setting of the asset	After the implementation of the EMP, no further mitigation is likely to be available.
	Operation - de-trunking of the existing A27	Permanent beneficial effect from removal of traffic from the setting of the asset during operation of the Scheme	No further mitigation is required.

Receptor	Scheme impact	Potential significant effects (following embedded mitigation)	Further mitigation to be explored
Church of St Andrew, Ford (Grade I listed building; NHLE 1233989; BH9)	Construction - presence of the Scheme within the setting of the asset	Permanent adverse effects due to changes within the wider landscape setting of the asset	After the implementation of the EMP, no further mitigation is likely to be available.
Avisford Park Hotel (Grade II listed building; NHLE 1222534; BH41)	Construction - presence of the Scheme within the setting of the asset	Permanent adverse effects due to changes within the setting of the asset	After the implementation of the EMP, no further mitigation is likely to be available.
Swiss Cottage (Grade II listed building; NHLE 1222535; BH78)	Construction - presence of the Scheme within the setting of the asset	Permanent adverse effects due to changes within the setting of the asset	After the implementation of the EMP, no further mitigation is likely to be available.
Beam Ends (Grade II listed building; NHLE 1222465; BH32)	Construction - presence of the Scheme within the setting of the asset	Permanent adverse effects due to changes within the setting of the asset	After the implementation of the EMP, no further mitigation is likely to be available.
The Glebe House, Binsted (Grade II listed building; NHLE 1221993; BH82)	Construction - presence of the Scheme within the setting of the asset	Permanent adverse effects due to changes within the setting of the asset	After the implementation of the EMP, no further mitigation is likely to be available.

Receptor	Scheme impact	Potential significant effects (following embedded mitigation)	Further mitigation to be explored
Church of St Mary's, Binsted (Grade II* listed building; NHLE 1274877; BH22)	Construction - presence of the Scheme within the setting of the asset	Permanent adverse effects due to changes within the setting of the asset	After the implementation of the EMP, no further mitigation is likely to be available.
	Operation of the Scheme within the setting of the asset	Permanent adverse effects due to the introduction of noise and visual intrusion into the setting of the asset	After the implementation of the EMP, no further mitigation is likely to be available.
Meadow Lodge (Grade II listed building; NHLE 1274878; BH63)	Construction - presence of the Scheme within the setting of the asset	Permanent adverse effects due to changes within the setting of the asset	After the implementation of the EMP, no further mitigation is likely to be available.
The Thatched Cottage (Grade II listed building, NHLE 1274880; BH91)	Construction - presence of the Scheme within the setting of the asset	Permanent adverse effects due to changes within the setting of the asset	After the implementation of the EMP, no further mitigation is likely to be available.
Tortington Priory Barn, to the north of Priory Farm (Grade II* listed building; NHLE 1221996; BH92)	Construction - presence of the Scheme within the setting of the asset	Permanent adverse effects due to changes within the setting of the asset	After the implementation of the EMP, no further mitigation is likely to be available.

Receptor	Scheme impact	Potential significant effects (following embedded mitigation)	Further mitigation to be explored
Windmill, Fitzalan Road (Grade II listed building NHLE 1353714; BH94)	Construction - presence of the Scheme within the setting of the asset	Permanent adverse effects due to changes within the setting of the asset	After the implementation of the EMP, no further mitigation is likely to be available.
The Camillia Hotel (Grade II listed building; NHLE 1027602; BH79)	Construction - presence of the Scheme within the setting of the asset	Permanent adverse effects due to changes within the setting of the asset	After the implementation of the EMP, no further mitigation is likely to be available.
Park Farm (Grade II listed buildings NHLE 1353713; BH205, 1027936; BH204 and 1247969; BH206)	Operation - de-trunking of the existing A27	Permanent beneficial effect from removal of traffic from the setting of the asset during operation of the Scheme	No further mitigation is required.
Non-designated Mesolithic site at Avisford Park (A20)	Activities associated with the construction of the Scheme	Permanent loss of remains during construction of the Scheme	After the implementation of the EMP, a programme of archaeological recording is likely to be implemented.
Non-designated Iron Age earthworks (A32)	Activities associated with the construction of the Scheme	Permanent loss or truncation of remains during construction of the Scheme	After the implementation of the EMP, a programme of archaeological recording is likely to be implemented.

Receptor	Scheme impact	Potential significant effects (following embedded mitigation)	Further mitigation to be explored
Non-designated Roman Villa at Blacksmith's Corner, Walberton (A 52)	Activities associated with the construction of the Scheme	Permanent loss or truncation of remains during construction of the Scheme	After the implementation of the EMP, a programme of archaeological recording is likely to be implemented.
Non-designated Chichester to Arundel Roman Road (A71)	Activities associated with the construction of the Scheme	Permanent loss or truncation of remains during construction of the Scheme	After the implementation of the EMP, a programme of archaeological recording is likely to be implemented.
Non-designated medieval pits (A98)	Activities associated with the construction of the Scheme	Permanent loss or truncation of remains during construction of the Scheme	After the implementation of the EMP, no further mitigation is likely to be necessary.
Non-designated kilns (A145)	Activities associated with the construction of the Scheme	Permanent loss or truncation of remains during construction of the Scheme	After the implementation of the EMP, a programme of archaeological recording is likely to be implemented.
Non-designated medieval park at Tortington (A90)	Activities associated with the construction of the Scheme	Permanent loss or truncation of remains during construction of the Scheme	After the implementation of the EMP, no further mitigation is likely to be available.

Receptor	Scheme impact	Potential significant effects (following embedded mitigation)	Further mitigation to be explored
Non-designated medieval ridge and furrow identified in aerial photographs and LiDAR data (A100, A249, A252)	Activities associated with the construction of the Scheme	Permanent truncation of remains during construction of the Scheme	After the implementation of the EMP, no further mitigation is likely to be necessary.
Non-designated medieval moated site (A93)	Activities associated with the construction of the Scheme	Permanent loss or truncation of remains during construction of the Scheme	After the implementation of the EMP, a programme of archaeological recording is likely to be implemented.
Non-designated deserted medieval village (A99)	Activities associated with the construction of the Scheme	Permanent loss or truncation of remains during construction of the Scheme	After the implementation of the EMP, a programme of archaeological recording is likely to be implemented.
Non-designated industrial activities (A143)	Activities associated with the construction of the Scheme	Permanent truncation of remains during construction of the Scheme	After the implementation of the EMP, a programme of archaeological recording is likely to be implemented.
Non-designated post-medieval field boundaries identified in aerial photographs and LiDAR data (A247)	Activities associated with the construction of the Scheme	Permanent truncation of remains during construction of the Scheme	After the implementation of the EMP, no further mitigation is likely to be necessary.

Receptor	Scheme impact	Potential significant effects (following embedded mitigation)	Further mitigation to be explored
Non-designated undated earthworks identified in aerial photographs and LiDAR data (A192, A193, A242, A243, A244, A245, A246)	Activities associated with the construction of the Scheme	Permanent truncation of remains during construction of the Scheme	After the implementation of the EMP, a programme of archaeological recording is likely to be implemented.
Non-designated ditch and embankment (A217)	Activities associated with the construction of the Scheme	Permanent truncation of remains during construction of the Scheme	After the implementation of the EMP, a programme of archaeological recording is likely to be implemented.
Non-designated flood defences identified in aerial photographs and LiDAR data (A250)	Activities associated with the construction of the Scheme	Permanent truncation of remains during construction of the Scheme	After the implementation of the EMP, no further mitigation is likely to be necessary.
Non-designated drainage features identified in aerial photographs and LiDAR data (A248)	Activities associated with the construction of the Scheme	Permanent truncation of remains during construction of the Scheme	After the implementation of the EMP, no further mitigation is likely to be necessary.

Receptor	Scheme impact	Potential significant effects (following embedded mitigation)	Further mitigation to be explored
Non-designated post-medieval house platforms identified in aerial photographs and LiDAR data (A251)	Activities associated with the construction of the Scheme	Permanent truncation of remains during construction of the Scheme	After the implementation of the EMP, a programme of archaeological recording is likely to be implemented.
Non-designated lynchets (A96, A134)	Activities associated with the construction of the Scheme	Permanent truncation of remains during construction of the Scheme	After the implementation of the EMP, no further mitigation is likely to be necessary.
Non-designated Avisford Park (A137)	Severance during construction of the Scheme and presence of the Scheme within the historic landscape	Permanent adverse effects due to the loss of historic features	After the implementation of the EMP, no further mitigation is likely to be available.
Non-designated dispersed historic landscape of Binsted	Severance during construction of the Scheme and presence of the Scheme within the historic landscape	Permanent adverse effects due to the loss of historic features	After the implementation of the EMP, no further mitigation is likely to be available.

Receptor	Scheme impact	Potential significant effects (following embedded mitigation)	Further mitigation to be explored
Non-designated Tortington medieval landscape	Severance during construction of the Scheme and presence of the Scheme within the historic landscape	Permanent adverse effects due to the loss of historic features	After the implementation of the EMP, no further mitigation is likely to be available.
Non-designated Arundel medieval landscape	Severance during construction of the Scheme and presence of the Scheme within the historic landscape	Permanent adverse effects due to the loss of historic features	After the implementation of the EMP, no further mitigation is likely to be available.

7. Landscape and Visual

7.1 Introduction

7.1.1 This chapter considers the Scheme with respect to landscape and visual effects which are likely to arise from construction and operation.

7.1.2 Landscape effects relate to changes to the fabric or individual elements of the landscape, including land use, vegetation, landform and the aesthetic and perceptual qualities of the landscape, which contribute to the landscape character.

7.1.3 Visual effects relate to changes to existing views of identified visual receptors ('people') from the loss or addition of features within their view due to the Scheme.

7.1.4 There may be interrelationships related to the potential effects on the landscape and visual receptors and other disciplines. Reference should also be made in particular to the following chapters:

a. Chapter 6: Cultural Heritage
b. Chapter 8: Biodiversity
c. Chapter 11: Noise and Vibration
d. Chapter 13: Road Drainage and Water Environment

7.1.5 The following legislation, policy framework and standards have been used to inform the scope and content of this chapter and will be further referred to within the ES. This builds on the overarching EIA methodology and guidance presented in *Chapter 4: Environmental Assessment Methodology:*

a. *The European Landscape Convention* (Ref 7-1)
b. *NPSNN* (Ref 1-7)
c. *NPPF* (Ref 1-8)
d. *PPG – Natural Environment* (Ref 7-2)
e. *PPG – Light Pollution* (Ref 7-3)
f. *Planning (Listed Building and Conservation Areas) Act 1990* (Ref 7-4)
g. *The Town and Country Planning (Tree Preservation) (England) Regulations 2012* (Ref 7-5)

Ref 7-1 Council of Europe Landscape Convention (ETS No. 176). Council of Europe (2020). 6
Ref 7-2 Planning Practical Guidance – Natural Environment. Department for Levelling Up, Housing and Communities, Ministry of Housing, Communities & Local Government (2019). t
Ref 7-3 Planning Practical Guidance – Light Pollution. Department for Levelling Up, Housing and Communities, Ministry of Housing, Communities & Local Government (2019). n
Ref 7-4 Planning (Listed Building and Conservation Areas) Act 1990, c.9. f
Ref 7-5 The Town and Country Planning (Tree Preservation) (England) Regulations 2012 (SI 2012/0605).

h. The Hedgerow Regulations 1997 (Ref 7-6)

i. *DMRB GG 103 Introduction and general requirements for sustainable development and design* (Ref 7-7)

j. *DMRB LA 104 Environmental assessment and monitoring* (Ref 4-1)

k. *DMRB LA 107 Landscape and visual effects* (Ref 7-8).

l. *DMRB LD 117 Landscape design* (Ref 7-9)

m. *West Sussex Structure Plan 2001-2016* (Ref 7-10)

n. *Adopted Arun Local Plan 2011-2031* (Ref 1-12)

o. *South Downs Local Plan 2014-2033* (Ref 1-13)

p. *The Arundel Neighbourhood Plan Review 2018-2031* (Ref 7-11)

q. *Amberley Neighbourhood Development Plan 2016-2032* (Ref 7-12)

r. *Walberton Neighbourhood Development Plan 2019-2031* (Ref 6-2)

s. *Barnham and Eastergate Neighbourhood Plan 2019-2031* (Ref 7-13)

t. *Yapton Neighbourhood Plan 2014-2029** (Ref 7-14)

u. *Ford Parish Council Neighbourhood Development Plan 2017-2031* (Ref 7-15)

v. *Littlehampton Neighbourhood Plan* (Ref 7-16)

w. *Burpham Neighbourhood Plan 2015-2035* (Ref 7-17)

x. *Houghton Neighbourhood Development Plan 2020-2029* (Ref 7-18)

** Note: 2nd version of Neighbourhood Plan is currently in progress*

7.1.6 The following guidance has been used to inform the scope and content of this chapter:

Ref 7-6 The Hedgerow Regulations 1997 (SI 1997/1160).
Ref 7-7 GG 103 Introduction and general requirements for sustainable development and design. Highways England, (2019).
Ref 7-8 DMRB LA 107 Landscape and Visual Effects. Highways England. (2020).
Ref 7-9 DMRB LD 117 Landscape Design. Highways England, (2020).
Ref 7-10 West Sussex Structure Plan 2001-2016. West Sussex County Council (2005).
Ref 7-11 The Arundel Neighbourhood Plan Review 2018-2031. Arundel Town Council (2019).
Ref 7-12 Amberley Neighbourhood Development Plan 2016-2032. South Downs National Park Authority (2017).
Ref 7-13 Barnham and Eastergate Neighbourhood Plan 2019-2031. Barnham and Eastergate Parish Council (2013).
Ref 7-14 Yapton Neighbourhood Plan 2014-2029. Yapton Parish Council (2014).
Ref 7-15 Ford Parish Council Neighbourhood Development Plan 2017-2031. Ford Parish Council (2018).
Ref 7-16 A neighbourhood Plan for Littlehampton. 2014-2029. Littlehampton Town Council (2014).
Ref 7-17 Burpham Neighbourhood Plan 2015-2035. Burpham Neighbourhood Forum (2016).
Ref 7-18 Houghton Neighbourhood Development Plan 2020-2029. Houghton Parish Council (2021).

a. *Design Principles for National Infrastructure* (Ref 7-19)
b. *Guidelines for Landscape and Visual Impact Assessment: Third edition (GLVIA3)* (Ref 7-20)
c. *An Approach to Landscape Character Assessment* (Ref 7-21)
d. *Townscape Character Assessment – Technical Information Note 05/17* (Ref 7-22)
e. *Assessing landscape value outside national designations - Technical Guidance Note 02/21* (Ref 7-23)
f. *Infrastructure - Technical Guidance Note 04/20* (Ref 7-24)
g. *Tranquillity – An overview – Technical Information Note 1/17* (Ref 7-25)
h. *Visual Representation of Development Proposals – Technical Guidance Note 06/19* (Ref 7-26)
i. *Reviewing Landscape and Visual Impact Assessments (LVIAs) and Landscape and Visual Appraisals (LVAs) – Technical Guidance Note 1/20* (Ref 7-27)
j. *Residential Visual Amenity Assessment – Technical Guidance Note 02/19* (7-28)
k. *West Sussex Transport Plan 2011-2026* (Ref 1-11)
l. *Local Distinctiveness Study of West Sussex* (Ref 7-29)
m. *Arun Green Infrastructure Study* (Ref 7-30)
n. *Arun Active Travel Connectivity Study Report* (Ref 7-31)

Ref 7-19 Design Principles for National Infrastructure. National Infrastructure Commission Design Group, (2020).
Ref 7-20 Landscape Institute and Institute of Environmental Management and Assessment. (2013). *Guidelines for Landscape and Visual Impact Assessment 3rd Edition*. Routledge: Abingdon.
Ref 7-21 An Approach to Landscape Character Assessment. Natural England, (2014).
Ref 7-22 *Townscape Character Assessment Technical Information Note 5/17.* Landscape Institute, (2017, Revised 2018).
Ref 7-23 *Assessing landscape value outside national designations – Technical Guidance Note 2/21.* Landscape Institute, (2021).
Ref 7-24 Infrastructure – Technical Guidance Note 4/20. Landscape Institute, (2020).
Ref 7-25 Tranquillity – An Overview – Technical Information Note 1/17. Landscape Institute, (2017).
Ref 7-26 Visual Representative of Development Proposals Technical Guidance Note 06/19. Landscape Institute, (2019).
Ref 7-27 Reviewing Landscape and Visual Impact Assessments (LVIAs) and Landscape and Visual Appraisals (LVAs) Technical Guidance Note 1/20. Landscape Institute, (2020).
Ref 7-28 Residential Visual Amenity Assessment – Technical Guidance Note 2/19. Landscape Institute, (2019).
Ref 7-29 Local Distinctiveness Study of West Sussex. West Sussex County Council (2020). /
Ref 7-30 Arun Green Infrastructure Study. LUC (2012).
Ref 7-31 Arun Active Travel Connectivity Study Report. Arun District Council (2021).

o. *South Downs Ecosystem Services Technical Advice Note* (Ref 7-32)

p. *South Downs Design Guide Supplementary Planning Document* (Ref 7-33)

q. *South Downs Dark Skies Technical Advice Note* (Ref 7-34)

r. *South Downs Partnership Management Plan 2020-2025* (Ref 7-35)

s. *South Downs Green Infrastructure Framework* (Ref 7-36)

7.2 Stakeholder engagement

7.2.1 Consultation on landscape and visual matters has been undertaken with the host local authorities of ADC, SDNPA, WSCC as well as Natural England and Historic England.

7.2.2 Consultation has included discussions regarding the location and distribution of viewpoints to be included in the LVIA, the approach to identifying Local Landscape Character Areas (LLCA) and the landscape design strategy.

7.2.3 Further consultation will seek to agree a final selection of viewpoints and appropriate locations for photomontages to illustrate the appearance of the Scheme, which will be submitted with the DCO application and fully assessed within the ES.

7.3 Assessment assumptions and limitations

7.3.1 The chapter has been informed by summer fieldwork and desktop study, inclusive of a review of relevant policy, published guidance and standards, mapping and the production of preliminary Zones of Theoretical Visibility (ZTVs) for the Scheme operational phase. ZTVs for the construction phase will be prepared and submitted with the DCO application.

7.3.2 ZTV modelling was initially undertaken within a 15 km radius of the Scheme. It should be noted that this represents 'theoretical' visibility and is generated using points distributed at intervals along the Scheme, as set out in *LA 107* (Ref 7-8). The results will be tested through further ZTV modelling as the Scheme design develops and detailed within the ES.

7.3.3 Further desktop study and winter fieldwork from publicly accessible areas, including Public Rights of Way (PRoW) or pavements close to residential properties or roads, will be carried out to inform the assessment. As stated

Ref 7-32 South Downs Ecosystem Services Technical Advice Note. South Downs National Park Authority (2018).
Ref 7-33 South Downs Design Guide Supplementary Planning Document. South Downs National Park Authority (2019).
Ref 7-34 South Downs Dark Skies Technical Advice Note. South Downs National Park Authority (2021).
Ref 7-35 South Downs Partnership Management Plan 2020-2025. South Downs National Park Authority (2020).
Ref 7-36 South Downs Green Infrastructure Framework. South Downs National Park Authority (2016)

in *GLVIA 3* (Ref 7-20), publicly accessible views should be identified and only in some instances may it also be appropriate to consider private viewpoints. Further detail is given later in this chapter regarding the threshold for Residential Visual Amenity Assessment.

7.3.4 The ZTVs have been tested through summer fieldwork and will also be tested through winter fieldwork when there is less leaf cover and therefore minimum screening, which represents the worst-case approach. The initial findings presented in this chapter may therefore be subject to change as the design of the Scheme is developed and refined through the EIA, design and consultation processes. Once the design is finalised, the potential effects will be fully assessed within the ES.

7.4 Study area

7.4.1 The landscape and visual study area is specific to the Scheme and is proportionate to criteria as identified in *LA 107* (Ref 7-8).

7.4.2 To consider these criteria, the study area has been informed by a review of existing information. This includes desk-based reviews of published landscape character assessments, which are defined in *Section 7.5*, and the wider landscape setting to determine the area which the Scheme may influence. This also includes consideration of other related environmental aspects, including biodiversity where relevant to informing landscape character, including designated sites and notable species and habitats. Examples in the local landscape include the Binsted Wood Complex, other large stands of ancient woodland and the River Arun floodplain.

7.4.3 The extents of preliminary, computer-generated ZTV modelling have been used to determine the potential visibility of the Scheme from the wider landscape, as advocated in *GLVIA 3* (Ref 7-20). The process by which the landscape and visual study area has been refined is described below.

Initial area of search

7.4.4 Figures 7-1 and 7-2 present the initial area of search, extending to 15 km from the draft Order Limits. Figure 7-2 also includes the screening function of areas of woodland taken from the *National Tree Map Data* (within 1 km) and *National Forest Inventory* (beyond 1 km) and buildings taken from Ordnance Survey data.

Theoretical visibility modelling

7.4.5 The preliminary ZTVs have been generated to cover the initial area of search, including areas of the surrounding landscape with potential intervisibility with the Scheme (refer to Figures 7-1 and 7-2). Fourteen points were placed at the proposed road surface level along the centreline of the Scheme, and then raised by 4.5 m to account for the height of a lorry.

7.4.6 A further ZTV has been prepared, which takes account of existing screening. This uses the woodland and building data, as described above.

A detailed methodology for the production of the bare earth and screened ZTVs will be set out in the ES.

7.4.7 The preliminary ZTVs indicate that the draft Order Limits are likely to be widely visible when in close proximity, and theoretically visible as far as the full 15 km area of search.

7.4.8 North and north west of the draft Order Limits, the ZTV indicates that Scheme visibility would potentially extend up to a ridgeline close to the A29 in the SDNP, with intermittent visibility beyond this point as the distance from the draft Order Limits increases.

7.4.9 North and north-east of the draft Order Limits, the ZTV indicates that potential Scheme visibility approximately follows the west-facing slopes of the Arun Valley as it extends into the SDNP, up to a ridgeline east of Amberley.

7.4.10 East of the draft Order Limits, the ZTV indicates that potential Scheme visibility is intermittent, extending towards Worthing.

7.4.11 South and south east of the draft Order Limits, the ZTV indicates that potential Scheme visibility extends around Littlehampton, and beyond Littlehampton across the English Channel.

7.4.12 South and south west of the draft Order Limits, the ZTV indicates that potential Scheme visibility extends initially to Eastergate, Barnham and Yapton, and then beyond to the landscape between Bognor Regis and Chichester.

7.4.13 West of the draft Order Limits, the ZTV indicates there would be limited, intermittent visibility of the Scheme.

Refinement of the study area

7.4.14 A study area has been defined beyond which there are not likely to be significant landscape or visual effects (Ref 7-37), and the text below explains how this study area has been refined. Further fieldwork will be undertaken to validate the desk-based research. The study area is presented on Figures 7-3 and 7-4 with reference to the bare earth and screened ZTVs at this scale and shown also on Figure 7-5.

7.4.15 In refining the study area, consideration was given to the following factors as set out in *LA-107* (Ref 7-8), informed by professional judgement and experience:

a. The draft Order Limits boundary.

b. The wider landscape and visual setting within which the Scheme has the potential to influence.

Ref 7-37 Landscape Institute and Institute of Environmental Management and Assessment. (2013). *Guidelines for Landscape and Visual Impact Assessment 3rd Edition*. Routledge: Abingdon.

c. The extent of the area visible by the Scheme and representative viewpoints.

d. The full extent of adjacent or affected landscape and visual receptors of special value and visual amenity whose setting can be influenced by the Scheme.

7.4.16 The study area incorporates several landscape designations, including the SDNP and the Grade II* Arundel Castle Registered Park and Garden to the north of Arundel. The study area has also been defined to cover the landscape character within the study area as it varies, informed by published landscape character assessments and Local Landscape Character Areas (LLCAs) defined by the applicant.

7.4.17 The wider landscape includes the relatively flat landform in which the Scheme is proposed. The Railway Line which runs between Barnham and Ford to the south of the draft Order Limits defines the southern edge of the landscape and visual study area. The Railway Line defines a point of transition in the local landscape. Beyond the Railway Line to the south, the landscape is predominantly flat. Existing landscape elements, including intervening hedgerows and mature woodland, combine such that the route of the Scheme is screened or barely perceptible and does not influence the character of the landscape. Therefore, significant landscape and visual effects are not likely.

7.4.18 With regard to potential visual effects, the desk-based review of the ZTVs found that to the north west of the draft Order Limits, there is limited visibility towards the draft Order Limits from beyond the A29. This was tested through summer fieldwork from two publicly accessible locations from which the screened ZTV indicates theoretical visibility, including near to Bignor Hill. There is considerable intervening woodland cover, which dominates the view from these locations, with the coastal plain visible on lower ground in the distance. Any views beyond the A29, towards the Scheme, were considered to be imperceptible and therefore not considered material in the context of the overall panorama. This will be further tested through winter fieldwork when there is less vegetation cover and therefore minimum screening available.

7.4.19 To the north-east of the draft Order Limits, Scheme visibility is expected to extend to a section of the South Downs Way National Trail east of Amberley. This route allows views down the Arun valley towards Arundel Castle and the draft Order Limits beyond. As such, despite the distance, the potential for significant visual effects due to the Castle's visual context cannot be ruled out.

7.4.20 There is likely to be limited Scheme visibility beyond Poling to the east of the draft Order Limits, due to the lower elevation of the coastal plain, and the screening provided by intervening buildings and vegetation. Therefore, should there be visibility east of Poling, then this is not likely to result in significant effects.

7.4.21 To the south of the draft Order Limits, Scheme visibility is expected to extend towards the Arun Valley Railway Line between Barnham and Worthing. Beyond this, the Scheme may be intermittently visible, but the intervening railway line, vegetation and buildings would generally screen views of the Scheme such that there is not likely to be significant effects.

7.4.22 To the south west, Scheme visibility is not expected to extend beyond Walberton, Eastergate and Barnham. Further to the south west, the intervening landform, buildings and vegetation screen the Scheme.

7.4.23 To the west, Scheme visibility is expected to be limited beyond Fontwell and Slindon as a result of the extent of woodland cover, vegetation along the existing A27 dual carriageway, and intervening landform and vegetation.

7.4.24 Based on professional judgement, this study area is considered to be the maximum extent in which significant landscape and visual effects are most likely. It will be reviewed and may be further refined following fieldwork carried out in winter 2021/22.

7.5 Baseline conditions

Landscape context

7.5.1 Baseline information on topography and hydrology, vegetation patterns, settlement and land use, movement and connectivity, tranquillity and designations are presented in Appendix 7-A. Figure 7-6 presents the topography and hydrology within the study area and should be viewed in conjunction with Appendix 7-A.

Designations

7.5.2 Figure 7-7 presents the landscape designations within the study area.

7.5.3 The SDNP was designated in 2010 in recognition of its exceptional natural beauty, as well as for the opportunities to learn about and appreciate its special qualities, and as a landscape of national importance. The SDNP extends across the northern part of the study area, including the Binsted Woods Complex to the south of the existing A27 dual carriageway, and across the northern part of Arundel and to the north of the Crossbush roundabout. A section of the existing A27 corridor, which is to be de-trunked, is located within the SDNP. The majority of infrastructure of the new dual carriageway is not located within the SDNP, although some elements would be located within very small parts of the SDNP, including utilities diversions.

7.5.4 The South Downs International Dark Sky Reserve (IDSR) was designated in May 2016 by the International Dark-Sky Association. The SDNP Authority's *Dark Skies Technical Advice Note* (TAN) states that, whilst the designation covers all the SDNP, the designation is largely defined by the "*darkest skies*" within a stated "*critical core and buffer*" which extends across the central part of the SDNP (Ref 7-34). The TAN also identifies an

area of *"intrinsic rural darkness*" which has the same luminance values as the identified "*buffer*".

7.5.5 The new dual carriageway does not fall within the IDSR. Part of the study area falls within the identified "*intrinsic rural darkness and buffer*" area, including part of the A27 proposed for de-trunking. The northern part of the study area falls within the identified "*critical core*". Further reference to this designation will be made in the DCO application and later within this chapter in relation to night-time assessments.

7.5.6 With reference to the *Arun District Local Plan 2011-2031* (Ref 1-12), there are no "*Areas of Special Character*" in close proximity to the Scheme. The closest "*Area of Special Character*" is in Eastergate, approximately 1.7 km to the south west.

7.5.7 There are many heritage assets across the study area as described in *Chapter 6*: *Cultural Heritage*. This includes Arundel Castle and its grounds, which is a Grade I Listed Building and Scheduled Monument. The castle is in an elevated position within the townscape, providing visitors with views across the wider landscape to the south of Arundel. The castle is a visitor attraction and has been depicted in art and literature, including paintings by J.M.W. Turner which depict the castle and the River Arun as seen from the present-day SDNP.

7.5.8 *Chapter 6: Cultural Heritage* also refers to the *Sussex Historic Landscape Characterisation* (Ref 7-38) published guidance, which will also be referred to and where relevant in the landscape baseline and in the design of appropriate mitigation.

7.5.9 Other heritage features of relevance to the LVIA which inform the character of the landscape include:

a. Arundel, Walberton and Lyminster conservation areas.

b. Listed buildings at Arundel, Crossbush, Binsted, Tortington, Walberton and Fontwell.

c. Tortington Priory Scheduled Monument.

d. Arundel Castle Registered Historic Park and Garden (Grade II*) to the north of Arundel and of which, in the listing notes, there are extensive views from within the grounds over the valley towards the Scheme.

7.5.10 With reference to the *Arun District Local Plan 2011-2031* (Ref 1-12), there are many Tree Preservation Orders (TPOs) across the study area, including to the north of Walberton and within Binsted. Havenwood Park and Paine's Wood. To the south of the existing A27 dual carriageway are also large areas of woodland covered by TPOs. The *Arun District Local Plan* also notes that ancient and veteran trees are recognised as a valuable resource. There are numerous ancient and veteran trees across the study area.

Ref 7-38 Historic Landscape Characterisation. West Sussex County Council, (2010).

Future baseline

7.5.11 A review will be undertaken to determine whether the existing baseline conditions might change between the time of undertaking the assessment and the future years in which the Scheme is planned to be constructed and become operational.

7.5.12 Consideration will be given to the following types of change that could potentially alter the landscape and views:

a. The natural evolution of the landscape, for example, whether the growth of existing vegetation would alter existing landscape character and how its components feature in existing views, including potential implications of plant pests and diseases such as ash dieback.

b. The loss of features and components of the landscape, for example, as a consequence of land take from planned developments in the area, leading to changes in landscape character and the opening of existing views for visual receptors.

c. The introduction of new built form and infrastructure into the existing landscape and views, which changes the character, value and appreciation of the local landscape and features in existing views.

d. The introduction of new receptors, for example, residents of new dwellings under construction that are expected to become occupied and subsequently would have views of the Scheme under construction and/or in operation.

7.5.13 Cumulative landscape and visual effects of the Scheme with other proposed developments is detailed in *Chapter 15: Cumulative, In-combination and Project-wide Effects* of the PEI Report and will be assessed within the ES.

Arboriculture

7.5.14 Tree surveys are currently ongoing and an Arboricultural Impact Assessment (AIA) to *BS 5837: 2012 Trees in relation to design, demolition and construction* (Ref 7-39) will be developed in support of the ES, which will identify trees to be removed or impacted to facilitate the Scheme. The tree survey study area has been refined from the 100 m buffer set out in the *EIA Scoping Report* to include all trees with the potential to be impacted by the construction and operation of the Scheme.

7.5.15 The Scheme design will continue to be developed to avoid important trees and to reduce, mitigate or compensate for any impacts where avoidance is not possible. The AIA will form an appendix to the Landscape and Visual chapter within the ES and the results will inform mitigation proposals.

Ref 7-39 British Standards Institution, (2012). *British Standard 5837:2012 Trees in relation to design, demolition and construction - Recommendations.* British Standards Limited.

Published landscape character assessments

7.5.16 Landscape character assessment is defined within *LA 107* (Ref 7-8) as the:

"Process of identifying and describing variation in character of the landscape - the unique combination of elements and features that make landscapes distinctive - to assist in managing change in the landscape."

7.5.17 Relevant published landscape character assessments are referred to below. These assessments have been undertaken by various organisations and at national, county and district scales, with their boundaries following natural lines in the landscape rather than administrative boundaries.

7.5.18 Similarly, Local Planning Authorities use their published landscape character assessments as part of their planning policy evidence base and the assessments often provide specific guidance or recommendations on managing landscape change. The following published Landscape Character Areas (LCAs) will be included as part of the assessment of landscape effects within the ES. Recommendations for future management and statements of environmental opportunity will be considered as part of the iterative design process.

7.5.19 The study area is covered by the following published landscape character assessments:

a. *Natural England National Character Areas* (Ref 7-40 and Ref 7-41)

b. *A Strategy for the West Sussex Landscape* (Ref 7-42)

c. *Arun Landscape Study* (Ref 7-43)

d. *South Downs Landscape Character Assessment* (Ref 7-44)

7.5.20 These studies identify spatial Landscape Character Types (LCTs) or LCAs based on the prevalent landscape characteristics. They then typically identify guidelines for managing future change or development, and opportunities to provide enhancement based on these LCAs.

7.5.21 LCTs are described in *LA 107* as (Ref 7-8):

"Distinct types of relatively homogeneous landscape, generic in nature but share broadly similar combinations of geology, topography, drainage patterns, vegetation and historical land use and settlement pattern, and perceptual and aesthetics attributes."

7.5.22 LCAs are described in *LA 107* as (Ref 7-8):

Ref 7-40 NCA 125 South Downs. Natural England, (2015).
Ref 7-41 NCA 126 South Coast Plain. Natural England, (2015). .
Ref 7-42 A Strategy for the West Sussex Landscape. West Sussex County Council, (2005). .
Ref 7-43 Arun Landscape Study. Hankinson Duckett Associates, (2006).
Ref 7-44 South Downs Landscape Character Assessment. Land Use Consultants, (2020).

"Single unique areas which are the discrete geographical areas of particular landscape type."

7.5.23 A summary of the LCTs and LCAs which fall within the study area, their key characteristics, and any management guidelines or environmental opportunities which may be relevant is given within Appendix 7-A (refer to Figure 7-8 and Figure 7-9).

Local Landscape Character Areas (LLCAs)

7.5.24 The extent of published LLCAs is large and the scales and geographic areas which they cover is varied. Paragraph 5.16 of *GLVIA 3* states that "*even where there are useful and relevant existing Landscape Character Assessments and historic landscape characterisations, it is still likely that it will be necessary to carry out specific and more detailed surveys of the site itself and perhaps its immediate setting or surroundings*".

7.5.25 In order to provide a more detailed assessment of the existing landscape character, a number of LLCAs have been identified and these will be included as part of the assessment of landscape effects within the ES. These LLCAs have been identified by the applicant within the study area at a scale relevant to the Scheme and its likely effects.

7.5.26 The LLCAs have been identified based on the prevalent characteristics of the landscape informed by desk-study and based on the existing LCTs and LCAs defined in published assessments. The boundaries of these LLCAs may be further refined following fieldwork to inform the DCO application.

7.5.27 The full list of LLCAs within the study area is set out below and shown on Figure 7-10:

a. LLCA 1 Fontwell Common
b. LLCA 2 Walberton Settled Woodland
c. LLCA 3 Hooe Farm
d. LLCA 4 Avisford Park
e. LLCA 5 Walberton
f. LLCA 6 Binsted Farmland
g. LLCA 7 Binsted Rife
h. LLCA 8 Binsted
i. LLCA 9 Tortington Rife
j. LLCA 10 Tortington Valley Sides
k. LLCA 11 Lower Arun Valley Floodplain
l. LLCA 12 Lyminster Arun Valley Sides
m. LLCA 13 Lyminster Angmering Coastal Plain
n. LLCA 14 Angmering Park Woodland

o. LLCA 15 Angmering Wooded Downland
p. LLCA 16 Arun Open Downs
q. LLCA 17 East Arun Valley Sides
r. LLCA 18 Upper Arun Valley Floodplain
s. LLCA 19 West Arun Valley Sides
t. LLCA 20 Arundel Historic Centre
u. LLCA 21 Arundel
v. LLCA 22 Arundel Wooded Downland
w. LLCA 23 Arundel Open Downland
x. LLCA 24 Slindon Upper Coastal Plain
y. LLCA 25 Slindon
z. LLCA 26 Fontwell
aa. LLCA 27 Walberton/Fontwell Settled Farmland
bb. LLCA 28 Walberton Farmland
cc. LLCA 29 Barnham
dd. LLCA 30 Binsted Nurseries
ee. LLCA 31 Ford
ff. LLCA 32 Lyminster
gg. LLCA 33 Littlehampton Northern Fringe

7.5.28 The Scheme lies within LLCAs 1-13.

Visual baseline

7.5.29 The assessment of visual effects is structured around the identification of visual receptors within the study area. Visual receptors are defined in *LA 107* (Ref 7-8) as "*individuals and/or defined groups of people who potentially could be affected by a project*." This means people with the potential for views of either the construction or operation of the Scheme.

7.5.30 The identification of visual receptors is a two-staged process, beginning by interrogating baseline mapping and the preliminary ZTVs and then fieldwork to refine and ascertain the actual inter-visibility between the Scheme and potential visual receptors, as described below.

ZTV and visual receptors

7.5.31 Figures 7-1, 7-2, 7-3 and 7-4 present initial bare earth and screened ZTVs for the Scheme. These were used to inform an initial selection of visual receptors with potential visibility of the Scheme. The initial viewpoint selection, shown in Figure 7-11, includes locations from within the relatively higher ground in Arundel and further north-east along the South Downs Way National Trail, east of the settlement of Amberley.

7.5.32 The types of visual receptor and receptor groups are identified in Table 7-1.

Table 7-1 Visual receptors

Visual receptor groups	Typical description
Residents	Arundel, including adjacent to the existing A27 and on the southern edge of Arundel. Binsted, including Binsted Lane, Yapton Lane and Hedgers Hill. Walberton, including residents on the northern edge of Walberton and Avisford Park Road. Tortington and Ford, including adjacent to Tortington Lane, Ford Lane and Priory Lane.
People travelling on roads and public transport	Road networks across the SDNP and study area, including the existing A27. Rail and bus passengers.
Recreational users	Users of PRoW across the study area, including between the villages and within the SDNP. People using parks, playing fields, community halls, libraries and anglers. Horse riders.
Visitors	Including visitors to the SDNP, Arundel Castle and Arundel Park.
Employment	People working across the study area, including at Crossbush.
Institutional	People attending educational facilities.
Astronomers	Notably within the designated IDSR.

7.5.33 A total of 56 viewpoints have been identified to represent the views of the visual receptors described above. The locations of these viewpoints have been discussed with ADC, WSCC, SDNPA, Natural England, and Historic England and feedback has been considered in finalising the viewpoint selection. The location of viewpoints and those that will be presented as annotated photographs (Type 1) and photomontages (Type 4) (Ref 7-26) will seek to be agreed with the stakeholders stated above.

7.5.34 The locations of the proposed viewpoints have also been established with regard to public accessibility, the number and sensitivity of viewers who may be affected (noting that the sensitivity of viewpoint receptors will be

provided as part of the DCO application), viewing direction, distance and elevation, the nature of the viewing experience and the view type, as set out within *LA 107* (Ref 7-8).

7.5.35 With regard to the nature of the viewing experience, *GLVIA 3* notes the difference between "*static*" (e.g., residents at home) and "*sequential*" views (e.g., views from a road or PRoW), which will be set out within the DCO application.

7.5.36 The potential for cumulative visual effects has been considered as far as reasonably practicable at this stage.

7.5.37 The locations of the proposed viewpoints selected are shown on Figure 7-11 and details of the proposed viewpoints are presented in Appendix 7-A.

7.5.38 *GLVIA 3* distinguishes between different types of viewpoint as follows (Ref 7-20):

a. "*Representative viewpoints, selected to represent the experience of different types of visual receptor, where larger numbers of viewpoints cannot all be included individually and where significant effects are unlikely to differ".*

b. "Specific viewpoints, chosen because they are key and sometimes promoted viewpoints within the landscape…, viewpoints in areas of particularly noteworthy visual and/or recreational amenity…, or viewpoints with particular cultural landscape associations".

c. *"Illustrative viewpoints, chosen specifically to demonstrate a particular effect or specific issues*".

7.5.39 Viewpoints 42 and 54 relate to two views that are closest to views identified in the *SDNP View Characterisation and Analysis Study, 2015* (Ref 7-45). Viewpoint 42 is considered to be "*specific*" in *GLVIA 3* terms. The remaining proposed viewpoints are considered to be "*representative*" in *GLVIA 3* terms.

7.5.40 The visual assessment within the ES will:

a. Not consider future road users of the Scheme as these are not representative of the existing baseline.

b. Not consider views from parts of recreational routes that would be closed during the construction phase.

c. Consider views of residents of the consented Avisford Grange housing development, which is currently under construction. These visual receptors will form part of the future baseline. Further development of future baseline schemes will be developed in the ES.

7-45 South Downs National Park: View Characterisation and Analysis. Land Use Consultants, (2015).

d. Consider fragmentation of existing landscape elements such as woodlands and hedgerows and potentially impacting ecosystem services.

e. Consider extensive changes in natural landform, including cuttings, embankments and bunds, which alter the topography of the area and results in severance of the landscape.

f. Consider the introduction of major highway infrastructure including junctions and structures in the rural landscape. Details of height of new structures will be set out within the DCO application and assessed within the ES.

g. Consider dominant vertical elements such as new signage and gantries, Variable Message Signs (VMS), Close Circuit Television (CCTV) cameras and masts, and lighting columns.

h. Consider changes to land use and landscape character with increased influence and dominance of traffic moving at speed through the landscape, resulting in reduced tranquillity.

i. Consider increased light spill and impacts on character of the night-time landscape.

Visual

a. Views of major highway infrastructure including junctions and bridges, new signage and gantries, VMS, CCTV cameras/masts and lighting columns.

b. Views of other elements including environmental bunds, noise barriers, and drainage retention basins.

c. Views of lighting columns/light spill.

d. Views of traffic moving at speed through the landscape, including the impact from headlights.

e. Visual screening reducing the extent of existing views.

7.6 Design, mitigation and enhancement measures

Embedded mitigation measures

7.6.1 The design of the Scheme is being developed with consideration of the criteria for good design set out in the *NPSNN*. This includes the development of Scheme-specific design principles to address the positioning and alignment, scale, height and massing and materials and finishes of elements, which contribute to visual appearance. This includes, where possible:

a. Optimising zones within construction compounds to minimise their temporary impact on the landscape and views, including at night.

b. Returning and reinstating land used temporarily to its former condition and profiles, where appropriate.

c. Optimising the horizontal and vertical alignment of the new dual carriageway to minimise impacts associated with crossing valleys and landform within the landscape.

d. Positioning sections of the new dual carriageway in cuttings and between blocks of existing vegetation to visually contain much of the road infrastructure and traffic movements in existing views of receptors in close range and more in distant views, including from the SDNP.

e. Designing earthwork slopes to gradients that soften their appearance and achieve good integration with the rural landscape.

f. Confining lighting on new and improved sections of road within the Scheme to locations where road safety is a priority to minimise the potential for light spill in night-time views.

g. Designing permanent structures, such as bridges, in a way that minimises their visual impact and achieves good visual appearance, specifically in relation to the proposed viaduct across the River Arun floodplain, designed in line with *DMRB CD 351* (Ref 7-46).

7.6.2 The design will continue to be developed to avoid and mitigate adverse impacts and maximise opportunities for landscape integration and enhancement.

7.6.3 The PLEM illustrated on Figure 2-1 presents an indication of the likely form and extent of planting incorporated into the design of the Scheme to mitigate landscape and visual impacts.

7.6.4 The following design principles have underpinned the landscape design approach, with respect to embedded mitigation measures:

Alignment and landform

a. The alignment of the new dual carriageway is designed to minimise the effects of the Scheme on the existing landform and landscape as far as practicable, within the context of environmental and engineering constraints.

b. Sections of cutting are included to minimise noise and visual intrusion at Walberton and Binsted, and to integrate overbridges more sensitively.

c. The contouring of earthworks has been designed where possible with maximum gradients of 1:3 to support planting.

d. A viaduct structure has been proposed for the crossing of the River Arun floodplain to maintain the openness and connectivity of the floodplain, reducing the impact of severance compared to an embankment in this location.

Ref 7-46 CD 351 The design and appearance of highways structures. Highways England (2020).

e. Moving the new dual carriageway alignment west, away from the Church of St Mary's, Binsted, and lowering the alignment to reduce the prominence of the structure and traffic.

f. Green bridges are proposed to mitigate severed wildlife connections and restore vegetated skylines in views west towards Tortington from the River Arun.

g. Retaining PRoW routes where the Scheme crosses existing routes minimising any diversions as far as practicable.

Planting, vegetation and soils

a. Planting is proposed to reduce the visual impact of the new dual carriageway by integrating the Scheme with the existing landscape elements in the view between the A27 Western tie-in and Ford Road.

b. Native, locally characteristic tree and shrub species and planting design are proposed to reflect the existing vegetation patterns.

c. The Scheme seeks to mitigate hedgerow loss where possible, noting that the quantum of loss and proposed hedgerow will be set out within the ES. The general strategy is as follows:

   i. Reduce removals of hedgerow.

   ii. Translocate hedgerows within the Scheme where viable.

   iii. Replant hedgerows and enhance existing hedgerows with a diverse planting mix reflecting local landscape character.

d. Consideration of genetic diversity to address long-term climate change, pest and disease resilience.

e. The Scheme seeks to reflect existing or required soil conditions for the proposed landscape mitigation as far as practicable. Existing soil conditions and any remedial recommendations will be determined by independent site-specific soil testing analysis.

f. The Scheme has been designed to reflect long-term landscape management and operational requirements of the highway in planting design.

SDNP

a. Crossbush Junction aligned to avoid encroachment onto the SDNP boundary.

b. Alignment of the Scheme at Binsted Lane to avoid the southern boundary of SDNP and retain Lake Copse woodland and Ancient Woodland.

c. Using a viaduct instead of raised embankment over the Arun floodplain to minimise the potential visual and environmental impact upon flood plain itself, Arundel and SDNP.

Integration with the rural landscape

a. Where practicable, existing landscape features would be retained to ensure continuity of features around the Scheme corridor.

b. The impact of severance would be reduced by maintaining and integrating existing footpaths, bridleways and local roads into the Scheme design.

c. The impacts on tranquillity would be reduced through screening via bunds, noise barriers and planting to reduce visual and audible impacts.

The road corridor

a. Lighting has and will be avoided as far as possible in the Scheme.

b. Where lighting is essential for safety, it will be designed to minimise intrusion through the careful siting of lighting columns, and to limit light spill and sky glow to reduce impacts on dark skies.

c. The siting and design of environmental barriers such as noise barriers will limit visual intrusion as far as practicable.

d. The siting and design of signage and other tall vertical elements such as CCTV where required will be designed to avoid sensitive views where practicable.

Heritage

a. To reduce impacts on the Church of St Mary's, Binsted, the Scheme alignment has been moved away from the church, and lowered to reduce the prominence of the structure and traffic.

b. As far as practicable, the Scheme visually and audibly screens road traffic from heritage assets with the use of screening where required. Refer to the heritage features listed in *Section 7.5*.

Standard mitigation measures

7.6.5 As detailed in *LA 120* (Ref 7-47), the first iteration EMP will be developed for the Scheme, which will include a series of measures that will be used as the framework for the development of the second iteration EMP during examination and securing of the third iteration EMP as part of the DCO obligations.

7.6.6 The first iteration EMP will set out working practices and measures to avoid and reduce impacts on landscape character and the visual environment, examples of which are expected to include the following:

a. Keeping construction sites and compounds tidy and in good order, for example, by keeping stockpiled material to a minimum and arranging goods deliveries on an 'as and when' basis.

7-47 DMRB LA 120 Environmental Management Plans. Highways England, (2020).

b. Keeping night-time works to a minimum; ensure low-level and directional lighting is used to illuminate construction compounds and working areas, where possible.

c. Siting compounds and other construction areas sympathetically within the landscape.

d. Rendering temporary construction buildings, fencing and facilities in tonal colours to reflect the landscape.

e. Form earthwork bunds early in the construction programme, where possible, to visually screen and contain construction works.

f. Establish advanced planting to soften and filter views of the construction phase, as well as part of the wider visual mitigation if land is not required for other construction activities.

g. Reinstatement and return of land used temporarily for construction to its previous condition and use, including agricultural land if appropriate, as soon as practicable. If land is not suitable for the return to its previous use, consideration will be given to appropriate land use.

h. Utilise existing structures associated with construction and demolition works as a visual screen.

i. The specification for planting, establishment maintenance, long-term management and associated monitoring.

7.6.7 Monitoring of effects and proposed mitigation will be detailed within the ES.

7.7 Assessment of likely significant effects

7.7.1 The LVIA is at an early stage and will be developed in detail based on the desk studies, continued fieldwork and consultation described above. Preliminary findings are discussed below for construction and the residual effects of operation, taking account of embedded mitigation.

Arboricultural Impacts

7.7.2 The Scheme has been designed to minimise any impact on trees and woodland where possible as set out in Chapter 3: Assessment of Alternatives. Following a review of preliminary tree survey information, covering over 2,000 tree features (individual trees, hedges, groups of trees, woodland), available to date (which is subject to change as further tree survey data is collected, processed and analysed), the Scheme is currently likely to require the removal of a substantial number of trees including those of moderate and high quality.

7.7.3 A preliminary assessment of the Scheme has identified that 226 individual trees (comprising 41 high quality, 107 moderate quality and 78 low quality features), 102 full tree groups or hedges (one high quality, 25 moderate quality and 77 low quality) and part of 55 groups, hedges or woodlands (four high quality, 20 moderate quality and 31 low quality) are likely to require removal to facilitate the Scheme. In addition, 26 individual trees and

three groups which are considered unsuitable for retention for more than 10 years are also to be removed. This is a preliminary assessment only and the final number of trees to be removed or impacted will be subject to change and will be finalised for the ES.

7.7.4 There are multiple contrasting definitions for the classification of veteran trees and therefore at this stage those trees considered likely to constitute veteran status are included as potential veterans (and will be subject to further review and assessment).

7.7.5 Eight individual potentially veteran trees and two potentially ancient trees are likely to require removal. A further four potentially veteran trees are currently undergoing further assessment to determine any loss or impact, and this will be developed and presented as part of the ES. Five potentially veteran trees may be impacted by the scheme but are not considered likely to require removal at this stage.

7.7.6 The table below summarises the current assessment of trees to be removed or impacted to facilitate the Scheme.

Table 7-2 Summary of Arboricultural Impacts

Impact	Category A (high quality)		Category B (moderate quality)	Category C (low quality)	Category U (unsuitable for retention >10 yrs)
Trees to be removed to facilitate the Scheme.	31 individual trees, one group and part of four groups	10 individual potential veteran or ancient trees	107 individual trees, 24 groups, 18 part groups, two part woodlands, one hedge	78 individual trees, 66 groups, 17 part groups, 11 hedges, 14 part hedges	26 individual trees, three groups
Trees to be directly impacted to facilitate the Scheme	Nine individual trees	Five individual potential veteran trees	Four individual trees, three groups	One group	-
Known further work required to	-	Four individual potential	-	-	-

Impact	Category A (high quality)		Category B (moderate quality)	Category C (low quality)	Category U (unsuitable for retention >10 yrs)
determine the impact of the Scheme.		veteran trees			

7.7.7 No trees within a conservation area have been identified for removal and there are no trees within Sites of Special Scientific Interest (SSSI) in proximity to areas of the Scheme. No ancient woodland is likely to be directly removed or impacted to facilitate the Scheme and the nearest works to Ancient Woodland are restricted to the footprint of existing highways only.

7.7.8 A single oak tree subject to Tree Preservation Order (TPO) (ref: *TPO/WA/2/20*) to the west of Tye Lane is close to the Scheme tie-in point and may be impacted (subject to the collection and analysis of detailed survey data in this area). No other trees subject to TPO are considered likely to be removed or impacted by the Scheme at this stage.

Arboricultural impacts from operation

7.7.9 At this stage, following tree clearance works, no additional pruning or management intervention has been identified as likely to be required for retained trees in proximity to the Scheme. Some trees may be subject to increased levels of dust or nitrogen deposition. This is unlikely to result in any significant negative impact on the health of the majority of trees; however, it could result in an impact to Ancient Woodland (and associated habitats, flora and fauna) and some veteran trees which may be more sensitive to changes in environment. This is considered further in the *Chapter 8: Biodiversity* and will be evaluated in the ES.

7.7.10 The Scheme design will continue to be developed to avoid important trees and to reduce, mitigate or compensate for any impacts where avoidance is not possible. The AIA will form an appendix to the Landscape and Visual chapter within the ES, with the results being used to inform mitigation proposals.

Landscape effects

Construction

7.7.11 During construction, the Scheme is likely to result in significant adverse landscape effects to the landscape features directly within the construction footprint and the immediate curtilage of the proposed roads, structures, junctions and construction compounds as a result of the removal of existing vegetation and changes to landform.

7.7.12 The assessment has identified that temporary significant adverse landscape effects are likely to relate to the following LLCAs as a result of the extensive and intense construction activity:

a. LLCA 2: Walberton Settled Woodland.
b. LLCA 3: Hooe Farm.
c. LLCA 4: Avisford Park.
d. LLCA 5: Walberton.
e. LLCA 6: Binsted Farmland.
f. LLCA 7: Binsted Rife.
g. LLCA 8: Binsted.
h. LLCA 9: Tortington Rife.
i. LLCA 10: Tortington Valley Sides.
j. LLCA 11: Lower Arun Valley Floodplain.
k. LLCA 12: Lyminster Arun Valley Sides.

7.7.13 Construction activity would be principally outside the SDNP boundary. Construction activity related to utilities diversions at the proposed eastern and western tie-ins of the Scheme would lie adjacent to and within very small parts of the SDNP. The iterative design process will seek to avoid or minimise potential significant landscape effects, including embedded and standard mitigation measures outlined in *Section 7.6*.

Operation

7.7.14 In operation, the Scheme is likely to result in significant adverse landscape effects as a result of the introduction of new highway infrastructure within the open landscape of the River Arun floodplain, and through the more intimate rural landscapes of Tortington, Tortington Rife, Binsted and Binsted Rife.

7.7.15 Mitigation of landscape effects includes softening and re-grading of earthworks to more natural forms, and planting to reduce fragmentation, and restore and reconnect landscape features. This would reduce the permanent landscape effects of the Scheme, but impacts resulting from the change in land use, landscape and settlement pattern, and reduction in tranquillity would not be wholly mitigated.

7.7.16 At the western and eastern tie-ins, the significance of landscape effects would be reduced compared to construction. The existing highway infrastructure in these areas reduces the susceptibility to change in these areas, where for example, tranquillity is limited in the existing baseline by traffic and lighting in these areas by the existing A27 dual carriageway. With mitigation established in these areas, it is expected landscape effects would not be significant.

7.7.17 It is anticipated that there would be significant adverse landscape effects to the following LLCAs during Scheme operation:

a. LLCA 3 Hooe Farm.
b. LLCA 4 Avisford Park.
c. LLCA 7 Binsted Rife.
d. LLCA 8 Binsted.
e. LLCA 9 Tortington Rife.
f. LLCA 10 Tortington Valley Sides.
g. LLCA 11 Lower Arun Valley Floodplain.

7.7.18 The SDNPA has identified seven special qualities within the SDNP, including reference to tranquillity and views (Ref 7-48). Further analysis of the special qualities of the SDNP will be undertaken during design development to identify potential effects. Any effects of the Scheme are unlikely to be considered significant due to the minor incursions into the SDNP. The ES will also refer to the *SDNP Partnership Management Plan (2020-2025)*, which includes reference to protecting landscape character and creating green infrastructure (Ref 7-35).

7.7.19 There are not expected to be significant adverse landscape effects to the SDNP as a result of Scheme operation. There is the potential for the Scheme to give rise to beneficial effects to the tranquillity of the SDNP and Arundel through a reduction in traffic as a result of de-trunking of the existing A27 and improvements for walkers, cyclists and horse riders.

7.7.20 The Scheme is expected to be lit with streetlights around the new Crossbush Junction and at the Western tie-in. At the Crossbush roundabout, the existing A27 is already lit and therefore the change in lighting extent in this location is not expected to give rise to significant landscape effects to LLCA 12, LLCA 13, LLCA 14 or LLCA 17.

7.7.21 At the Tye Lane slip road there is expected to be a small section of lighting required in LLCA 3 Hooe Farm, which is currently unlit. This lighting ties into the A27 to the west, which is already lit, and therefore not into a wholly unlit part of the landscape. Best practice measures would be used to reduce the impact of light spill, but it is expected the lighting would result in adverse landscape effects, albeit not significant.

7.7.22 The remainder of the Scheme between the A27 Western tie-in and Crossbush, including side roads, would not be lit.

Visual effects

Construction

7.7.23 During construction, the Scheme is likely to result in temporary significant adverse visual effects on a number of visual receptors. This would result

7-48 South Downs National Park Special Qualities. South Downs National Park Authority, (2015).

from views of construction activity, including operation of machinery such as cranes, compounds, haul roads, and laydown areas. Visual receptors likely to be experience significant adverse visual effects include:

a. Visitors to the SDNP and Arundel as a result of views from elevated positions, such as Arundel Castle, of construction activity within the River Arun floodplain.

b. Residents of Arundel with views across the River Arun floodplain to the south.

c. Residents of Tortington, Binsted, and Walberton where there would be close views of construction activity.

d. Residents at Ford with views north across the River Arun floodplain.

e. Recreational users of PRoW crossed by or in close proximity to the Scheme, including adjacent to the Church of St Mary's, Binsted, and Tortington Manor.

f. Road and rail users.

Operation

7.7.24 In operation, the Scheme is likely to give rise to significant adverse visual effects relating to the introduction of a highway, traffic, and highway infrastructure, such as signage and barriers into views.

7.7.25 Mitigation of visual effects, including the alignment of the Scheme in cutting, the introduction of bunds and barriers, and extensive screen planting, would reduce the magnitude of the permanent effects, but these effects are still expected to be significant for a number of visual receptors including:

a. Visitors to the SDNP and Arundel Castle as a result of views of the viaduct across the River Arun floodplain.

b. Residents of Arundel with views across the River Arun floodplain to the south.

c. Residents of Tortington, Binsted, and Walberton where there would be close views of the Scheme, or where the introduction of planting to mitigate views of the highway would alter the composition and characteristics of existing views.

d. Residents at Ford and Arundel with views north across the River Arun floodplain.

e. Users of PRoW crossed by the Scheme and in the vicinity of Scheme.

f. Road users and rail passengers.

7.7.26 As noted previously, photomontages will be produced to illustrate the effects of the Scheme in the year of its opening, and 15 years after opening (to account for the establishment of planting). These will be produced for both winter, to reflect the worst-case scenario when leaf cover is lowest and

therefore minimum screening, and summer. These images will be presented within the Landscape and Visual chapter of the ES and will further inform the identification of likely significant effects on landscape character and views and visual amenity.

7.7.27 There is the potential for the Scheme to introduce beneficial change within the SDNP and at Arundel through the removal of signage, introduction of planting, and reduction in visible traffic on the existing A27.

7.7.28 Further mitigation to reduce the magnitude of visual effects is being explored, in particular looking at the design and appearance of the viaduct crossing of the River Arun floodplain.

7.7.29 Based on the preliminary assessment outlined above, there is potential for significant effects to result from the construction and/or operation of the Scheme. A summary of these potentially significant effects is reported below in Table 7-3.

7.8 Scheme options

7.8.1 As described in *Chapter 2: The Scheme*, options are still being considered for the potential reprovision of Avisford Park Golf Club. In addition, a potential alternative option from the current proposed alignment where the Scheme passes between Avisford Park, the new housing development at Avisford Grange and the existing Yapton Lane is being considered. This would raise the vertical alignment of the Scheme, with an offline Yapton Lane overbridge. The sections below discuss these in turn and outline whether adopting either of these would change anything stated in the preceding baseline conditions, potential impacts and assessment of effects sections and consider the potential for different effects of the options.

Options for Avisford Park Golf Club reprovision

Option 1: 9 hole golf course with driving range or practice facilities

7.8.2 Future visual receptors would be similar to those using the existing golf course and would include views from the new car parking and clubhouse facilities. The proposed new access to the golf club off Yapton Lane and reprovision of car parking and clubhouse facilities would result in localised vegetation loss. Therefore, the reprovision of an amended golf course would result in minimal changes to the information already provided in the baseline conditions, potential impacts and assessment of effects sections of this chapter. The preliminary conclusions in terms of the potential for likely significant effects remains the same. Adopting this option would mean less change in terms of the existing land use, compared with Option 2, which means Option 1 is preferred from a landscape and visual perspective.

7.8.3 This option cannot be assessed in relation to arboriculture at this time as no design layout for the amended golf course is available. If taken forward, this option would be assessed in the AIA to be appended to the ES.

Option 2: Replacement 18 hole golf course

7.8.4 Future visual receptors would be similar to those using the existing golf course. The land is currently agricultural, which is common in the surrounding landscape. Therefore, the replacement of this with a further nine holes would have a localised impact on the landscape character, which means Option 1 is considered the better option when compared with Option 2. However, in the overall context of the assessment of the Scheme, full reprovision of the existing golf course would result in minimal changes to the information already provided in the baseline conditions, potential impacts and assessment of effects sections of this chapter. Therefore, the preliminary conclusions in terms of the potential for likely significant effects remain the same.

7.8.5 This option cannot be assessed in relation to arboriculture at this time as no design layout is available for the replacement golf course. If taken forward, this option would be assessed in the AIA to be appended to the ES.

Option for raised vertical alignment with offline Yapton Lane overbridge

7.8.6 This option would mean a raised profile of Yapton Lane which would result in increased visibility of the road infrastructure and traffic from properties off Yapton Lane and Hedgers Hill compared to the current proposed alignment. The proposed offline route would result in segregation of the local landscape as it cuts into the existing golf course and arable field enclosure. It would also result in further mature vegetation removal adjacent to and to the north-east of Yapton Lane. However, there would also be a small parcel of land to the west between the proposed route and Yapton Lane which is unlikely to be able to be returned to arable land use and could be used as mitigation for native planting to soften the appearance of the proposed infrastructure. Therefore, whilst there would be changes required to the information provided in the baseline conditions, potential impacts and assessment of effects sections of this chapter, the preliminary conclusions in terms of the potential for likely significant environmental effects remain the same.

7.8.7 This option would result in the likely retention of a potential veteran tree to the west of Yapton Lane which would otherwise be removed to facilitate the current proposed alignment of the Scheme. This tree would nevertheless be subject to a direct impact to its Root Protection Area (from earthworks, drainage and works access). At this stage it is considered likely that the tree could be retained and would tolerate this impact which would be minimised through a careful installation methodology. Whilst this tree could likely be retained, this option would also likely result in the loss of one high quality (category A) tree, two additional moderate quality (category B) trees, one moderate quality tree group and one low quality (category C) tree group which would not otherwise be removed to facilitate the Scheme. In addition, one moderate quality tree and the veteran tree to the west of

Yapton Lane would likely be subject to a direct impact but would not require removal.

7.8.8 On balance, the current proposed alignment is preferred to this option from a landscape and visual perspective.

Table 7-3 Summary of potential significant effects

Receptor	Scheme impact	Potential significant effects (following embedded mitigation)	Further mitigation to be explored
Landscape receptors			
LLCA 2: Walberton Settled Woodland	Construction	Temporary adverse landscape effects associated with the removal of existing vegetation and changes to landform.	After the implementation of the EMP, no further mitigation is likely to be required.
LLCA 3: Hooe Farm	Construction	Temporary adverse landscape effects associated with the removal of existing vegetation and changes to landform.	After the implementation of the EMP, no further mitigation is likely to be required.
	Operation	Permanent adverse landscape effects associated with the change in land use, landscape pattern and reduction in tranquillity.	After the implementation of the EMP, no further mitigation is likely to be required.
LLCA 4: Avisford Park	Construction	Temporary adverse landscape effects associated with the removal of existing vegetation and changes to landform.	After the implementation of the EMP, no further mitigation is likely to be required.
	Operation	Permanent adverse landscape effects associated with the change in land use, landscape pattern and reduction in tranquillity.	After the implementation of the EMP, no further mitigation is likely to be required.

Receptor	Scheme impact	Potential significant effects (following embedded mitigation)	Further mitigation to be explored
LLCA 5: Walberton	Construction	Temporary adverse landscape effects associated with the removal of existing vegetation and changes to landform.	After the implementation of the EMP, no further mitigation is likely to be required.
LLCA 6: Binsted Farmland	Construction	Temporary adverse landscape effects associated with the removal of existing vegetation and changes to landform.	After the implementation of the EMP, no further mitigation is likely to be required.
LLCA 7: Binsted Rife	Construction	Temporary adverse landscape effects associated with the removal of existing vegetation and changes to landform.	After the implementation of the EMP, no further mitigation is likely to be required.
	Operation	Permanent adverse landscape effects associated with the change in land use, landscape pattern and reduction in tranquillity.	After the implementation of the EMP, no further mitigation is likely to be required.
LLCA 8: Binsted	Construction	Temporary adverse landscape effects associated with the removal of existing vegetation and changes to landform.	After the implementation of the EMP, no further mitigation is likely to be required.
	Operation	Permanent adverse landscape effects associated with the change in land use, landscape pattern and reduction in tranquillity.	After the implementation of the EMP, no further mitigation is likely to be required.

Receptor	Scheme impact	Potential significant effects (following embedded mitigation)	Further mitigation to be explored
LLCA 9: Tortington Rife	Construction	Temporary adverse landscape effects associated with the removal of existing vegetation and changes to landform.	After the implementation of the EMP, no further mitigation is likely to be required.
	Operation	Permanent adverse landscape effects associated with the change in land use, landscape pattern and reduction in tranquillity.	After the implementation of the EMP, no further mitigation is likely to be required.
LLCA 10: Tortington Valley Sides	Construction	Temporary adverse landscape effects associated with the removal of existing vegetation and changes to landform.	After the implementation of the EMP, no further mitigation is likely to be required.
	Operation	Permanent adverse landscape effects associated with the change in land use, landscape pattern and reduction in tranquillity.	After the implementation of the EMP, no further mitigation is likely to be required.
LLCA 11: Lower Arun Valley Floodplain	Construction	Temporary adverse landscape effects associated with the removal of existing vegetation and changes to landform.	After the implementation of the EMP, no further mitigation is likely to be required.
	Operation	Permanent adverse landscape effects associated with the change in land use, landscape pattern and reduction in tranquillity.	After the implementation of the EMP, no further mitigation is likely to be required.

Receptor	Scheme impact	Potential significant effects (following embedded mitigation)	Further mitigation to be explored
LLCA 12: Lyminster Arun Valley Sides	Construction	Temporary adverse landscape effects associated with the removal of existing vegetation and changes to landform.	After the implementation of the EMP, no further mitigation is likely to be required.
Visual receptors			
Visitors to SDNP and Arundel	Construction	Temporary adverse visual effects associated with views of construction activity, including operation of machinery such as cranes, compounds, haul roads and laydown areas into elevated views across the River Arun floodplain.	After the implementation of the EMP, no further mitigation is likely to be required.
	Operation	Permanent adverse visual effects associated with the introduction of highway, traffic and highway infrastructure into views of the viaduct across the River Arun floodplain.	After the implementation of the EMP, no further mitigation is likely to be required.
Residents of Arundel	Construction	Temporary adverse visual effects associated with views of construction activity, including operation of machinery such as cranes, compounds, haul roads and laydown areas into elevated views across the River Arun floodplain.	After the implementation of the EMP, no further mitigation is likely to be required.

Receptor	Scheme impact	Potential significant effects (following embedded mitigation)	Further mitigation to be explored
	Operation	Permanent adverse visual effects associated with the introduction of highway, traffic and highway infrastructure into views across the River Arun floodplain to the south.	After the implementation of the EMP, no further mitigation is likely to be required.
Residents of Tortington, Binsted and Walberton	Construction	Temporary adverse visual effects associated with views of construction activity, including operation of machinery such as cranes, compounds, haul roads and laydown areas into elevated views across the River Arun floodplain.	After the implementation of the EMP, no further mitigation is likely to be required.
	Operation	Permanent adverse visual effects associated with the introduction of highway, traffic and highway infrastructure into views where there would be close views of the Scheme or where introduction of planting to mitigate views of the highway would alter the composition and characteristics of existing views.	After the implementation of the EMP, no further mitigation is likely to be required.
Residents at Ford	Construction	Temporary adverse visual effects associated with views of construction activity, including operation of machinery such as cranes, compounds, haul roads and laydown areas into elevated views across the River Arun floodplain.	After the implementation of the EMP, no further mitigation is likely to be required.

Receptor	Scheme impact	Potential significant effects (following embedded mitigation)	Further mitigation to be explored
	Operation	Permanent adverse visual effects associated with the introduction of highway, traffic and highway infrastructure into views into views north across the River Arun floodplain.	After the implementation of the EMP, no further mitigation is likely to be required.
Users of the PRoW crossed by or in close proximity	Construction	Temporary adverse visual effects associated with views of construction activity, including operation of machinery such as cranes, compounds, haul roads and laydown areas into views, including adjacent to the Church of St Mary's, Binsted and Tortington Manor.	After the implementation of the EMP, no further mitigation is likely to be required.
	Operation	Permanent adverse visual effects associated with the introduction of highway, traffic and highway infrastructure into views.	After the implementation of the EMP, no further mitigation is likely to be required.
Road users and rail passengers	Construction	Temporary adverse visual effects associated with views of construction activity, including operation of machinery such as cranes, compounds, haul roads and laydown areas.	After the implementation of the EMP, no further mitigation is likely to be required.
	Operation	Permanent adverse visual effects associated with the introduction of highway, traffic and highway infrastructure into views.	After the implementation of the EMP, no further mitigation is likely to be required.

8. Biodiversity

8.1 Introduction

8.1.1 This chapter describes the baseline habitats, protected and notable species and designated sites present within the study area (refer to *Section 8.4*), how these would be potentially impacted by the Scheme and the measures proposed to avoid, reduce or mitigate and compensate the potential impacts. Measures that would contribute towards enhancement of biodiversity at local and landscape scales are also described and clearly identified as enhancement rather than mitigation.

8.1.2 This chapter is supported by the following figures and appendices:

a. Figure 8-1 – Statutory Designated Sites (International, National Sites and Local Nature Reserves)

b. Figure 8-2 – Non-statutory Designated Sites and Ancient Woodland within 2 km of the draft Order Limits and Veteran Trees Identified as Potentially Being Affected by Changes in Air Quality

c. Appendix 8-A – Habitat Regulations Assessment (HRA) Screening

8.1.3 There may be interrelationships related to the potential effects on the biodiversity features and other disciplines. Reference should also be made in particular to the following chapters:

a. Chapter 5: Air Quality

b. Chapter 6: Cultural Heritage

c. Chapter 7: Landscape and Visual

d. Chapter 11: Noise and Vibration

e. Chapter 13: Road Drainage and Water Environment

8.1.4 Key biodiversity legislation, policy (national and local) and guidance in relation to protected and notable biodiversity sites, habitats, and species relevant to the Scheme and considered as part of the assessment are listed below:

a. The Conservation of Habitats and Species Regulations 2017 (as amended) (Ref 8-1)

b. The Wildlife and Countryside Act 1981 (as amended) (Ref 8-2)

c. The Countryside and Rights (CRoW) of Way Act 2000 (Ref 8-3)

d. The Natural Environment and Rural Communities (NERC) Act 2006 (Ref 8-4)

Ref 8-1 London: The Stationery Office. The Conservation of Habitats and Species Regulations 2017 (SI 2017/1012).
Ref 8-2 London: The Stationary Office. Wildlife and Countryside Act 1981 (c.69).
Ref 8-3 London: The Stationery Office. Countryside and Rights of Way Act 2000 (c.37).
Ref 8-4 London: The Stationery Office. Natural Environment and Rural Communities Act 2006 (c.16).

e. The Protection of Badgers Act 1992 (Ref 8-5)

f. The Environment Act 2021 (Ref 5-7)

g. The Hedgerows Regulations 1997 (Ref 8-6)

h. The Water Environment (WFD) (England and Wales) Regulations 2017 (Ref 8-7)

i. *NPSNN* (Ref 1-7)

j. *NPPF* (Ref 1-8)

k. ADC – *Arun Local Plan 2011-2031* (adopted July 2018) (Ref 1-12)

l. SDNPA – *South Downs Local Plan 2014-2033* (Adopted 2 July 2019) (Ref 1-13)

m. Biodiversity and Planning in Sussex (Ref 8-8)

8.1.5 This stage of the assessment process has been undertaken in accordance with the standards as set out in:

a. *DMRB LA 108 Biodiversity Revision* 1 (Ref 8-9)

b. *DMRB LA 115 Habitats Regulations Assessment Revision 1* (Ref 8-10)

c. *DMRB LD 118 Biodiversity Design Revision 0* (Ref 8-11)

8.1.6 Supplementary DMRB standards in relation to air quality impacts on biodiversity, which falls primarily within the scope of *Chapter 5: Air Quality*, but which overlap with this chapter, are set out within:

a. *DMRB LA 105: Air Quality (Revision 0)* (Ref 5-1)

8.1.7 Supplementary DMRB standards in relation to Groundwater Dependent Terrestrial Ecosystems (GWDTE) which fall primarily within the scope of *Chapter 13: Road Drainage and the Water Environment*, but which overlap with this chapter, are set out within:

a. *DMRB LA 113 Road Drainage and the Water Environment* (Revision 1) (Ref 8-12)

8.1.8 As specified within *DMRB LA 108* Section 3.11.1, the method used for the ecological assessment also follows the Chartered Institute of Ecology and Environmental Management (CIEEM) Guidelines for Ecological Impact Assessment (Ref 8-13).

Ref 8-5 London; The Stationary Office. The Protection of Badgers Act 1992 (c.51)
Ref 8-6 London: The Stationery Office. The Hedgerows Regulations 1997 (SI 1997/1160)
Ref 8-7 London: The Stationery Office. The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017
Ref 8-8 Sussex Wildlife Trust (undated) Biodiversity and Planning in Sussex
Ref 8-9 Highways England (2019) LA 108 Biodiversity.
Ref 8-10 Highways England (2019) LA 115 Habitats Regulations Assessment.
Ref 8-11 Highways England (2019) LD 118 Biodiversity Design.
Ref 8-12 Highways England (2019) LA 113 Road drainage and the water environment.
Ref 8-13 CIEEM (2018) Guidelines for Ecological Impact Assessment in the UK and

8.2 Stakeholder engagement

8.2.1 *EIA Scoping Opinion* (Appendix 1-B) responses regarding biodiversity have been received from the Planning Inspectorate, the relevant planning authorities of ADC, WSCC and SDNPA, and Natural England, Environment Agency, and Forestry Commission. This PEI Report seeks to address some of these responses; others will be addressed in full in the ES once the baseline data and the Scheme designs are fully developed.

8.2.2 Consultation on biodiversity aspects was undertaken with key stakeholders prior to the determination of the preferred route for the Scheme. Further consultation in relation to biodiversity has been undertaken in 2021 and will continue as work towards the ES progresses.

8.2.3 The key stakeholders involved in consultation regarding the Scheme and biodiversity, as part of Focus Group meetings held throughout 2021 (27 January 2021, 23 February 2021 and 23 March 2021) are listed below:

a. Natural England
b. Environment Agency
c. ADC
d. Forestry Commission
e. SDNPA
f. WSCC

8.2.4 A biodiversity sub-group meeting was held on 20 May 2021 with the above key stakeholders. The meeting included discussions on the scope of ecological surveys to inform the biodiversity baseline and approach for mitigation.

8.2.5 In addition to the Focus Group and sub-group meetings, targeted meetings have also been held with Natural England regarding bats. This has involved discussions on advanced bat survey techniques (21 April 2021) and evolutions of Scheme design, including a site visit in September 2021 to maintain ecological connectivity at a local and landscape scale.

8.3 Assessment assumptions and limitations

8.3.1 This chapter presents a preliminary description of the ecological features within the study area (*Section 8.4*) and the potential ecological impacts and significant effects arising from the Scheme. The ecological baseline presented herein is based on third party data obtained as part of a desk study and data from field surveys undertaken between 2017 and 2021. The baseline is subject to limitations arising from:

a. Information obtained during the course of a desk study is dependent on people and organisations having made and submitted records for the

Ireland: Terrestrial, Freshwater, Coastal and Marine, Version 1.1 – Updated September 2019, CIEEM, Winchester.

area of interest. As such, a lack of records for a particular habitat or species does not necessarily mean that the habitats or species do not occur in the study area. Likewise, the presence of records for particular habitats and species does not automatically mean that these still occur within the area of interest or are relevant in the context of the Scheme. However, where there were gaps in the available information, we have undertaken field surveys for the Scheme and have confirmed presence/likely absence within the Survey Area.

b. Surveys for lichens, fungi and barn owl were not complete at the time of writing this report. Therefore, a preliminary assessment has been included below. The assessment is ongoing and will be reported in the ES.

c. Data analysis and reporting is still ongoing at the time of writing this report. Therefore the results presented within this report are subject to change. A precautionary approach has been adopted in the preliminary assessment reported below. The full results of the surveys will be reported within the ES.

8.3.2 When assessing the Scheme's potential biodiversity effects, the assessment takes into account the embedded mitigation measures that have been integrated into the design as shown in the PLEM (provided in Figure 2-1). The assessment is subject to limitations as the design of the PLEM is an iterative process and will continue to be developed as further survey data is analysed. The final PLEM will be submitted with the ES. At this stage however, the PLEM is considered to be sufficiently developed to allow an initial assessment of biodiversity effects of the Scheme on the study area to be undertaken.

8.3.3 Embedded ecological mitigation to address potential significant effects on biodiversity receptors is evolving. The design of these features has been based on professional best practice guidelines and standards, and scientific research available at that time.

8.3.4 Previous surveys undertaken between 2017 and 2019 used different survey areas to the 2020 and 2021 surveys since the 2017 to 2019 surveys were undertaken for an earlier design iteration of the Scheme. However, the survey areas associated with the 2017 to 2019 surveys overlap with the study area defined for the current design of the Scheme and this data has been used to determine the scope of the field surveys undertaken in 2020 and 2021 as well as to inform this assessment of potential impacts alongside the 2020/2021 data. The 2020/2021 baseline reports including these results are currently in production, so are unavailable for the PEI Report at the time of writing. However, the data gathered throughout the survey period has been reviewed to inform the assessment presented here, the PLEM and Scheme design.

8.4 Study area

8.4.1 A variety of study areas has been defined and applied in the assessment, based on the consideration of the likely Zone of Influence (ZoI) of the Scheme on ecological features (habitats, protected and notable species and designated sites). Study area definition has been informed using a combination of professional judgement, good practice guidance where that exists, National Highways standards, and guidance contained within the CIEEM guidelines (refer to *Section 8.1* for references), which define the ZoI as:

"…the area over which ecological features may be affected by biophysical changes as a result of the proposed project and associated activities".

8.4.2 The study area extends beyond the draft Order Limits (the extent of land to be acquired or used permanently or temporarily), for example where there are ecological or hydrological links beyond the draft Order Limits. The ZoI therefore differs for different ecological features and the impacts considered.

8.4.3 In accordance with *DMRB LA 115* (Ref 8-14), the study area for sites designated at an international/European level (Special Area for Conservation (SAC), candidate SAC (cSAC), Special Protected Area (SPA), possible SAC (pSAC), potential SPA and Ramsar) has been defined using the following criteria:

a. The European site or its functionally linked land are located within 2 km of the Scheme.

b. The European site is designated for bats and is located within 30 km of the Scheme.

c. The Scheme crosses or lies adjacent to, upstream of, or downstream of, a watercourse which is designated part or wholly as a European site.

d. There are potential hydrological or hydrogeological linkages to a European site that may require further assessment in accordance with *DMRB LA 113* (refer to *Section 8.1* for reference).

e. There is the possibility that the Affected Road Network (ARN) will require assessment for effects on European sites in accordance with *DMRB LA 105* (refer to *Section 8.1* for reference).

8.4.4 For other designated sites, the ZoI varies dependent on the reasons for designation:

a. Sites of Special Scientific Interest (SSSI) and National Nature Reserves (NNR) have been considered within 2 km of the Scheme or where their

impact zones, as defined by Natural England, extended into the draft Order Limits.

b. Sites designated at a local level (Local Nature Reserves (LNR)), non-statutory designated sites (Local Wildlife Sites (LWS)) and ancient woodlands have been considered up to 2 km from the draft Order Limits or otherwise within 200 m of the wider ARN to account for the zone of influence for deposition of nutrient nitrogen from road traffic emissions (as assessed in *Chapter 5: Air Quality*).

8.4.5 For protected and notable species, third party data has been obtained and considered up to 2 km from the centreline of the Scheme.

8.4.6 Table 8-1 outlines the study area for each species and habitat survey completed in 2020/2021. This has considered the Scheme at its current stage of development, the ecology of the species or habitat and the types of impact that potentially arise from highway schemes. All ZoIs will be continually reviewed and if necessary updated as work is completed towards finalisation of the ES.

Table 8-1 Ecological field surveys (2020/21)

Ecological surveys	Study area for 2020/2021 surveys
Phase 1 habitat	A survey of all habitats within 100 m of the centreline of the Scheme was undertaken in 2020/21.
Grassland, woodland, arable weed and hedgerow	This includes: a. Hedgerow surveys in May 2021 (according to wildlife and landscape criteria of Hedgerow Regulations 1997) of hedgerows within the draft Order Limits. b. National Vegetation Classification (NVC) survey of suitable areas of woodland within 100 m of the centreline of the Scheme, carried out in May 2021. c. NVC survey of suitable grassland habitat within 100 m of the centreline of the Scheme, carried out in June 2021. d. Survey for scarce arable flora of suitable habitat within 100 m of the centreline of the Scheme, carried out in July 2021.
Lower plant surveys	Fungi and lichen surveys were undertaken between September and December 2021, comprising a survey of suitable habitat within 100 m of the centreline of the Scheme.

Ecological surveys	Study area for 2020/2021 surveys
Aquatic macrophytes	Surveys of six reaches within the River Arun, Binsted Rife, Tortington Rife, their tributaries and other watercourses and ponds within the draft Order Limits. The surveys were undertaken during August 2021.
Aquatic invertebrates	Surveys of 16 reaches within the River Arun, Binsted Rife, Tortington Rife, their tributaries and other watercourses and ponds within the draft Order Limits. The surveys were undertaken in autumn (October) 2020 and spring (March 2021) and summer 2021 (September 2021).
Pond PSYM (Predictive System for Multimetrics)	Six ponds were surveyed in August 2021.
Terrestrial invertebrates	Surveys focused on butterflies, moths and other terrestrial invertebrates, including groups such as molluscs, beetles, spider and ants. Surveys were carried out over the period June to September 2021. Sampling was focused on representative habitats within the draft Order Limits.
Fish	Targeted survey, including environmental DNA (eDNA) survey, of two reaches within the River Arun, Binsted Rife, Tortington Rife, their tributaries and other watercourses within the draft Order Limits. Surveys comprising electric fishing and eDNA were undertaken in August 2021 and December 2021.
Great crested newts (GCN)	Assessment of all waterbodies located within 500 m of the centreline of the Scheme, including eDNA survey of ponds in April 2021, where necessary.
Reptiles	Survey of suitable reptile habitat within the draft Order Limits in the period March to September 2021.
Wintering birds	Two transect surveys of representative habitats across the draft Order Limits were completed between October 2020 and March 2021. The transects included point counts of selected habitats.
Breeding birds	Two transect surveys of representative habitats across the draft Order Limits were completed between March

Ecological surveys	Study area for 2020/2021 surveys
	and July 2021. The transects included point counts of selected habitats. The transect routes were selected to cover those habitats that provide the greatest diversity for breeding birds.
Barn owls (*Tyto alba*)	Habitat assessment up to 1.5 km from the centreline of the Scheme and survey of potential breeding and resting sites in December 2020 and October 2021 located up to 500 m from the centreline of the Scheme.
Badgers (*Meles meles*)	Survey of suitable habitat up to 250 m from the centreline of the Scheme was undertaken and was extended to areas outside the 250 m where previous surveys had identified main or subsidiary setts, which could be within the territory of a badger clan affected by the Scheme. Territory Mapping survey of main setts was undertaken in March and April 2021.
Bats	Bat roost survey of trees and structures located within the draft Order Limits. Automated static bat detector surveys were undertaken at 18 locations. Detectors were deployed for five consecutive nights each month from June to August 2020, inclusive, at 12 locations and from September to October 2020 inclusive at six locations. Six different bat activity transects were undertaken. Two were undertaken once a month between June and October 2020 inclusive, two were undertaken between June and August 2020, inclusive, and two were undertaken in September and October 2020, inclusive. Crossing point surveys at locations along the route of the Scheme over the period 2020 to 2021. Trapping and radio-tagging of bats at locations along or adjacent to the Scheme in the pre-maternity, post-maternity and autumn dispersal periods over 2019 to 2021, apart from in 2020 when pre-maternity was not covered and autumnal dispersal was not covered in 2019. Radiotracking of bats in these seasons was undertaken, with the furthest bat being recorded up to 4km from the Scheme. Aerial monitoring of radio-tagged bats at locations across the Scheme in summer and autumn 2021.

Ecological surveys	Study area for 2020/2021 surveys
Hazel dormouse (*Muscardinus avellanarius*)	Dormouse surveys undertaken in 2017 and 2018 confirmed the presence of dormouse within the vicinity of the A27. In 2020/2021 the following surveys were completed in selected areas of suitable habitat that had not been previously surveyed for dormouse within and immediately adjacent to the draft Order Limits: a. Nut searches in November 2020 b. Nest tube presence/absence surveys were undertaken between August and November 2020 and between April to November 2021.
Water voles (*Arvicola amphibius*)	Survey of all suitable water vole habitat within the draft Order Limits during July and September 2020 and June, July, August and November 2021.
Otters (*Lutra lutra*)	Survey of all suitable water vole habitat within the draft Order Limits during July and September 2020 and June, July, August and November 2021.

Field surveys

8.4.7 Baseline ecology within the study area has been determined taking into account the findings of the habitat and species surveys as outlined in Table 8-2, as well as the surveys undertaken between 2017 and 2019. The scope of the 2020/2021 surveys has been defined though the review of previous survey work (2017 to 2019), updated desk study, site walk-over survey and consultation.

Table 8-2 Ecological field surveys (2017-2019)

Ecological surveys undertaken between 2017 and 2019
Arable Weed Surveys Surveys carried out in July 2017.
Aquatic Surveys Walkover Surveys to assess suitable waterbodies in 2017. Further surveys as required following walkover assessment. River Habitat Surveys/River Corridor Surveys undertaken in 2017. Aquatic Macroinvertebrates undertaken in 2017. Fish undertaken in 2017.

Ecological surveys undertaken between 2017 and 2019
Predictive System for Multimetrics undertaken in 2018.
Badger Surveys Walkover surveys – site walkover to record any badger setts or other features (latrines, etc) in November 2017, January to February 2018, and October 2018.
Barn Owl Surveys Stage 1 – site walkover to record features of the habitat which may support barn owls. Stage 2 – a detailed investigation of the features identified during Stage 1 to record Potential Nest Sites (PNS), Active Roost Sites (ARS), Temporary Rest Sites (TRS), and Potential Foraging Habitat (PFH). Stage 3 – further detailed investigation during the barn owl breeding survey (specifically between June to July) to identify breeding activity.
Bats Transect and static detector surveys undertaken in 2017 and 2018. Trapping and radiotracking in 2017 and 2018. Bat emergence survey in 2018
Breeding Birds Dawn transect surveys undertaken in March to June 2017 and April to June 2018. Dusk transect surveys undertaken in June 2017. Nightingale-specific suitable habitat surveys undertaken in May 2018.
Wintering Birds Transect surveys undertaken in 2017 and 2018 Vantage point and intertidal surveys in 2017, 2018 and 2019
Hazel Dormouse Nest tubes/boxes installed for monitoring in May 2017 (nine areas) and May 2018 (two areas). Checks of tubes/boxes undertaken monthly from June-November 2017 and 2018.
Grassland National Vegetation Classification Surveys undertaken in June 2017 and 2018.

Ecological surveys undertaken between 2017 and 2019
Great Crested Newt (GCN) Presence/absence surveys in 2017. eDNA surveys in 2018.
Otter and Water Vole Presence/absence surveys undertaken in June, July and September 2017; and May June and September 2018.
Phase 1 Walkover surveys undertaken July and September 2017, May-July and October 2018.
Reptiles Habitat suitability assessment undertaken August 2017 and February 2018. Presence/absence surveys undertaken September and October 2017, April to June 2018.
Terrestrial Invertebrates Site Walkover to assess suitable habitats undertaken in May 2017, and 2018. Sampling surveys undertaken May, July, August and September 2017, and May to July 2018.
Watercourse Flora Botanical surveys undertaken in September-October 2017 and June 2018.
Woodland Site Walkover – initial assessment identifying types of woodland present across site in May 2017. National Vegetation Classification Surveys undertaken in May to June 2017, and May 2018.

8.5 Biodiversity receptors

8.5.1 This section describes the baseline conditions recorded within the study area (as defined by the distances detailed in Table 8-1). It includes the preliminary identification of possible impacts and effects on ecological features, the potential necessary mitigation measures and also where enhancement measures may be achieved within the design.

Statutory designated sites

8.5.2 The statutory sites designated for nature conservation (biodiversity) interests that are of international or national importance are listed in Table 8-3 and illustrated in Figure 8-1. This sub-section considers each of the internationally designated sites, the potential for impacts and effects due to the Scheme and the appropriate design, mitigation and enhancement measures. A HRA Screening assessment has also been carried out to support this assessment and should be read in conjunction with this chapter (refer to Appendix 8-A).

8.5.3 Each internationally designated site also has one or more national designations and, to avoid duplication, all the impacts on the nationally designated sites are considered concurrently with the international sites in the text.

8.5.4 There are two LNR within 200 m of the ARN as outlined in Table 8-3.

8.5.5 There would be no direct impacts to any statutory designated sites as a result of the Scheme and therefore the following section considers the potential for indirect impacts on these sites.

Table 8-3 Statutory designated sites of nature conservation importance within the study area

Designated site	Proximity to the Scheme (approx.)	Summary of designation
Statutory Sites of International Importance (SSSI)		
Solent and Dorset Coast SPA	5.1 km south	Site is designated to protect the open water marine foraging habitat of the breeding common, little and sandwich tern populations of the various SPAs of the Solent and Dorset Coast (the closest of which to the Scheme is Pagham Harbour SPA 11 km to the south-west), as these other SPAs only protect the nesting habitat of those species.
Arun Valley SAC	6.3 km north	Designated for the presence of ramshorn snail population.
Arun Valley SPA	6.3 km north	Designated for the following: a. Bewick's swan (Cygnus Columbianus bewickii) b. Waterfowl

Designated site	Proximity to the Scheme (approx.)	Summary of designation
Arun Valley Ramsar	6.3 km	a. Designated for the following: b. Ramsar criterion 2 - The site holds seven wetland invertebrate species listed in the British Red Data Book as threatened. One of these, *Pseudamnicola confusa*, is considered to be endangered. The site also supports four nationally rare and four nationally scarce plant species. c. Ramsar criterion 3 - In addition to the Red Data Book invertebrate and plant species, the ditches intersecting the site have a particularly diverse and rich flora. All five British duckweed *Lemna* species, all five water-cress *Rorippa* species, and all three British water milfoils (*Myriophyllum* species), all but one of the seven British water dropworts (*Oenanthe* species), and two-thirds of the British pondweeds (*Potamogeton* species) can be found on site. d. Bewick's swan e. Waterbird assemblage
Singleton & Cocking Tunnels SAC	10.5 km north-west	Designated for the populations of Barbastelle bat (*Barbastella barbastellus*) and Bechstein's bat (*Myotis bechsteinii*)
The Mens SAC	14.4 km north	Designated for the presence of beech forest and the population of Barbastelle bat
Ebernoe Common SAC	17.9 km north	Designated for the presence of beech forest and the populations of Barbastelle and Bechstein's bat

Designated site	Proximity to the Scheme (approx.)	Summary of designation
Statutory Sites of National Importance		
Arundel Park SSSI	350 m north	Beech woodland, chalk grassland and a lake supporting notable plant, invertebrate and bird populations
Fairmile Bottom SSSI (and LNR)	1.4 km north	Woodland and chalk grassland on a scarp slope that supports notable plants and invertebrates.
Adur Estuary SSSI	Within 200 m of the ARN	Saltmarsh habitat and intertidal mudflats which are important for a variety of wading birds.
Statutory Sites of County Importance		
Widewater Lagoon LNR	Within 200 m of the ARN	A landlocked brackish lagoon, which supports a variety of bird species.
Lancing Ring LNR	Within 200 m of the ARN	Important for its chalk grassland. Other habitats present include woodland and dewpond.

Solent and Dorset SPA

8.5.6 The Solent and Dorset SPA is located approximately 6.9 km to the south of the Scheme and lacks any habitat connections with the Scheme. Therefore, no impacts upon the qualifying features of the SPA or its functionally-linked habitat are anticipated during Scheme construction or operation.

Arun Valley SPA/SAC/Ramsar

Potential impacts (construction and operation)

8.5.7 The potential impact pathways that have been identified for the Arun Valley SPA/SAC/Ramsar are as follows as outlined in Appendix 8-A:

a. Saline wedge pushed up the valley; and

b. Loss of functionally-linked land used by Bewick's swan or other qualifying species.

8.5.8 Saline wedges occur in estuaries where tidal motion is weak or absent, resulting in wedge-shaped bottom layers of salt water that do not mix with the overlaying freshwater. Changes in the saline wedge can lead to alterations to habitat structure and function through the associated

increases in salinity. The tidal flow in the River Arun can reach speeds of 6 knots (approximately 3 m/s) under normal tidal conditions, resulting in visible turbulence along the banks and where it passes through bridges. As an estuary it is thus well mixed, and stratification will not occur. Thus, a classic saline wedge where fresh water sits on top of saline water will not occur. However, a gradation in salinity from the sea to the normal tidal limit is likely to occur. The proposed crossing of the Arun Valley is a viaduct with a clear span across the river channel and would therefore have no effects on in channel flows.

8.5.9 Modelling has shown that the viaduct crossing would have insignificant effects on any floodplain flows during either extreme tidal or fluvial events even allowing for climate change. Even locally, differences in water depths on the floodplain with the viaduct are equivalent to less than 1% of the typical depth during a fluvial event and less than 0.5% during an extreme tidal event.

8.5.10 Taking the above into consideration, no impacts on the qualifying features of the Arun Valley SAC or Ramsar are anticipated as a result of the Scheme.

8.5.11 Bewick's swan are a qualifying feature of the Arun Valley SPA and Ramsar sites and are known to make extensive use of habitat (including arable land and grassland) outside the boundary of these designated sites. Survey of bird assemblage in proximity to the Scheme alignment in the winter periods of 2017/18, 2018/19 and 2020/21 has not identified any evidence of Bewick's swan making use of land near or within the Scheme draft Order Limits.

8.5.12 The Supplementary Advice on the Conservation Objectives for the SPA states that, in addition to Bewick swan, key assemblage species comprise: wigeon, teal, shoveler, pintail, lapwing, ruff, black-tailed godwit and green sandpiper. The only species listed and found at land in or adjacent to the survey area were teal, lapwing and green sandpiper. All such species were recorded on a single occasion. Therefore, there is no evidence to suggest that these species make significant use (i.e., use by more than 1% of the SPA population on a regular basis) of farmland in or close to the Scheme footprint.

8.5.13 There is therefore no evidence of functionally-linked habitat within or close to the Scheme and no impacts are anticipated on the qualifying bird populations of the Arun Valley SAC and Ramsar site.

Singleton & Cocking Tunnels SAC

8.5.14 Singleton & Cocking Tunnels SAC comprises two disused brick railway tunnels that are used by hibernating Bechstein's bat and Barbastelle bat.

Potential impacts (construction)

8.5.15 There is potential for the Scheme to result in the loss of habitat that is functionally-linked to the SAC, or to disrupt routes used by qualifying bat

populations to commute to and from the hibernation site (or for foraging during winter).

8.5.16 As a result of radiotracking of Barbastelle, the *Sussex Bat Special Area of Conservation Planning and Landscape Scale Enhancement Protocol* (2017) has been created by Natural England and SDNPA (Ref 8-15). This identifies suitable habitat up to 12 km from The Mens SAC and Ebernoe Common SAC as 'the wider conservation area which is the full extent of the range of foraging areas required by the bats'. The same 12 km distance was also applied to Singleton & Cocking Tunnels SAC in the Sussex Bat Protocol as the bats associated with the SAC (particularly Barbastelle) can actively forage in winter. The western end (to the north of Walberton) of the Scheme falls just within this 12 km area of consideration for Singleton & Cocking Tunnels SAC.

8.5.17 National Highways is aware of swarming studies (including ringing of bats) being undertaken at Singleton & Cocking Tunnels SAC, outside the tunnel entrances. These are not frequent, consisting of 2-3 visits per year (none for the last two years due to COVID-19) but Bechstein and Barbastelles have been recorded. Although the site is not designated for swarming, swarming is a likely function of mating pre-hibernation. While no bats ringed during swarming at the tunnels have ever been recorded in the vicinity of the Scheme (e.g., at Slindon), this is not conclusive due to lack of a systematic ringing programme.

8.5.18 Survey has demonstrated that Barbastelle bat and Bechstein's bat make regular use of the following features that are crossed by the route of the Scheme:

a. Existing A27 at Ashbeds
b. Binsted Rife
c. Hedgerows south of Lake Copse
d. Tortington Rife
e. Tortington Lane

8.5.19 Construction of the Scheme would result in the loss and severance of habitats that are regularly used by these bat populations and may prevent them from accessing their roosts and foraging areas throughout their yearly life cycle. This could lower breeding success and reduce population levels over time. At this stage, until the bat underpass and green bridge design has been agreed with Natural England, it is not possible to dismiss a potential likely significant effect on the favourable conservation status of the qualifying features of the Singleton & Cocking Tunnels SAC; namely Barbastelle bat and Bechstein's bat.

Ref 8-15 Natural England and South Downs National Park Authority (2017) Sussex Bat Special Area of Conservation Planning and Landscape Scale Enhancement Protocol.

Potential impacts (operation)

8.5.20 During Scheme operation there is potential for an increase in mortality of Barbastelle and Bechstein's bats through accidental collision with vehicles. In the absence of mitigation, this has the potential to lead to lower population levels and reduced breeding success, undermining the favourable conservation status of the qualifying features of the Singleton & Cocking Tunnels SAC.

Design and mitigation measures (embedded)

8.5.21 Design is focused on maintaining the ecological function of commuting and foraging areas that are used by Barbastelle and Bechstein's bats and other bat species. The approach to mitigation takes the form of strategically located green bridges and underpasses. These structures would be integrated into the road and landscape design of the Scheme and would be designed to support habitats suitable for bats, comprising hedgerows and trees (green bridges) or watercourses (underpasses). These habitats would link to retained features in the surrounding landscape that are known to be used by Barbastelle and Bechstein's bats. Sensitive landscaping would be designed to encourage bats towards the structures and away from the corridor of the road. Construction would also be carefully timed so that ecological connections are maintained for bats throughout the Scheme construction period.

8.5.22 Landscape planting that increases the coverage of suitable bat habitat and connects favoured foraging and commuting habitat would offset the loss and severance of bat commuting routes.

The Mens SAC and Ebernoe Common SAC

8.5.23 The Mens SAC is designated for the presence of Barbastelle bat and Ebernoe Common SAC is designated for the presence of both Barbastelle bat and Bechstein's bat. As described above, radiotracking surveys have defined a 12 km wider conservation area around the SACs that covers the foraging area required to support the bat populations.

8.5.24 The only potential impact pathway is loss of functionally-linked habitat or related disruption of commuting routes for bats that roost at the SAC. However, as outlined in the HRA Screening report (Appendix 8-A), the scheme lies approximately 15.8 km south of Mens SAC and 18.7 km south of Ebernoe Common. Therefore, the Scheme falls well outside the 12 km wider conservation area from both these SACs and it is considered that there would be no direct or indirect impacts during construction or operation.

Arundel Park SSSI & Fairmile Bottom SSSI & LNR

8.5.25 Arundel Park SSSI and Fairmile Bottom SSSI and LNR both support mosaics of woodland and grassland habitats that are sensitive to significant alterations in the levels and deposition of aerial pollutants that could occur as a result of the Scheme. Preliminary investigation has indicated that the Scheme may reduce the levels of nitrogen oxide concentrations currently

generated by the existing A27 due to reduced traffic flows, with potential beneficial effects for habitats at each SSSI and the LNR. Therefore, at this stage no potentially significant adverse impacts on the SSSIs and LNR from aerial emissions have been identified through the air quality modelling undertaken as reported in *Chapter 5: Air Quality* in these locations. The ES will provide further analysis of the magnitude of changes in aerial emissions and any associated changes in the structure or function of habitats and their dependent species within these sites.

Adur Estuary SSSI, Widewater Lagoon LNR and Lancing Ring LNR

8.5.26 These sites are located more than 16 km from the Scheme, and therefore there would be no direct loss of habitat from these sites. However, an impact pathway has been identified, as both of these sites are located within 200 m of the ARN. Therefore, changes in the levels and deposition of aerial pollutants that could occur as a result of the Scheme could have an effect on these sites. Air quality modelling undertaken to date indicates that there would be no change in nitrogen deposition at these sites, therefore no significant effects on these sites are currently predicted from the construction or operation of the Scheme.

Non-statutory designated sites

8.5.27 There are eight non-statutory designated sites within 2 km of the proposed draft Order Limits that are of either national or county importance (Figure 8-2). There is also a single Designated Road Verge of county importance within the Scheme boundary (along the existing A27). Table 8-4 outlines these sites including their location in relation to the Scheme and a summary of their reasons for designation. This sub-section identifies the potential impacts on these sites and then considers the design, mitigation and enhancement measures which may be required.

Table 8-4 Non-statutory designated sites of nature conservation interest within the study area

Designated site	Proximity to the Scheme (approx.)	Summary of designation	Importance
Binsted Wood Complex LWS	Directly adjacent at closest point to the Scheme and within 200 m of the ARN	Mixture of ancient woodland, recent woodland, conifer plantation, shaws and species-rich pasture supporting diverse flora and butterfly assemblage.	National (areas which are classified as Ancient Woodland) County (all other parts of the site)

Designated site	Proximity to the Scheme (approx.)	Summary of designation	Importance
Rewell Wood Complex LWS	Directly adjacent at closest point to the Scheme	Rewell Wood is a large ancient woodland complex with a diversity of habitats including ancient semi-natural woodland, sweet chestnut coppice, conifer plantation, beech plantation and species-rich chalk grassland. Supports diverse butterfly assemblage.	National (areas which are classified as Ancient Woodland) County (all other parts of the site)
Poling Copse LWS	Directly adjacent eastern extent at closest point to the Scheme and within 200 m of the ARN	Ancient semi-natural woodland	National
Arun Valley, Watersfield to Arundel LWS	Directly adjacent at closest point to the Scheme	Wetland habitat associated with the River Arun floodplain. Includes network of ditches, unimproved meadow and diverse faunal assemblages	County
Slindon Bottom LWS	118 m west of the Scheme	Semi-natural and replanted ancient woodland with diverse flora	National
Fontwell Park Racecourse LWS	602 m west of the Scheme	Species-rich hay meadow	County
Warningcamp Hill and New Down LWS	1.5 km north of the Scheme	Species-rich chalk grassland and area of ancient semi-natural woodland	National

Designated site	Proximity to the Scheme (approx.)	Summary of designation	Importance
Conyers Bank LWS	1.9 km north of the Scheme	Unimproved grassland	County
Designated Road Verge	Within boundary of the Scheme (along verge of existing A27)	Assumed to be species-rich grassland and scrub	County

Potential impacts (construction)

8.5.28 The Designated Road Verge is located within the section of the existing A27 that would be de-trunked. De-trunking of the road would involve only localised habitat loss of limited extent (for installation of signage) and therefore is unlikely to undermine the conservation status of the Designated Road Verge. There would be no direct habitat loss from any other designated LWSs.

8.5.29 Depending on their distance to the Scheme, there is potential for direct and or indirect effects upon the conservation status of all eight LWSs and the Designated Road Verge as a result of habitat severance and increased habitat disturbance from alterations in noise, light, dust, water quality and human activity during Scheme construction.

Potential impacts (operation)

8.5.30 There is potential for impacts on habitat quality of LWSs and the Designated Road Verge as a result of alterations in air quality (increase in nitrogen deposition as discussed under Ancient Woodland within *Section 8.5*), water quality, noise and light during Scheme operation. Alterations in human activity as a consequence of the changes to public rights of way also has the potential to lead to effects upon habitats, for example, increased trampling of sensitive habitats.

Design and mitigation measures (embedded)

8.5.31 The impacts of habitat severance would be addressed through the maintenance of ecological connectivity between LWS habitat and the surrounding landscape. The green bridges integrated into the Scheme design would contribute to the maintenance of connectivity, alongside the use of habitat translocation. This would assist in the development of habitats and retain the translocated species assemblage and soils and the establishment of additional habitats that would form new linkages between existing habitats.

8.5.32 The proposed woodland planting around the margins of the Binsted Wood Complex LWS may improve the resilience of this habitat and enhance opportunities for colonisation of new areas by woodland specialists.

Habitats

8.5.33 The study area is dominated by areas of improved pasture and arable farmland, with meadows and damp grasslands associated around the watercourses of Binsted Rife and Tortington Rife. Ancient Woodland is present within the study area, whilst hedgerows which separate the field compartments also include veteran trees.

Ancient Woodland and Veteran Trees

8.5.34 Planning policy recognises ancient woodland and veteran trees as important and irreplaceable habitat and is afforded the highest level of protection by the NPSNN 2014 and the revised NPPF, 2021.

8.5.35 Paragraph 5.32 of the NPSNN states that "*the Secretary of State should not grant development consent for any development that would result 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 national need for and benefits of the development, in that location, clearly outweigh the loss […] Where such trees would be affected by development proposals, the applicant should set out proposals for their conservation or, where their loss is unavoidable, the reasons for this.*"

8.5.36 Paragraph 180 of the NPPF states that "*when determining planning applications, local planning authorities should apply the following principles: […] c) development resulting in the loss or deterioration of irreplaceable habitats (such as ancient woodland and ancient or veteran trees) should be refused, unless there are wholly exceptional reasons and a suitable compensation strategy exists.*"

8.5.37 There are over 110 areas of woodland that are listed on the Ancient Woodland Inventory (AWI) within 2 km of the draft Order Limits and 200 m of the ARN. Table 8-5 lists all the ancient woodlands which are within 500 m of the draft Order Limits (considered to be the zone in which significant adverse effects are most likely to arise) and those within 200 m of the ARN. All areas of ancient woodland are considered to be of National Importance.

Table 8-5 Ancient Woodland up to 500 m from the draft Order Limits and/or within 200 m of the ARN

Name	Proximity to the Draft order limits (approx.) or ARN	Category
Unnamed woodland at Slindon Common	Adjacent and within 200 m of the ARN	Ancient and Semi-Natural Woodland

Name	Proximity to the Draft order limits (approx.) or ARN	Category
Unnamed woodland East of Yapton Lane	Adjacent and within 200 m of the ARN	Ancient and Semi-Natural Woodland
Unnamed woodland to the north of Ashbeds	Within the draft Order Limits	Ancient and Semi-Natural Woodland
Batworthpark Plantation	Within the draft Order Limits and within 200 m of the ARN	Ancient Replanted Woodland
Eight unnamed woodlands	Adjacent	Ancient and Semi-Natural Woodland
One unnamed woodland	Adjacent	Ancient Replanted Woodland
Brickkiln Copse	Within the draft Order Limits	Ancient and Semi-Natural Woodland
Dane's wood. Great Deans. West and Stubbs Copse	Within the draft Order Limits and within 200 m of the ARN	Ancient and Semi-Natural Woodland
Fowlers Copse	Within the draft Order Limits	Ancient and Semi-Natural Woodland
Goblestubbs Copse	Within the draft Order Limits	Ancient and Replanted Ancient Woodland
Great Deans Wood	Within the draft Order Limits and within 200 m of ARN	Ancient and Semi-Natural Woodland
Lake Copse	Within the draft Order Limits	Ancient and Semi-Natural Woodland
Paine's Wood	Within the draft Order Limits	Ancient Replanted Woodland

Name	Proximity to the Draft order limits (approx.) or ARN	Category
	and within 200 m of ARN	
Pedlers Croft	Adjacent	Ancient and Semi-Natural Woodland
Potwell Copse	Within the draft Order Limits and within 200 m of ARN	Ancient and Semi-Natural Woodland
Steward's Copse	Within the draft Order Limits	Ancient and Semi-Natural Woodland
Stringer's piece	Within the draft Order Limits	Ancient and Semi-Natural Woodland
The Waterwoods	Within the draft Order Limits and within 200 m for ARN	Ancient and Semi-natural Woodland and Ancient Replanted Woodland
Three corner Copse	Adjacent	Ancient and Semi-Natural Woodland
Tortington common & lodge meadow	Within the draft Order Limits	Ancient and Semi-Natural Woodland
Tottington common	Adjacent	Ancient and Semi-Natural Woodland
Slindon Wood	1 m and within 200 m of the ARN	Ancient and Semi-Natural Woodland
Steward's Copse	3 m	Ancient and Semi-Natural Woodland
Hundredhouse Copse	5 m	Ancient and Semi-Natural Woodland

Name	Proximity to the Draft order limits (approx.) or ARN	Category
Unnamed woodland	6 m	Ancient and Semi-Natural Woodland
Unnamed woodland	9 m	Ancient Replanted Woodland
High wood	10 m	Ancient and Semi-Natural Woodland
Rocks Copse, Rooke's Coppice	62 m and within 200 m of the ARN	Ancient and Semi-Natural Woodland
Wincher's Copse	75 m	Ancient and Semi-Natural Woodland
Rewell Wood	80 m	Ancient Replanted Woodland
Unnamed woodland	90 m	Ancient and Semi-Natural Woodland
Slindon Wood & Common	191 m	Ancient and Semi-Natural Woodland
Unnamed woodland	186 m	Ancient and Semi-Natural Woodland
West Stubbs Copse	192 m	Ancient Replanted Woodland
Copy Thorn Copse	233 m	Ancient and Semi-Natural Woodland
Slindon Wood	243 m	Ancient Replanted Woodland
Furzefield Copse	268 m	Ancient and Semi-Natural Woodland
Butcher's Copse	288 m	Ancient and Semi-Natural Woodland
Unnamed woodland	332 m	Ancient and Semi-Natural Woodland

Name	Proximity to the Draft order limits (approx.) or ARN	Category
Unnamed woodland	346 m	Ancient and Semi-Natural Woodland
Wanley's Copse	373 m	Ancient and Semi-Natural Woodland
Spinningwheel Copse	370 m	Ancient and Semi-Natural Woodland
Unnamed woodland	406 m	Ancient and Semi-Natural Woodland
Unnamed woodland	413 m	Ancient and Semi-Natural Woodland
Butcher's Copse	415 m	Ancient Replanted Woodland
Binsted Wood	428 m	Ancient and Semi-Natural Woodland
Mill & castle hanger, old keep moat flower garden	490 m and within 200 m of ARN	Ancient and Semi-Natural Woodland
Arundel Park	494 m and within 200 m of the ARN	Ancient and Semi-Natural Woodland
Westlands Copse	Within 200 m of the ARN	Ancient and Semi-Natural Woodland
Poling Copse	Within 200 m of the ARN	Ancient and Semi-Natural Woodland
Charlow Furze Field	Within 200 m of the ARN	Ancient and Semi-Natural Woodland
Grooms Copse	Within 200 m of the ARN	Ancient and Semi-Natural Woodland
Potlands Copse	Within 200 m of the ARN	Ancient and Semi-Natural Woodland

Name	Proximity to the Draft order limits (approx.) or ARN	Category
Clapham Common	Within 200 m of the ARN	Ancient and Semi-Natural Woodland
Goring Wood	Within 200 m of the ARN	Ancient and Semi-Natural Woodland
Church Copse	Within 200 m of the ARN	Ancient and Semi-Natural Woodland
The White House Coppice	Within 200 m of the ARN	Ancient and Semi-Natural Woodland
Unnamed woodland by Slindon C of E Primary School	Within 200 m of the ARN	Ancient and Semi-Natural Woodland
Unnamed Ancient Woodland south of Long Furlong	Within 200 m of the ARN	Ancient and Semi-Natural Woodland
Unnamed Ancient Woodland East of Titnore Lane	Within 200 m of the ARN	Ancient and Semi-Natural Woodland
Unnamed Ancient Woodland West of Titnore Lane	Within 200 m of the ARN	Ancient and Semi-Natural Woodland

8.5.38 When the Natural England AWI was started in 1980, at that time woodland areas smaller than 2ha were not included in the original inventory. Government Standing Advice guidance states that ancient woodland status must be given to any woodland meeting the criteria, and surveys and map regression should be used to determine the status of each woodland. Therefore, a review of woodlands not currently listed on the AWI, but that lie within 500 m of the draft Order Limits is being carried out to assess if there are other areas of woodland which could meet the criteria for ancient woodland. The results of which will be reported within the ES.

8.5.39 Standing advice from Natural England and the Forestry Commission and as outlined in *DMRB LA 108*, veteran trees may not be very old, but they have decay features which contribute to its biodiversity, cultural and heritage value. However, there are multiple contrasting definitions for the

classification of veteran trees and therefore at this stage those trees considered likely to constitute veteran status are included as potential veterans (and will be subject to further review and assessment).

8.5.40 Tree survey and assessment work is ongoing, however at present there are circa 78 trees across the Scheme that have been identified as potentially veteran. The number of potentially veteran trees will be reviewed and updated and reported in the ES.

8.5.41 There are two trees within the draft Order Limits that have potentially been classified as 'ancient trees' due to the size of their stem diameter in relation to guidance in the book *Ancient and Other Veteran Trees - Further guidance on management* (Ref 8-16).

Potential impacts - construction

8.5.42 There are several areas of ancient semi-natural woodland on the ancient woodland inventory within the draft Order Limits, as outlined below:

a. Unnamed woodland to the north of Ashbeds – within the draft Order Limits for ecological mitigation. There would be no loss of ancient woodland at this location.

b. Potwell Copse - within the draft Order Limits for ecological mitigation. There would be no loss of ancient woodland at this location.

c. Unnamed woodland within Avisford Park Golf Club – within the draft Order Limits for reprovision of an amended golf course and ecological mitigation. There would be no loss of ancient woodland at this location.

d. Lake Copse - within the draft Order Limits for ecological mitigation. There would be no loss of ancient woodland at this location.

e. Stubbs Copse (north and south of the existing A27) - it is anticipated that there would be no loss of ancient woodland at this location as works would be minor and located within the existing A27 highway carriageway.

f. Batworthpark Plantation - it is anticipated that there would be no loss of ancient woodland at this location as works would be minor and located within the existing A27 highway carriageway.

g. Paine's wood - it is anticipated that there would be no loss of ancient woodland at this location as works would be minor and located within the existing A27 highway carriageway.

h. Great Deans - it is anticipated that there would be no loss of ancient woodland at this location as works would be minor and located within the existing A27 highway carriageway.

Ref 8-16 Ancient Tree Forum (2013) - Ancient and Other Veteran Trees - Further guidance on management

i. Brickkiln Copse - it is anticipated that there would be no loss of ancient woodland at this location as works would be minor and located within the existing A27 highway carriageway.

j. The Waterwoods - it is anticipated that there would be no loss of ancient woodland at this location as works would be minor and located within the existing A27 highway carriageway.

k. Tortington common and lodge meadows - it is anticipated that there would be no loss of ancient woodland at this location as works would be minor and located within the existing A27 highway carriageway.

l. Fowler's Copse - it is anticipated that there would be no loss of ancient woodland at this location as works would be minor and located within the existing A27 highway carriageway.

m. Goblestubbs Copse - it is anticipated that there would be no loss of ancient woodland at this location as works would be minor and located within the existing A27 highway carriageway.

n. Stewards's copse - it is anticipated that there would be no loss of ancient woodland at this location as works would be minor and located within the existing A27 highway carriageway.

o. Stringer's piece - it is anticipated that there would be no loss of ancient woodland at this location as works would be minor and located within the existing A27 highway carriageway.

8.5.43 There are no other areas of ancient woodland on the AWI within the draft Order Limits and therefore no loss of ancient woodland is expected. However, this will be reviewed and updated for the ES following completion of the review of woodlands not currently listed on the AWI.

8.5.44 Whilst there would be no direct loss of ancient woodland on the ancient woodland inventory, there is potential for habitat degradation, due to direct or indirect impacts such as disturbance of tree roots during excavation works, as well as from dust from construction activities and nitrogen deposition from construction traffic, resulting in the reduction in the condition of the ancient woodland.

8.5.45 The Scheme has been designed to minimise any impact on trees where possible as set out in *Chapter 3: Assessment of Alternatives.* The Scheme design will continue to be developed to avoid important trees and to reduce, mitigate for any impacts where avoidance is not possible. To date, it has been identified that eight individual potentially veteran trees and two potentially ancient trees are likely to require removal.

8.5.46 A further four potentially veteran trees are currently undergoing further assessment to determine any loss or impact, and this will be developed and presented as part of the ES.

8.5.47 Five potentially veteran trees may be impacted by the scheme but are not considered likely to require removal at this stage.

Potential impacts – operation

8.5.48 There would be no direct impact on ancient woodland and potentially veteran trees during operation of the Scheme. The potential operational impacts on the ancient woodland and veteran trees therefore relates to indirect impacts which could result in habitat degradation.

8.5.49 Ancient Woodlands and veteran trees are sensitive to changes in air quality. Therefore, as detailed in *DMRB LA 108*, paragraph 3.11.2 an assessment informed by the outcomes of air quality modelling in accordance with *DMRB LA 105* has been undertaken for ancient woodland and veteran trees and other sensitive ecological features (i.e., designated sites), located within 200 m of the affected road network.

8.5.50 To inform the air quality assessment on sensitive ecological features, the *DMRB LA 105* outlines that the assessment should refer to the UK Air Pollution Information System (APIS) website to obtain the background deposition rates that are used in the modelling and the critical loads for habitats. The information gathered from the APIS website is therefore used to complement the methodologies stated in *DMRB LA 105* and *DMRB LA 108* rather than replace any aspect of them.

8.5.51 With regards to changes in air quality and the effect on ancient woodland and veteran trees (and other sensitive ecological features) the assessment considers the following two elements, nitrogen oxides (NO_x) concentrations in the atmosphere and nitrogen deposition.

8.5.52 Vehicle exhaust emissions can affect vegetation by its contribution to nitrogen deposition. The addition of nitrogen is a form of fertilisation, which can have a negative effect on many habitats (depending on the scale and duration) over time by encouraging more competitive plant species that can force out the less competitive species that are more characteristic. Unlike NO_x in atmosphere, the nitrogen deposition rate below which we are confident effects would not arise is different for each habitat. APIS states that the critical load relates to the quantity of pollutant deposited from air to the ground, whereas the critical level is the gaseous concentration of a pollutant in the air. The lowest part of the critical load range for woodland is 10 kgN/ha/yr. Therefore 1% of the critical load is 0.1 kgN/ha/yr. If the forecast worst-case deposition due to the Scheme is less than 0.1 then it can be considered imperceptible.

8.5.53 *DMRB LA 105* guidance based on published nitrogen dose-response relationships for a range of habitats, advises that no significant adverse effect would occur if the maximum nitrogen dose is less than 0.4 kgN/ha/yr. This is on the basis that National Highways considers this to be the minimum dose that has been identified to be associated with a reduction in 'species richness' of one species, irrespective of background deposition rate.

8.5.54 With regards to NO_x in the atmosphere (as distinct from its role in nitrogen deposition), APIS identifies that effects are most likely to arise in the presence of equivalent concentrations of sulphur dioxide (SO_2). Vehicle

exhausts do not emit SO_2 and initial air quality modelling for the Scheme forecasts that NO_x concentrations are below the critical level and therefore a conclusion of no significant effect from change in NO_x in the atmosphere can be drawn.

8.5.55 Initial air quality modelling forecasts highlight that a number of areas of ancient woodland and veteran trees would experience negative impacts due to changes in nitrogen deposition from the Scheme. These are as follows:

a. Slindon Ancient Woodland – the nitrogen dose due to Scheme operation would exceed 1% of the critical load up to 30 m from the roadside, but would only exceed the DMRB threshold for significance of 0.4 kgN/ha/yr at the roadside itself. Therefore, although the largest dose is not so small as to be imperceptible, following *DMRB LA 105* a conclusion of no significant effect can be drawn.

b. Stubbs Copse Ancient Woodland – the nitrogen dose due to the Scheme would exceed 1% of the critical load up to 20 m from the roadside on both transect E15a and E15b, but would only exceed the DMRB threshold for significance of 0.4 kgN/ha/yr at the roadside itself. Therefore, although the largest dose is not so small as to be imperceptible, following *DMRB LA 105* a conclusion of no significant effect can be drawn.

c. Westlands Copse Ancient Woodland – similar to Stubbs Copse and Slindon Wood, the nitrogen dose due to the Scheme would exceed 1% of the critical load up to 20 m from the roadside, but would only exceed the DMRB threshold for significance of 0.4 kgN/ha/yr at the roadside. Therefore, although the largest dose is not so small as to be imperceptible, following *DMRB LA105* a conclusion of no significant effect can be drawn.

d. Poling Copse Ancient Woodland/Local Wildlife Site – similar to Stubbs Copse, Slindon Wood and Westlands Copse, the nitrogen dose due to the Scheme would exceed 1% of the critical load up to 30 m from the roadside, but would only exceed the DMRB threshold for significance of 0.4 kgN/ha/yr at the roadside. Therefore, although the largest dose is not so small as to be imperceptible, following *DMRB LA 105* a conclusion of no significant effect can be drawn.

e. Charlow Furze Field Ancient Woodland – the nitrogen dose due to the Scheme would exceed 1% of the critical load up to 10 m from the roadside, but would only exceed the DMRB threshold for significance of 0.4 kgN/ha/yr at the roadside. Therefore, although the largest dose is not so small as to be imperceptible, following *DMRB LA 105* a conclusion of no significant effect can be drawn.

f. Clapham Common Ancient Woodland, White House Coppice Ancient Woodland and Unnamed Ancient Woodland East of Titnor Lane – the nitrogen dose due to the Scheme would exceed 1% of the critical load at the roadside, but at no point does it exceed the DMRB threshold for

significance of 0.4 kgN/ha/yr. Therefore, although the largest dose is not so small as to be imperceptible, following *DMRB LA 105* a conclusion of no significant effect can be drawn.

g. Potentially veteran Trees 4 and 5 – the nitrogen dose due to the Scheme would exceed 1% of the critical load, but does not exceed the DMRB threshold for significance of 0.4 kgN/ha/yr. Therefore, although the dose is not so small as to be imperceptible, following *DMRB LA 105* a conclusion of no significant effect can be drawn.

h. Potentially veteran Tree 6 – the nitrogen dose due to the Scheme would exceed 1% of the critical load and meets the DMRB threshold for significance of 0.4 kgN/ha/yr, being 0.4 kgN/ha/yr (using the critical load for woodland of 10 kgN/ha/yr as a proxy for veteran trees). In this case a survey of that specific tree is advisable to confirm whether it currently has a good lichen interest and whether there are any current signs of nitrogen deposition effects (e.g., leaf chlorosis). Results will be reported in the ES.

8.5.56 By taking traffic off the existing route of the A27, there are numerous areas of ancient woodland where an air quality benefit (up to a large improvement, i.e., 10% of the critical load) is forecast as listed below. Further assessment work is being undertaken to determine if other areas of woodland and veteran trees could be affected, which will be reported in the ES:

a. Unnamed ancient woodland east of Yapton Lane – small to large improvements in nitrogen deposition forecast throughout the transects, the greatest improvement being 0.7 kgN/ha/yr (7% of the critical load) up to approximately 35 m from the road on transect 5b.

b. Great Deans ancient woodland, Danes Wood ancient woodland and Goblestubbs Copse ancient woodland – small to large improvements in nitrogen deposition forecast throughout the transect, the greatest improvement being approximately 1 kgN/ha/yr (10% of the critical load) at the roadside.

c. Paine's Wood ancient woodland - small to medium improvements in nitrogen deposition forecast throughout the transect, the greatest improvement being 0.6 kgN/ha/yr (6% of the critical load) at the roadside.

d. The Waterwoods ancient woodland and Rock's Copse ancient woodland - small to large improvements in nitrogen deposition forecast throughout the transect, the greatest improvement being 2 kgN/ha/yr (20% of the critical load) at the roadside.

e. Batworth Park Plantation ancient woodland - small to large improvements in nitrogen deposition forecast throughout the transects, the greatest improvement being 0.9 kgN/ha/yr (9% of the critical load) at the roadside.

f. Binsted Wood Complex LNR - small to large improvements in nitrogen deposition forecast throughout the transects, the greatest improvement being 0.9 kgN/ha/yr (9% of the critical load) up to 10 m from the roadside.

Design and mitigation measures (embedded)

8.5.57 The Scheme design will continue to be developed to avoid important trees and to reduce, mitigate or compensate for any impacts where avoidance is not possible. Further measures will be explored to identify practicable solutions for mitigating impacts on trees, including translocation of veteran trees to retained habitat either as deadwood monoliths or, where practicable, live trees. Further mitigation will be required to avoid significant effects to these features (see *Section 8.7*).

Habitats of Principal Importance

8.5.58 The majority of habitats within the study area comprise intensively managed arable fields or grasslands, exhibiting various amounts of agricultural improvement, and which are therefore of limited ecological importance.

8.5.59 The following Habitats of Principal Importance (HPI) (habitats listed under Section 41 of the *Natural Environment and Rural Communities Act 2006*; and any habitats listed under the Arun District Local Plan or SDNP Local Plan) have been identified within the study area:

a. Lowland mixed deciduous woodland
b. Wet woodland
c. Wood-pasture and parkland
d. Hedgerows
e. Lowland meadows
f. Arable field margins
g. Lowland fen
h. Ponds
i. Reedbed
j. Coastal and Floodplain Grazing Marsh
k. Intertidal mudflats
l. River

8.5.60 Woodland coverage within the Scheme boundary is dominated by a section of Ashbeds and Potwell Copse at the western extent, with other smaller, scattered blocks of woodland. Ashbeds and Potwell Copse are both examples of National Vegetation Classification (NVC) W10 woodland and represent HPI. Areas of lowland mixed deciduous woodland HPI and wet woodland HPI are also located in close proximity to the Scheme boundary. The other scattered blocks comprise semi-natural woodland along

Tortington Lane and plantations on embankments of Lyminster Road and the A27 at the eastern Scheme extent.

8.5.61 Avisford Park Golf Club comprises a mix of trees, scrub patches and grassland. A range of tree ages are represented, including veterans. Although it is not grazed, due to the presence of veteran trees the habitat is considered likely to qualify as wood-pasture and parkland HPI.

8.5.62 Hedgerows are located along field boundaries, with a network of hedgerows present in the central areas of the Scheme that are connected with the woodland of Lake Copse. The majority of hedgerows comprise at least 80% native species and therefore represent HPI. Some hedgerows along Binsted Lane and in the vicinity of Crossbush are considered Important according to the wildlife and landscape criteria of the Hedgerow Regulations 1997.

8.5.63 Grasslands within the Scheme boundary are largely dominated by either improved or semi-improved swards, none of which are considered to represent HPI. A horse-grazed paddock north of the existing A27 (grid reference TQ 0296 0596) comprises a species-rich neutral sward and has the potential to qualify as lowland meadow HPI. Extensive areas of marshy grassland are associated with both Binsted Rife and Tortington Rife. The mix of damp grassland and mire communities associated with Binsted Rife has the potential to represent lowland fen HPI.

8.5.64 The margins of arable fields in the River Arun floodplain support diverse assemblages of arable weeds and qualify as arable field margin HPI.

8.5.65 An approximately 1 ha area adjacent to the main channel of the River Arun has been colonised by common reed (*Phragmites australis*) and represents reedbed HPI (identified as coastal saltmarsh HPI on the MAGIC website, but detailed survey completed in 2021 has demonstrated that this habitat does not meet the criteria for this habitat type). Reedbed HPI is also associated with the network of ditches in the River Arun floodplain at the western extent of the Scheme.

8.5.66 The River Arun, Binsted Rife and Tortington Rife are considered likely to represent river HPI.

8.5.67 Approximately nine ponds are located within the study area, all of which are of limited diversity and are not considered to meet the criteria as HPI.

Potential impacts (construction)

8.5.68 Direct impacts during Scheme construction would comprise the permanent and temporary loss of habitats that are mainly associated with arable fields and species-poor grasslands, with smaller and more localised losses from areas of woodland, sections of hedgerow, trees, river and marshy grassland.

8.5.69 The localised losses from woodland HPI, river HPI, lowland fen HPI and reedbed HPI represent only a small fraction of their overall extent and is considered unlikely to undermine the conservation status of these

ecological features. The alignment of the Scheme would result in direct loss and fragmentation of habitat from wood pasture and parkland HPI.

8.5.70 There is a risk of habitat disturbance and degradation as a result of alterations in noise, dust, water quality and human activity during Scheme construction.

Potential impacts (operation)

8.5.71 Potential Scheme operational impacts include habitat degradation as a result of altered air quality, habitat shading and increases in sediments and pollutants from road run-off though infiltration into soils or flowing into watercourses.

Design and mitigation measures (embedded)

8.5.72 Where the Scheme leads to losses from woodland, grassland, hedgerow, trees and ponds, the losses would be compensated through the establishment of native habitats of local provenance. The current understanding of the location and nature of these habitats is illustrated in the PLEM. This proposed habitat creation is considered to be of sufficient scope to avoid significant adverse effects on the HPI present following establishment of habitats.

8.5.73 The re-alignment of Binsted Rife would provide an opportunity for enhancement of this river HPI and the associated lowland fen HPI, through provision of morphological and in-stream habitat diversity compared to the existing modified state of Binsted Rife and long-term management. Increases in the overall coverage of woodland, grassland and wetland habitats would also contribute to improvements in the local conservation status of these habitat types.

Protected species and species of principal importance

8.5.74 Table 8-6 details the protected species assemblages and Series of Principle Importance (SPI) identified as being present, or potentially present, within the study area.

Table 8-6 Summary of protected species and SPI including their baseline status, potential impacts, and design and mitigation measures in relation to the Scheme

Receptor & importance	Baseline	Potential impacts (construction)	Potential impacts (operation)	Design and mitigation measures	Likely significant effect?
Plants **Local to County Importance**	Scarce arable weeds, including stinking mayweed and rye brome, are present and individual fields in the Arun floodplain are considered to support notable assemblages of arable weeds. The plant assemblages associated with the aquatic and riparian habitat of Binsted Rife, Tortington Rife and River Arun include species listed on the Red Data Book and Sussex Rare Species Inventory (SRSI). The arable weed survey in 2021 has re-affirmed this baseline data.	Direct impact on scarce arable weeds is likely during construction from permanent and temporary land take. Construction has the potential to result in the direct loss and disturbance of the aquatic and riparian habitats supporting notable plant assemblages.	Indirect impacts on notable plant communities may occur as a consequence of alterations in hydrology, pollution and shading of habitats.	At this stage it is considered unlikely that there would be any significant effects. Landscape and habitat planting, as indicated on the PLEM, would mitigate for any potential impacts. To reinforce this, the development of the Scheme may include additional mitigation measures to address potential impacts on this feature. Refer to *Section 8.7*.	Construction – No Operation – No
Fungi **Importance to Be**	Notable fungi species, including those listed as SPI, Red Data Book species	Direct impact on notable fungi assemblages has	Indirect impacts to fungi assemblages may	It has not been possible to rule out a significant effect at this stage.	Assessment ongoing – to be

Receptor & importance	Baseline	Potential impacts (construction)	Potential impacts (operation)	Design and mitigation measures	Likely significant effect?
Determined (TBD) on completion of Surveys	and SRSI have been recorded, generally in association with woodland habitat. Surveys of key habitat within or in close proximity to the Scheme have been completed in 2021 and will be reported in the ES.	the potential to occur during construction as a result of permanent and temporary land take. Indirect impacts associated with dust deposition during construction have the potential to lead to changes in the assemblage	result from altered air quality. The Scheme diverts traffic from the existing A27 that lies adjacent ancient woodland, which may have beneficial indirect impacts upon fungi assemblages through an associated improvement in air quality.	Ongoing Scheme design would aim to avoid loss in the first instance and seek to translocate habitat features supporting fungi (e.g., tree trunks) if loss is unavoidable. Further mitigation may be required depending upon the assessment of baseline data and confirmation of the Scheme design.	reported in the ES
Lichens **Importance TBD**	Notable lichen species, including those listed as Nationally Rare, Nationally Scarce or SRSI, are present in the local area. Surveys of key habitats within or in close proximity to the Scheme have been completed in 2021.	Direct impact on notable lichen assemblages has the potential to occur during construction as a result of permanent and temporary land take.	Indirect impacts to lichens assemblages may result from alterations in NOx deposition. The Scheme diverts traffic from the existing A27 that lies adjacent	It has not been possible to rule out a significant effect at this stage. Further mitigation may be required depending upon the assessment of baseline data and confirmation of the Scheme design.	Assessment ongoing – to be reported in the ES

Receptor & importance	Baseline	Potential impacts (construction)	Potential impacts (operation)	Design and mitigation measures	Likely significant effect?
		Indirect impacts associated with changes in air quality and dust deposition during construction have the potential to lead to changes in the assemblage.	ancient woodland, which may reduce NOx deposition and have beneficial indirect impacts upon lichen assemblages.		
Badgers **Local Importance**	Badger setts have been identified within the draft Order Limits and one main sett would be directly impacted by the Scheme.	It is likely that all badger setts within the Scheme boundary would be lost. Night-time working practices have the potential to disturb or deter badgers from foraging within certain areas, although badgers tend to become habituated to these impacts in a	There is potential for an increased risk of accidental mortality associated with the proposed road corridor, exacerbated by concrete within the central reservation. Bait marking has confirmed that the proposed route alignment is anticipated to sever the	At this stage it is considered unlikely that there would be a significant adverse effect due to the importance attributed to the local badger population; however embedded mitigation in the form of artificial badger sett provision, will be detailed in the ES, including a Protected Species Licence for the closure of the existing sett within the Scheme.	Construction – No Operation - No

Receptor & importance	Baseline	Potential impacts (construction)	Potential impacts (operation)	Design and mitigation measures	Likely significant effect?
		relatively short period of time.	territories of at least three badger clans.	Green bridges and underpasses would maintain habitat connectivity for badgers and mitigate the risk of road mortalities. Badgers would be guided to these features using badger fencing where required to reduce the risk of badgers crossing the road carriageway. Habitat creation would lead to an overall increase in the extent of badger foraging habitat. The development of the Scheme would include additional mitigation measures to address potential impacts on this feature. Refer to *Section 8.7*.	

Receptor & importance	Baseline	Potential impacts (construction)	Potential impacts (operation)	Design and mitigation measures	Likely significant effect?
Bats **National Importance**	15 bat species are present, including the Annex II species Barbastelle bat, Bechstein's bat and greater horseshoe bat. A brown long-eared bat maternity roost has been confirmed within the Scheme boundary (Tortington Lane), with other low status roosts for common and widespread species also present. Confirmed or assumed maternity roosts for whiskered bat, Natterer's bat and brown long-eared bat are located in close proximity to the Scheme boundary. In the surrounding landscape notable bat colonies are associated with the Binsted Wood Complex. Activity and radiotracking surveys carried out in 2020 and 2021 have identified	Vegetation clearance during construction has the potential to result in the direct loss of bat roosts and potential roosting features. The Scheme could result in the direct loss of habitat between important bat foraging, commuting, and roosting habitat. The severance of these connective habitats may result in a barrier effect which could reduce the success of foraging and thus breeding.	The operational road has the potential to lead to increased levels of accidental mortality of bats where the route severs key flightlines. Increased noise or lighting levels have the potential to disturb roosting and/or foraging bats by altering habitat suitability and reducing breeding success.	At this stage it has not been possible to rule out a significant effect on bat populations. Further mitigation (such as replacement bat roosts) is likely to be required and will be detailed in the ES. A European Protected Species Mitigation Licence (EPSML) will be applied for, and mitigation measures agreed with Natural England and implemented in accordance with the licence. Habitat severance in the long-term has been addressed through: a. A change in scheme alignment at the western end of the scheme. Surveys identified	Construction – Yes (temporary until habitat establishes) Operation – Until the form of green bridges has been discussed in formal consultation with Natural England, a potential significant effect cannot be dismissed. Further details of green bridge design and the associated assessment of effects on bats

Receptor & importance	Baseline	Potential impacts (construction)	Potential impacts (operation)	Design and mitigation measures	Likely significant effect?
	key bat foraging areas and flight lines in association with the western extent of the Scheme, Binsted Rife, Lake Copse, Tortington Rife and the Arun floodplain.	Increased levels of noise, light and vibration associated with construction activities have the potential to result in disturbance impacts on roosting bats if adjacent to roosts. Night-time construction working activities may lead to disturbance to bats through increases in light levels.		Bechstein's bat crossing the existing A27 at this location (between Ashbeds and Potwell Copse) and the realignment would allow Bechstein's bat to continue to cross the A27 at this location. b. Two bat underpasses, located at Binsted Rife Underbridge and Tortington Rife Underbridge and two green bridges, located at Binsted Lane Overbridge and Tortington Lane Overbridge. These features have been designed specifically for bats, and the final design	will be included in the ES.

Receptor & importance	Baseline	Potential impacts (construction)	Potential impacts (operation)	Design and mitigation measures	Likely significant effect?
				will be agreed with Natural England. Loss of foraging habitat would be compensated through establishment of new bat habitat (hedgerows and woodland) that is connected with similar features in the surrounding landscape. Most of the Scheme would be unlit, with lighting limited to roundabouts and junctions.	
Breeding Birds **Local Importance**	Notable birds have been recorded in 2021 as breeding or probably breeding within the study area. These include the Schedule 1 species barn owl (assessed separately). The assemblage of birds is considered typical of the	Vegetation clearance has the potential to damage and disturb bird nests, particularly within the main bird breeding season.	Noise from the road has the potential to disturb birds, degrading the suitability of nesting habitat. The distance separating the breeding lapwing	At this stage it is considered unlikely that there would be significant adverse effects. The creation of woodland, scrub, hedgerow and grassland habitat as	Construction – No Operation - No

Receptor & importance	Baseline	Potential impacts (construction)	Potential impacts (operation)	Design and mitigation measures	Likely significant effect?
	farmland and woodland habitats present. A high density of breeding lapwing was identified in a field east of the River Arun (grid reference TQ 0204 0520) No evidence of nightingale or nightjar has been identified within the study area during the 2021. Green sandpiper was also noted as a passage species in 2021.	The losses of woodland, trees, hedgerows, arable fields, lowland fen, watercourses and ditches during construction would reduce the availability of breeding and foraging habitat. Disturbance from increased lighting, noise, vibration and human presence has the potential to result in a reduction of breeding success for bird species. This is anticipated to affect only a few species as many species	from the Scheme (>440 m) is likely to be sufficient to avoid noise disturbance. The road alignment and associated vehicles have the potential to increase the accidental mortality of some bird species.	part of the Scheme would increase the availability of breeding and foraging habitat for some birds, including SPI. The development of the Scheme may include additional mitigation measures to address potential impacts on this feature. Refer to *Section 8.7*.	

Receptor & importance	Baseline	Potential impacts (construction)	Potential impacts (operation)	Design and mitigation measures	Likely significant effect?
		would habituate to the changes.			
Wintering Birds **Local Importance**	A total of 31 notable bird species was recorded within the study area during the winter period 2020/21. No significant flocks were recorded within the survey area and the assemblage was typical of the habitats present.	Disturbance from construction activities may result in the temporary displacement of over-wintering birds from favoured foraging and loafing areas.	Increased noise levels from the operational road may deter some bird species from the available over-wintering habitat. This is anticipated to affect only a few species as many species would habituate to the changes.	At this stage it is considered unlikely that there would be significant adverse effects. The development of the Scheme may include additional mitigation measures to address potential impacts on this feature. This will be reported in the ES. Refer to *Section 8.7*.	Construction – No Operation – No

Receptor & importance	Baseline	Potential impacts (construction)	Potential impacts (operation)	Design and mitigation measures	Likely significant effect?
Barn owl **Importance TBD** on completion of surveys	Surveys over 2017, 2018 and 2021 have identified up to eight observed nesting sites located within the study area, of which two occur within the draft Order Limits Scheme. Tall grassland, in particular the valley of Binsted Rife provide suitable foraging habitat for barn owl.	The loss of up to two barn owl breeding sites and foraging habitat would occur during habitat clearance in the construction phase. Increased noise, vibration, lighting and human presence as a result of construction activities have the potential to deter barn owls from breeding sites and foraging areas.	There is potential for increased mortality to barn owls as a result of accidental vehicle collisions, particularly where the road is at grade or on embankment. Increased noise levels from the operational road have potential to deter barn owls from observed breeding sites but are unlikely to significantly affect foraging.	It is not possible to discount a significant effect at this stage. This will be fully assessed within the ES.	Assessment ongoing to be reported in the ES
Hazel Dormouse **County Importance**	Surveys in 2021 have confirmed the presence of hazel dormouse in all suitable habitat across the Scheme. Dormouse is	Habitat clearance would result in the loss of dormouse habitat (woodland, scrub and	Increased noise or lighting levels have the potential to disturb hazel dormice by	An adverse significant effect on hazel dormouse is anticipated due to the loss of habitat and potential direct	Construction - Yes Operation - No

Receptor & importance	Baseline	Potential impacts (construction)	Potential impacts (operation)	Design and mitigation measures	Likely significant effect?
	considered to be absent only from poor habitat associated with the River Arun floodplain between Ford Road to Crossbush.	hedgerows) and has the potential to result in the damage or destruction of hazel dormice nests and hibernation habitat. The Scheme has the potential to sever hazel dormouse habitat, limiting the ability of the local population to disperse between breeding and foraging areas in the wider landscape. Increased levels of noise, light and vibration associated with construction	altering habitat suitability, exacerbating habitat severance and reducing breeding success.	harm to the species. This effect would be ameliorated where practicable through additional mitigation measures to be detailed in the ES and EPSML. Most of the route would be unlit, with lighting limited to roundabouts and junctions. The development of the Scheme will include additional mitigation measures to address potential impacts on this feature. Refer to *Section 8.7*.	

Receptor & importance	Baseline	Potential impacts (construction)	Potential impacts (operation)	Design and mitigation measures	Likely significant effect?
		activities have the potential to result in disturbance impacts on nesting or hibernating hazel dormice if adjacent to suitable habitat.			
Fish **Up to County Importance**	Fish surveys have been completed in 2021 to establish fish communities present in the River Arun (through eDNA sampling), Binsted Rife and Tortington Rife. Previous survey data exists for fish communities in the associated ditches and watercourses. From a review of previous data (Ref 8-17) (Ref 8-18), it is likely that European eel and other notable species are present.	At this time no construction works are anticipated to be required in the River Arun or Tortington Rife, as such no direct impacts are assumed likely. However, fish may be affected by noise and vibration during	Increased noise, vibration and lighting, together with viaduct shading, may have an adverse effect on fish passage and fish community present, and may also affect spawning activity locally.	The realignment of Binsted Rife would provide additional suitable habitat for fish and allow continued fish passage. However, direct impacts from construction activities may result in temporary significant effects on fish populations. The development of the Scheme will include additional mitigation	Construction – Yes Operation - No

Ref 8-17 Highways England 2019 A27 Arundel Bypass Watercourse Interim Baseline Report; Appendix 8-2: Watercourse Interim Baseline Report Part 1 and 2
Ref 8-18 Environment Agency 2021 Ecology and Fish Data explorer Online

Receptor & importance	Baseline	Potential impacts (construction)	Potential impacts (operation)	Design and mitigation measures	Likely significant effect?
		construction activities near watercourses, e.g., piling. Binsted Rife would be realigned to accommodate the oblique crossing of the viaduct, therefore there would be direct impacts to this watercourse. Increased siltation and pollution resulting from water runoff from the Scheme could adversely affect fish present in all watercourses. This may result in adverse impacts to the fish		measures to address potential impacts on this feature. Refer to *Section 8.7*.	

Receptor & importance	Baseline	Potential impacts (construction)	Potential impacts (operation)	Design and mitigation measures	Likely significant effect?
		communities present.			
Great crested newt **Local Importance**	Survey work undertaken in 2020 and 2021 has confirmed the absence of GCN from all 73 ponds and ditches surveyed. The closest record for GCN are located 40 m from the draft Order Limits, near Yapton Lane. A single ditch in the River Arun floodplain is directly impacted and remained inaccessible to GCN survey. GCN were absent from all other ditches in this area within 250 m of the Scheme. Therefore, it is considered likely that this species is absent from the floodplain. Where ponds have not been surveyed then as a precaution GCN are assumed to be present.	The Scheme would not result in the loss of any known or assumed GCN ponds. At present there are six inaccessible (i.e., assumed GCN) ponds located within 250 m of the Scheme. There is potential for the loss and severance of terrestrial habitat from known or assumed GCN populations, particularly for those located close to the Scheme.	The abundance of retained habitat in close proximity to retained known or assumed GCN populations and the provision of GCN-suitable habitat as part of the PLEM is considered sufficient to avoid operational impacts to this species.	At this stage it is considered unlikely that there would be any significant effects as no known or assumed breeding sites would be lost. However temporary impacts would require additional mitigation through an EPSML The development of the Scheme may include additional mitigation measures to address potential impacts on this feature. Refer to *Section 8.7.*	Construction – No Operation - No

Receptor & importance	Baseline	Potential impacts (construction)	Potential impacts (operation)	Design and mitigation measures	Likely significant effect?
		There is potential for harm or disturbance of GCN during the clearance of vegetation and stockpiling.			
Common toad **Local Importance**	Common toad records are scattered across the local area, with a population of up to 1,000 adults noted at a pond 470 m north of the Scheme (the Madonna Pond). Common toad are also known to breed in Tortington Rife.	There is potential for harm to toads during the clearance of vegetation and stockpiling. There is potential for some localised loss of common toad habitat, although the majority of suitable habitat for this wide-ranging species is likely to be associated with retained woodland.	The Scheme alignment has the potential to sever migratory routes used by the local common toad population. There is potential for increased mortality of common toad as a result of traffic collisions along the Scheme route.	At this stage it is considered unlikely that there would be any adverse effects upon common toad. Habitat creation, including the provision of new woodland, scrub and waterbodies, would increase the coverage of suitable habitat for common toad. Toad migration routes would be maintained through the use of strategic habitat creation, provision of green bridges and	Construction – No Operation - No

Receptor & importance	Baseline	Potential impacts (construction)	Potential impacts (operation)	Design and mitigation measures	Likely significant effect?
				underpasses and barrier fencing. The development of the Scheme may include additional mitigation measures to address potential impacts on this feature. Refer to *Section 8.7*.	
Invertebrates (terrestrial) **Importance TBD** on completion of Surveys and analysis	Awaiting baseline survey data to evaluate the species and assemblages of terrestrial invertebrates.	The majority of habitats lost to the Scheme are intensively managed arable fields and specie-poor grasslands, where only common and widespread species are likely to occur. There is potential for SPI terrestrial invertebrates to	An assessment of potential impacts will be considered within the ES, following receipt of the baseline data from terrestrial invertebrate surveys and completion of detailed Scheme design.	At this stage it is considered unlikely that there would be any significant effects. This will be fully assessed within the ES. The habitats created as part of the Scheme and as shown in the PLEM, which include new areas of woodland, scrub and grassland, and also the retention of deadwood habitat, would all provide an increased	Assessment ongoing – to be reported in the ES

Receptor & importance	Baseline	Potential impacts (construction)	Potential impacts (operation)	Design and mitigation measures	Likely significant effect?
		be impacted by loss of habitat should they be confirmed as being present.		resource for terrestrial invertebrates. The inclusion of food plants for specific species within seed mixes would provide additional opportunities for enhancement.	
Invertebrates (aquatic) **Importance TBD** on completion of Surveys and analysis	Aquatic invertebrate and pond PSYM surveys have been completed in 2020-21. Awaiting baseline survey data to evaluate the species and assemblages of aquatic invertebrates.	There are currently no construction works anticipated to be required in the River Arun, as such no direct impacts are assumed likely. Increased siltation and pollution resulting from water runoff from the Scheme could adversely affect aquatic invertebrates present within the	No direct or indirect impacts on aquatic invertebrates are expected at the River Arun or other watercourses as no additional outfall locations are expected to be required. Shading from the viaduct may result in habitat fragmentation for some species if the growth of	At this stage, it is considered unlikely that there would be any significant effects on aquatic invertebrates as the shading effect of the viaduct would be minimal in the context of the watercourses as a whole. The development of the Scheme may include additional mitigation measures to address potential impacts on this feature. Refer to *Section 8.7*.	Construction – No Operation - No

Receptor & importance	Baseline	Potential impacts (construction)	Potential impacts (operation)	Design and mitigation measures	Likely significant effect?
		River Arun, Rifes, other watercourses and ponds, and this may result in the temporary reduction of invertebrate abundance and diversity.	aquatic plants is reduced.		
Otter **Negligible Importance**	Consistent with desk study results and previous survey from 2017/18, no evidence of otter has been identified during survey in 2020/21. This species is therefore considered to be likely absent from the Scheme study area.	Otter are considered to be absent from the study area, no impacts are likely.	Otter are considered to be absent from the study area, no impacts are likely.	None required	Construction – No Operation - No
Reptiles **Local Importance**	Reptile populations have been identified within the study area and comprise populations of common lizard, grass snake and slow-worm. All three species	Localised loss of reptile habitat would occur during vegetation clearance.	The viaduct is unlikely to affect the movement of reptiles in the River Arun floodplain.	At present there are considered to be no significant effects upon the local reptile populations.	Construction – No Operation - No

Receptor & importance	Baseline	Potential impacts (construction)	Potential impacts (operation)	Design and mitigation measures	Likely significant effect?
	have been recorded in grassland south of Lake Copse. Within the Scheme boundary low densities of reptile are assumed to be present in all suitable semi-natural habitat, including the verges of the existing A27.	There is potential for fragmentation of reptile populations where suitable habitat is crossed by the route. Vegetation clearance and stockpiling materials in areas of suitable habitat has the potential to harm individual reptiles.	The Scheme would establish new grassland and woodland-edge that is linked to retained areas of reptile-suitable habitat. This is anticipated to increase the overall coverage of reptile habitat, benefiting the conservation status of the individual species present.	The habitat creation shown in the PLEM is anticipated to increase the overall coverage of reptile habitat, benefiting the conservation status of the individual species present. The development of the Scheme may include additional mitigation measures to address potential impacts on this feature. Refer to *Section 8.7*.	
Water vole **County Importance**	Water vole have been confirmed to be present in the ditches of the River Arun floodplain and also at Binsted Rife and Tortington Rife.	Habitat clearance and storage of materials during construction have the potential to result in the loss, damage and fragmentation of water vole habitat.	The viaduct across the River Arun floodplain is unlikely to impact the movement of water vole across this area. Binsted Rife Underbridge and	At present, it is considered that there may be significant effects on water vole as result of potential direct harm to water voles during construction activities. There may also be a temporary loss	Construction - Yes Operation - No

Receptor & importance	Baseline	Potential impacts (construction)	Potential impacts (operation)	Design and mitigation measures	Likely significant effect?
		Vegetation clearance, particularly that directly associated with ditches and watercourses, has the potential to result in harm to individual water voles. High intensity vibration and noise associated with some construction activities, such as piling, may also lead to the disturbance of water vole.	Tortington Rife Underbridge would result in some over-shading of these watercourses that may lead to localised degradation of water vole habitat.	of water vole habitat. Additional mitigation measures are currently being contemplated and the intention will be to apply for a Protected Species Licence. The development of the Scheme may include additional mitigation measures to address these potential impacts on water vole. Refer to *Section 8.7*.	
White-clawed crayfish **Negligible**	Although the waterbodies and ditches provide some suitable habitat for this species, there are no local records for the native, white-	White-clawed crayfish are considered to be absent from the	White-clawed crayfish are considered to be absent from the	None required.	No

Receptor & importance	Baseline	Potential impacts (construction)	Potential impacts (operation)	Design and mitigation measures	Likely significant effect?
	clawed crayfish within 2 km of the Scheme. The non-native signal crayfish is known to be present in the wider catchment of the River Arun (Ref 8-19). The non-native signal carries crayfish plague, which is fatal to the native white clawed crayfish, therefore the presence of this species will reduce the likelihood of white clawed crayfish being present in the catchment. No crayfish have been found during any aquatic invertebrate surveys in 2017 or 2021.Therefore it is considered likely that white-clawed crayfish are absent from the Scheme.	study area, no impacts are likely.	study area, no impacts are likely.		
Other SPI	Desk study has identified record of the following SPI:	Direct impacts on brown hare, harvest mouse	During the operation of the Scheme there is	At this stage it is considered unlikely that there would be any	Construction – No

Ref 8-19 https://species.nbnatlas.org/species/NHMSYS0000377494 [accessed 12/09/2021]

Receptor & importance	Baseline	Potential impacts (construction)	Potential impacts (operation)	Design and mitigation measures	Likely significant effect?
Local Importance	brown hare, harvest mouse, hedgehog and polecat. The closest records for brown hare and polecat are from the central areas of the Scheme in the vicinity of Binsted. The closest harvest mouse records are associated with wet meadows on Tortington Rife. Hedgehogs are widely distributed across the study area.	hedgehog, and polecat have the potential to occur through loss and/or fragmentation of suitable habitat during the construction of the Scheme. Other indirect impacts may include disturbance during the construction works.	potential for increased mortality of some species as a result of collision with traffic.	significant effects upon these species. The proposed habitat creation in the PLEM would increase the coverage of suitable habitat for these species. The creation and provision of green bridges and underpasses would maintain and improve upon the habitat connections for these species. The development of the Scheme may include additional mitigation measures to address potential impacts on this feature. Refer to *Section 8.7*.	Operation - No

8.6 Design, mitigation and enhancement measures

Summary of design and embedded mitigation

8.6.1 Construction of the Scheme would be subject to measures and procedures as defined within the EMP for the Scheme. This will include a range of best practice measures to minimise potential impacts on ecological habitats, protected species and the water environment, that accord with legal requirements and best practice guidance.

8.6.2 As outlined in *Chapter 2: The Scheme,* the Scheme design incorporates embedded mitigation measures to address environmental sensitivities and constraints.

8.6.3 The scheme includes a 50 mph tie into the western end to allow the new dual carriageway to tie-in to the existing A27 at an earlier point than what would have been possible with the 70 mph proposal. This would reduce habitat loss, allowing for bats which have been recorded crossing the A27 at this location to continue to do so.

8.6.4 The Scheme includes two green bridges, one at Binsted Lane Overbridge and one at Tortington Lane Overbridge, two bat underpasses, one at Binsted Rife Underbridge and one at Tortington Rife Underbridge, a viaduct crossing of the River Arun and Arun floodplain (Arun Valley Viaduct) and landscaping.

8.6.5 Green bridges have been provided to maintain north-south habitat connectivity across areas which would be severed by the Scheme, particularly where linear features are being removed. These structures aim to minimise adverse impacts on bat and bird assemblages, which utilise linear features in navigating across landscapes and as foraging corridors. The green bridges would also provide connectivity across the scheme for other species such as dormouse and badger.

8.6.6 The bat underpasses at Binsted Rife Underbridge and Tortington Lane Underbridge have been designed to maintain ecological function and existing access and have been designed specifically to maintain flight paths for bat species which are known to forage and commute along the Rifes.

8.6.7 The underpasses are also designed to provide safe crossing opportunities for animals (e.g., badger) to minimise the risk of animals accessing the road. The underpasses would also allow water vole to continue to move along the Rifes.

8.6.8 Landscaping, planting and the creation of bespoke features for biodiversity along the corridor of the Scheme would establish additional east-west links between existing habitats and species populations.

8.6.9 Essential mitigation measures that are required for landscaping, materials management and drainage would provide important connective habitat across the Scheme area. These measures include the creation of additional woodland and wetland areas which would provide both direct habitat linkages and ‘stepping-stone’ habitat across the landscape. This would be

of benefit to SPI and contribute to the resilience of biodiversity in the local area.

8.6.10 The cuttings, embankment and verges of the Scheme provide the opportunity to create a mosaic of habitat, comprising woodland, scrub and species-rich grassland. Woodland planting would increase the extent of these habitat types, focusing on both expanding existing woodlands and creating more diverse edge habitat. Nutrient-poor soils would be used to promote the establishment of species-rich grasslands typical of those found in the wider landscape.

8.6.11 The re-alignment of Binsted Rife and the Scheme's proposed drainage features would provide opportunities to create wetland habitat types, including reedbeds and damp grassland communities similar to those found locally.

8.6.12 The drainage design would incorporate provision to control pollution and keep any hydrological change within the acceptable limits.

Additional Mitigation Measures

8.6.13 The following additional mitigation measures to avoid adverse impacts to biodiversity features may be required as outlined below.

Plants

8.6.14 Additional mitigation for scarce arable flora may include the safe storage and re-use of topsoil as part of agricultural reinstatement.

8.6.15 Best working practices, including demarking and fencing of areas supporting notable plant assemblages, will be detailed in the first iteration of the EMP.

Fungi

8.6.16 Mitigation for impacts on fungi may include the retention of deadwood, including that associated with mature to veteran trees, and the re-use of soils during habitat reinstatement. The first iteration EMP will include measures to control dust during construction.

Lichen

8.6.17 Additional mitigation for impacts to lichen may include retention of features, for example, deadwood from mature trees, that they are associated with. The first iteration EMP will include measures to control dust during construction.

Badgers

8.6.18 Any badger sett closures would be undertaken under a Natural England licence. The loss of a main sett would need to be compensated though the provision of a nearby artificial sett.

Breeding and wintering birds

8.6.19 Indirect impacts associated with disturbance activities could be mitigated by measures including sensitive working practices such as seasonal restrictions on vegetation clearance.

8.6.20 Barriers would be used to mitigate noise impacts at key locations across the Scheme.

Great Crested Newt

8.6.21 No great crested newts have been recorded within the draft Order Limits, and it is anticipated that they are not present. However, because not all ponds have been surveyed to date, taking a precautionary approach, required mitigation measures, may include appropriate timing of work, the safe capture of GCN, ecological supervision and provision of compensatory habitat creation, which would be detailed in an EPSML.

Common Toad

8.6.22 Best working practices to adequately protect common toads include the appropriate timing and supervision of works.

Terrestrial invertebrates

8.6.23 Additional mitigation measures may be required depending on the assessment of baseline data and confirmation of Scheme design. Such measures include the combined use of low nutrient spoil and flower-rich seeding to establish a network of 'invertebrate banks' along the Scheme.

Aquatic invertebrates

8.6.24 Recommended additional mitigation measures would include pollution prevention measures during Scheme construction. The inclusion of an infiltration drainage system would prevent any additional runoff into the River Arun or other watercourses to provide similar or better-quality drainage compared to existing conditions.

Reptiles

8.6.25 The best working practices to avoid harm to reptiles would include the appropriate timing of works and the displacement of reptiles from the working area and into areas of retained or created habitat. The measures for displacement would include a combination of the sensitive management of vegetation and/or capture and translocation of animals.

Enhancement measures and Opportunities

8.6.26 There may be the potential to provide enhancement measures, however, these will be considered following the completion of the habitat and protected species surveys and a full evaluation of the final design undertaken.

8.6.27 Potential enhancement measures could include the following:

a. The deepening of drainage features to allow ponding, alongside the creation of bespoke wildlife ponds.

b. Creation of hibernacula piles adjacent to wildlife ponds to provide hibernation shelter for amphibians and other species including reptiles and hedgehogs.

c. Creation of bug hotels within suitable habitats for terrestrial invertebrates.

8.6.28 A Habitat Metric Calculation exercise is currently being carried out and will be provided in the ES. Biodiversity units will be determined based on Natural England Metric 2.0 (as per DMRB guidance).

8.6.29 As per the *Environment Act 2021*, and consistent with National Highway's own policy objectives, the Scheme, including all mitigation and enhancement measures, will be designed to achieve a 10% measurable net gain in biodiversity. However, the aspiration of the Scheme as a whole is to aim to deliver 24% measurable net gain in biodiversity, though some of this may be provided outside the DCO process.

8.7 Summary of significant effects

8.7.1 The effects of the Scheme have been assessed following the consideration of the potential impacts as outlined in *Section 8.5* and the embedded design mitigation measures and mitigation as outlined in *Sections 8.5* and *8.6.* Recommendations are also given below for additional mitigation measures (as appropriate).

8.7.2 As set out in *Section 8.5* and Table 8-6, biodiversity features have been identified, the potential impacts from the Scheme on those features have been described and the effects assessed, based on the current stage of the Scheme design, the PLEM and the baseline information available. At the time of writing, where possible a provisional evaluation of the geographic scale of importance of the receptors has been carried out in accordance with CIEEM. Further assessment will be included in the ES after completion of baseline surveys and their analysis, further surveys as necessary, and the further development of the PLEM.

8.7.3 A HRA Screening has been conducted for each SAC, SPA and Ramsar (a shadow HRA Screening (Likely Significant Effects) Report is provided as Appendix 8-A). Potential likely significant effects have been identified in relation to the bat populations of Singleton & Cocking Tunnels SAC, but no other potential likely significant effects are predicted to the qualifying features of any other international sites. Appropriate Assessment will be required to evaluate the likelihood of significant effects on the qualifying bat populations of Singleton & Cocking Tunnels SAC. National Highways has been and will continue to liaise with the relevant stakeholders to ensure the Scheme includes the measures required to maintain the integrity of Singleton & Cocking Tunnels SAC.

8.7.4 The seven biodiversity features for which potentially significant adverse effects are predicted are:

a. Potentially Veteran trees

b. Ancient trees/ancient woodland
c. Bats
d. Barn owl
e. Hazel dormouse
f. Fish
g. Water vole

8.7.5 Planning policy recognises veteran and ancient trees as important and irreplaceable, and they are afforded a high level of protection by the NPSNN and the revised NPPF. Therefore, it is not possible to mitigate the loss of veteran and ancient trees. The Scheme has been designed to avoid the loss and minimise impacts on potential veteran and ancient trees. However at this stage it is not possible to rule of the loss of potential veteran and ancient trees. The Scheme design will continue to be developed to avoid potential veteran and ancient trees and where the loss of such trees is unavoidable an explanation as to why the trees would be lost will be provided within the ES in accordance with the NPSNN. Measures to compensate for the direct loss of veteran and ancient trees include the retention of deadwood habitat and, where practicable, the translocation of live trees. At this preliminary stage of assessment, a permanent significant adverse effect is predicted due to reduction on the veteran and ancient tree resource.

8.7.6 The risk of damage (direct and dust deposition impacts) to ancient woodland and potential veteran trees may be mitigated by implementation of protection measures included in BS5837: 2012 (Ref 8.42), which include fencing boundaries of working areas with appropriate standoffs where required to protect both above-ground vegetation and roots. These measures will be detailed within the EMP which details standard construction management activities that the Scheme would implement during construction.

8.7.7 For potential veteran tree 6, which may be indirectly impacted by the operation of the Scheme, additional mitigation measures will be explored and outlined in the ES. Measures which will be considered include mulching, which increases fine root growth in the surface horizons and enhances soil biological functioning. Mulch will also provide nutrients available for uptake by the tree and help to counter any deficiencies due to inherent soil infertility, the effects of atmospheric pollution and nutrient removal by vegetation.

8.7.8 A nationally important bat population makes use of habitat that would be directly lost and/or severed by the Scheme. Potential indirect effects on this bat population include indirect disturbance effects, including altered levels of noise and lighting. These indirect effects would be controlled during both the construction and operational phases of the Scheme, for example:

a. During construction the location of haulage routes, material storage areas, compounds, generators, lighting and other construction activities

would be carefully sited to minimise noise and lighting effects on bats and lighting would be designed to reduce light spill on important bat habitat.

b. Lighting is only being incorporated into the scheme design where it is essential for safety reasons. The lighting strategy will be further developed, and measures will be integrated into the Scheme design to avoid significant changes to lighting in sensitive areas, including the areas known to be regularly used by Barbastelle and Bechstein's bats. This will include lighting that is low intensity and directional to minimise light spill on to retained and new created habitat. The green bridges and underpasses would not be lit.

8.7.9 Further assessment work is being undertaken with regards to noise levels. Where noise is considered to have an effect on bats, the use of barriers will be explored to mitigate the magnitude of noise impacts at key locations, for example, adjacent to key foraging routes or maternity roosts.

8.7.10 The provision of two green bridges and two underpasses on key routes used by bats, as well as the Arun Valley Viaduct across the floodplain, will maintain habitat connectivity for bats.

8.7.11 An EPSML will be put in place detailing additional mitigation measures (these will also be outlined in the ES) required during construction of the Scheme, which will include but not limited to the appropriate timing and supervision of works that affect roosts and the provision of compensatory habitat required to maintain the Favourable Conservation Status of the local bat populations. At this stage a temporary significant residual adverse effect is predicted during the period required for replacement habitat to establish (up to 5 years for hedgerows to establish and between 20 and 30 years for woodland to establish).

8.7.12 While the importance of the barn owl is still to be determined as surveys are ongoing, taking the precautionary approach it is not possible to dismiss a significant adverse effect on barn owl at this stage during operation of the Scheme. Barn owls are known to be vulnerable to direct mortality by road traffic collisions, especially where a new road severs foraging habitat. Mortality of barn owl has the potential to reduce the local numbers of breeding barn owl, potentially undermining the conservation status of this species. Further assessment work will be undertaken and reported in the ES on completion of surveys and analysis of data.

8.7.13 This effect on barn owls may be offset by a series of mitigation measures in addition to the embedded design and mitigation measures to minimise the risk of vehicular collisions. Measures that will be considered include the use of fences, mounds and additional planting to deter barn owls from the road corridor, as well as the provision of replacement barn owl nest boxes in an area of suitable habitat away from the Scheme (located more than 1.5 km from the scheme, existing roads and railways). At present, a permanent significant adverse effect is predicted due to the potential local reduction of breeding barn owl numbers.

8.7.14 Adverse significant effects are predicted for hazel dormouse. However, additional mitigation measures within the first iteration EMP will protect retained habitat and any impacts to individual hazel dormice, or their habitat will be addressed with best practice measures set out in an EPSML. The latter will include the appropriate timing and supervision of the works (to avoid direct harm to hazel dormouse), the maintenance of connectivity (for example, using dormouse bridges) and the provision of improved and replacement habitat. Loss of breeding and foraging habitat will be compensated through establishment of new habitat for hazel dormouse that is connected with retained areas of suitable habitat. Habitat severance can be addressed through the use of green bridges or purpose-built bridges for hazel dormouse. A temporary significant adverse effect is predicted on hazel dormouse during the period required for replacement habitat to establish.

8.7.15 Adverse significant effects are predicted for water vole. However, additional measures within the EMP will address potential impacts during construction, including control of encroachment into suitable habitat and noise. The mitigation strategy for water vole will also be detailed in a Protected Species Licence. Water vole will be displaced from the working area through a combination of sensitive vegetation management and/or capture and translocation of animals to pre-prepared receptor sites (to avoid direct harm to the species). The receptor sites will consist of suitable water vole habitat and will increase the overall coverage of habitat for this species. The creation of new habitat will support the water vole population temporarily displaced by the Scheme.

8.7.16 Adverse significant effects are predicted for fish. However, additional measures to mitigate any potential impacts on fish will include preventing pollution, avoiding works in the channel (with the exception of Binsted Rife), and measures to minimise noise and vibration during construction and to allow continued fish passage. The inclusion of an infiltration drainage system will also prevent any additional runoff into the River Arun and other watercourses. The temporary indirect impacts will be avoided through suitable construction methods. New culverts in smaller watercourses will also allow continued fish passage and longitudinal habitat connectivity.

8.8 Scheme options

8.8.1 As described in *Chapter 2: The Scheme*, options are still being considered for the potential reprovision of Avisford Park Golf Club. In addition, a potential alternative option from the current proposed alignment where the Scheme passes between Avisford Park, the new housing development at Avisford Grange and the existing Yapton Lane is being considered. This would raise the vertical alignment of the Scheme, with an offline Yapton Lane overbridge. The sections below discuss these in turn and outline whether adopting either of these would change anything stated in the preceding baseline conditions, potential impacts and assessment of effects sections and consider the potential for different effects of the options.

Options for Avisford Park Golf Club reprovision

Option 1: 9 hole golf course with driving range or practice facilities

8.8.2 The land is already managed as a golf course and is known to support protected species including dormouse and bats. As this is within the draft Order Limits, this is already included in the assessment. Therefore, the reprovision of an amended golf course will result in no changes to the information already provided in the baseline conditions, potential impacts and assessment of effects sections of this chapter. Option 1 is considered to be the better option on account of the reduced land take compared with Option 2.

Option 2: Replacement 18 hole golf course

8.8.3 The additional land required for this option is under agricultural production which is common within the study area. Hedgerows are present which could support dormouse and be used by bats for commuting. Ancient woodland is present along the north-east boundary of the site. The replacement of this land with a further nine holes would result in the loss of habitat that could be used by protected species, including dormouse and bats.

8.8.4 It could also change the drainage of the adjacent ancient woodland and could have indirect effects on protected species, which could be using the woodland through increased noise and disturbance. Indirect effects on the ancient woodland may also arise due to an increase in visitors.

8.8.5 Reprovision of a full golf course at this location, with careful design offers opportunities to provide habitat for dormouse and planting to increase habitat connections between Pedlar's Croft and Little Danes Wood.

8.8.6 Full reprovision of the golf course would result in minimal changes to the information already provided in the baseline conditions. However, it would not result in any changes to the potential impacts and assessment of effects sections outlined in this chapter. The preliminary conclusions in terms of the potential for likely significant environmental effects remains the same.

Option for raised vertical alignment with offline Yapton Lane overbridge

8.8.7 This option may result in additional habitat loss compared to the current proposed alignment due to construction of the offline Yapton Lane overbridge. However, this additional loss of habitat would be minimal in the context of the overall Scheme as the online option presented in the Scheme would require a degree of additional habitat loss to create a temporary offline diversionary route. Therefore, the offline option would not result in any changes to preliminary assessment already presented in the baseline conditions, potential impacts and assessment of effects sections of this chapter. The preliminary conclusions in terms of the potential for likely significant environmental effects remains the same for either option.

9. Geology and Soils

9.1 Introduction

9.1.1 This chapter describes the Scheme's potential impacts and effects on geology and soils. This chapter also outlines proposed design and management measures to help mitigate likely significant effects. This assessment has been undertaken in accordance with the guidance in *DMRB LA 110 Geology and Soils* (LA 109).

9.1.2 There may be interrelationships related to the potential effects on material assets and waste and other disciplines. In particular, reference should be made to the following chapters:

a. Chapter 10: Material Assets and Waste

b. Chapter 12: Population and Human Health

9.1.3 The assessment of geology and soils impacts, and the design of appropriate mitigation is informed by the legislation and policies in the following:

Legislation

a. *Environmental Protection Act 1990* and *Part 2A Contaminated Land Statutory Guidance* (Ref 9-1).

b. *The Water Act 2003* (Ref 9-2).

c. *The Water Resources Act 1991* (Ref 9-3).

d. Other legislation includes T*he Water Framework Directive (2000/60/EC)*; *The Groundwater Directive (2006/118/EC)*; *The Environmental Quality Standards* (EQS) *Directive (2008/105/EC)*; *The Environmental Liability Directive (2004/35/EEC)*; *The Environment Act 1995*; *The Town and Country Planning Act 1990*; *Environmental Permitting (England and Wales) Regulations 2016*; *Hazardous Waste (England and Wales) (Amendment) Regulations 2016*; *Contaminated Land (England) (Amendment) Regulations 2012*; *Environmental Damage (Prevention and Remediation) (England) Regulations 2015*; and *Anti-Pollution Works Regulations 1999*.

National Policy

a. *NPPF* (Ref 1-8), paragraphs 170, 171, 172 and 173 in relation to conserving and enhancing the natural environment.

b. *NPSNN* (Ref 1-7), paragraphs 5.117, 5.118 and 5.119 in relation to land instability; 5.168 in relation to agricultural land and land

Ref 9-1 HMSO (2012) Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance (April 2012)
Ref 9-2 HMSO (2003) The Water Act 2003
Ref 9-3 HMSO (1991) The Water Resources Act 1991

contamination; and 5.169 in relation to safeguarding of mineral resources.

Local Policy

a. *Arun Local Plan 2011-2031* (Ref 1-12), Policy SO DM1 Soils; Policy ENV SP1 Natural Environment; Policy ENV DM1 Designated Sites of Biodiversity or Geological Importance; Policy ENV DM3 Biodiversity Opportunity Areas; and Policy QE DM4 Contaminated Land.

b. *South Downs Local Plan 2014-2033* (Ref 1-13), Strategic Policy SD9: Biodiversity and Geodiversity; Development Management Policy SD11: Trees, Woodland and Hedgerows; Strategic Policy SD17: Protection of the Water Environment; Strategic Policy SD48: Climate Change and Sustainable Use of Resources; and Development Management Policy SD55: Contaminated Land.

c. The *NPPF PPG* (Ref 1-9), sections on 'land affected by contamination' and 'land stability' and how planning can take account of the quality of agricultural land and safeguard soils have also been considered.

9.2 Stakeholder engagement

9.2.1 Liaison has been undertaken with the Environment Agency to obtain records of licensed groundwater and surface water abstractions within the study area (refer to *Section 9.4*). Liaison has also been undertaken with ADC to obtain records of private and/or unlicensed groundwater and surface water abstractions within the study area (refer to paragraph 9.5.27). Further details are also provided in *Chapter 13: Road Drainage and the Water Environment*.

9.2.2 The Sussex Geodiversity Partnership has been consulted to obtain records of any Local Geological Sites (LGS) or geological sites of interest, located within the study area. Further consultation will be undertaken with the Sussex Geodiversity Partnership, and if required with the local authorities, to seek their views on the geological site of interest, identified in the study area, as a result of this initial engagement.

9.2.3 Further consultation will be undertaken with the host authorities WSCC and ADC, the closest national park authority (SDNPA) and the Environment Agency regarding environmental and ecological aspects related to the Scheme and possible contaminated land sites, including landfills, present within the study area.

9.2.4 Natural England will be consulted regarding loss of Best and Most Versatile (BMV) agricultural land, where the Scheme involves the loss of 20 hectares or more of grade 1, 2 or 3a BMV agricultural land.

9.3 Assessment assumptions and limitations

9.3.1 The assessment undertaken for the PEI Report has been based on the collation and evaluation of available documentation provided by the Sussex Geodiversity Partnership, Environment Agency, British Geological Survey

(BGS), Groundsure historical mapping and Groundsure Geo and Enviro data (Ref 9-4) and information in the PCF Stage 2 Environmental Assessment Report (EAR) (Ref 9-5). Further information will be obtained as the Scheme design develops and will be reported in the ES.

9.3.2 Baseline information on ground stability will be included in the ES, although the assessment of structural and engineering geology will be undertaken as part of the separate Ground Investigation Report (GIR). Slope stability and issues around potential solution features will be included in the Geotechnical Design Report (GDR). The GIR will be submitted as part of the DCO application. The ES will summarise relevant assessment and reference these reports where appropriate.

9.4 Study area

9.4.1 As shown in Figure 9-1, the study area for the land contamination assessment comprises the draft Order Limits, excluding the area of the existing A27 to be de-trunked due to the limited proposed engineering works in this area at this time, and an additional radial zone of 250 m. This is considered appropriate for the consideration of historical and current land uses which may have resulted in land contamination within the study area and it also aligns with established industry practice for defining land contamination study areas for EIA.

9.4.2 An extended study area of 1 km has been considered for groundwater, surface water and water abstractions as potential receptors to any land contamination.

9.4.3 The study area has been defined according to the guiding principles included in the DMRB, LA109 Geology and soils (formerly DMRB Volume 11, Section 3, Part 11 & Part 6), in paragraph 3.5.

9.4.4 For the remainder of the topic and other receptors including soil resources and geological sites, the study area comprises the draft Order Limits only as these receptors are only likely to be impacted where the Scheme directly crosses, or interacts, with them.

9.5 Baseline conditions

Geology

Made ground

9.5.1 Made ground is not mapped within the study area. However, it is anticipated to be present in areas of previous and existing development and along existing roads. BGS boreholes within the draft Order Limits indicate the following information.

Ref 9-4 Groundsure Geo and Enviro Insight data (in GIS format) (June 2021)
Ref 9-5 Highways England (2019) Chapter 9 – Geology and Soils of the A27 Arundel Bypass Environmental Assessment Report

9.5.2 In the eastern extent of the draft Order Limits, there is the potential for made ground associated with infilled ground and within cuttings along the Arun Valley Railway (which crosses the eastern extent of the draft Order Limits, west of Crossbush). At this location, the historical BGS borehole referenced TQ00NW46 indicates made ground (very sandy clay with gravel and occasional cinder) up to 1.4 m in thickness. Historical BGS boreholes (referenced TQ00NW204, TQ00NW203 and TQ00NW190) indicate made ground (sandy clay with gravel of flint, chalk and brick) up to 3.5 m in thickness at the existing A27 Crossbush Interchange. There may also be buried river channels within the River Arun floodplain (within the eastern area of the draft Order Limits).

9.5.3 In the western and central areas of the draft Order Limits, made ground is not indicated in any historical BGS boreholes. In these areas, borehole records generally indicate a limited thickness of topsoil, overlying superficial or bedrock geology.

Superficial deposits

9.5.4 A complex sequence of quaternary superficial deposits is present within the draft Order Limits and study area, as summarised in Table 9-1.

Table 9-1 Summary of the published superficial geology (source: British Geological Survey, Ref 9-6)

Superficial Strata	General Composition	Location
Alluvium	Clay, silt, sand and gravel	Present around the primary watercourses (except for the River Arun, which is surrounded by Raised Marine Deposits), in the central and western parts of the draft Order Limits and study area.
Head Deposits	Gravel, sand, silt and clay	Western extent of the draft Order Limits and study area, typically following the dry valley bottoms associated with former/ seasonal surface water and/or groundwater flow; and central extent of the study area, south-west of Arundel.
River Terrace Deposits	Sand, silt and clay	Central part of the draft Order Limits (north/north-east of Torrington)*; western part of the

Ref 9-6 British Geological Survey (2021). Geoindex Onshore online geological mapping. Accessed June 2021

Superficial Strata	General Composition	Location
		draft Order Limits (Walberton) and study area; and eastern part of the draft Order Limits and study area, at Poling Corner.
Raised Storm Beach Deposits	Gravel	Western extent of the draft Order Limits and study area, north and north-east of Binsted; and eastern extent of the study area, at Crossbush.
Raised Beach Deposits	Sand and gravel	Eastern and central areas of the draft Order Limits and study area.
Raised Marine Deposits	Variable, comprising clay, silt, sand and gravel	Within the floodplain of the River Arun, in the eastern extent of the draft Order Limits and study area.

*The superficial deposits in this area are indicated as 'Aeolian/Brickearth' in the British Geological Survey (BGS) (1996) Chichester and Bognor, sheet 317/332 (England and Wales), 1:50,000. The geotechnical investigation currently taking place at the site indicates that the deposits in this area are River Terrace Deposits (refer to WS324 and WS381, located north of Tortington). This is supported by the Geoindex Onshore online geological mapping (Ref 9-6) and the Groundsure Report (Ref 9-4).

Bedrock

9.5.5 The bedrock underlying the draft Order Limits and study area (beneath the superficial deposits, where present) comprises the London Clay Formation overlying the Lambeth Group (clay, silt and sand), and in turn, the Culver Chalk Formation or a combination of the Lewes Nodular, Seaford, Newhaven, Culver and Portsdown Chalk Formations (hereafter, referred to as 'various chalk formations'). The London Clay Formation is absent on the western extent of the draft Order Limits and study area and around the location of the River Arun. In these areas, the Lambeth Group sub-crops beneath the superficial deposits, where they are present. The Culver Chalk Formation sub-crops (beneath the superficial deposits, where they are present) across some of the eastern areas of the draft Order Limits and study area, south of Arundel. Various chalk formations sub-crop (beneath the superficial deposits, where they are present) in the western-most and southern-most extents of the study area.

9.5.6 An axial plane trace of a major syncline (fold of stratified rock in which the strata slope upwards from the axis) is indicated across the draft Order Limits, in the central and eastern part of the study area.

9.5.7 No faults are indicated as being present within the study area.

BGS borehole records

9.5.8 A review of the BGS Viewer (Ref 9-6) identified several borehole records located across the draft Order Limits and study area. The borehole records generally align with the expected geological conditions interpreted from the geological mapping. The stratigraphy reported in a selection of the borehole records is summarised in Table 9-2.

Table 9-2 Historical Exploratory Boreholes in BGS Archive

Boreholes Reference NGR Depth Location Date	Description*	Depth to Top of Stratum (m below ground level (bgl))	Thickness (m)
TQ00NW146 501149, 105690 Depth: 40 m Location: south of Arundel, adjacent east of the River Arun (eastern part of the study area) Date: 1990	Topsoil	0.0	0.30
	Raised Marine Deposits: silty clay	0.30	1.45
	Alluvium: clayey very silty sand	1.75	18.85
	Lambeth Group	20.6	19.4 (full thickness not proven)
SU90NE24 498760, 105560 Depth: 38.1 m Location: Binsted Lane (central part of the study area) Date: 1928	Drift: mould, gravel and sand	0.0	6.7
	London Clay	6.7	7.6
	Lambeth Group	14.3	28.3 (full thickness not proven)
SU90NE23 498120, 106400 Depth: 56.1 m Location: Church Farm, Binsted (western part of the study area)	Drift/ Lambeth Group	0.0	37.5
	Upper Chalk (possibly)	37.5	18.6 (full thickness not proven)

Boreholes Reference NGR Depth Location Date	Description*	Depth to Top of Stratum (m below ground level (bgl))	Thickness (m)
Date: 1910			

* The geological description is based on information that is presented on the historical borehole record referenced and held by the BGS.

Natural ground subsidence hazards

9.5.9 Information contained within the Groundsure Report (Ref 9-4) indicates that the following natural ground subsidence hazards may exist across the draft Order Limits and study area:

a. There is a negligible to moderate potential for shrinkage/swelling of clays. Areas of moderate potential for shrinkage/swelling of clays are indicated across the western part of the draft Order Limits, north-west of Walberton; across the draft Order Limits north of Binsted; and across the draft Order Limits at Tortington.

b. There is a very low to moderate potential for landslides. Areas of low and moderate potential for landslides are indicated along the Binsted Rife watercourse within the draft Order Limits; and south-east of Arundel within the study area.

c. There is a negligible to high potential for ground dissolution of soluble rocks. Areas of moderate to high potential for ground dissolution of soluble rocks are at the western-most extent of the draft Order Limits and study area, at Fontwell.

d. There is a negligible to moderate potential for compressible deposits. Areas of moderate potential for compressible deposits are along the Binsted Rife and west of Tortington, in the central parts of the draft Order Limits.

e. There is a negligible to low potential for collapsible deposits.

f. There is a negligible to low potential for running sands.

Geological sites

9.5.10 There are no geological Sites of Special Scientific Interest (SSSI) within the study area (Ref 9-7). According to the Sussex Geodiversity Partnership mapping (Ref 9-8), there are no LGS within the study area. The mapping indicates that standard geological sites which have no formal conservation status (not LGS or SSSI) may be present in the study area. Further liaison with the Sussex Geodiversity Partnership confirmed that one standard

Ref 9-7 Department for Environment, Food, and Rural Affairs (2021). Magic Map online application http://magic.defra.gov.uk/magicmap.aspx
Ref 9-8 Sussex Geodiversity Partnership: Local Geological Sites (geodiversitysussex.org.uk)

geological site (SU90/86) is located within the draft Order Limits. The standard geological site reference SU90/86 consists of a historical tile kiln, located east of Binsted Lane.

Mining and mineral resources

9.5.11 The quaternary deposits are located within a Mineral Safeguarding Area (MSA) and within a Sharp Sand Resource Consultation Area (Ref 9-9). They are a source of aggregates, including sharp sand and gravel. These are discussed further in *Chapter 10: Material Assets and Waste* of this PEI Report and no further consideration of the MSA and the Sharp Sand Resource Consultation Area is undertaken in this section.

9.5.12 The western extent of the draft Order Limits and study area, and isolated areas within the eastern part of the study area are located in a non-coal mining region (chalk) where sporadic underground mining of restricted extent may have occurred. However, the Groundsure Report (Ref 9-4) indicates that *'the potential for difficult ground conditions are unlikely and localised and are at a level where they need not be considered'*.

Soils

9.5.13 The agricultural land quality within the draft Order Limits has been reviewed with reference to Agricultural Land Classification (ALC) system (refer to Appendix 10-2 Agricultural Land Report of the previous PCF Stage 2 Further Consultation) (Ref 9-10), and ALC mapping provided by Natural England and in the Groundsure Report (Ref 9-4).

9.5.14 As defined in Natural England's Agricultural land classification: protecting the BMV agricultural land (Ref 9-11), agricultural land in England and Wales is graded between 1 and 5, depending on the extent to which physical or chemical characteristics impose long-term limitations on agricultural use. Grade 1 land is excellent quality agricultural land with very minor or no limitations to agricultural use, and Grade 5 is very poor quality land, with severe limitations due to adverse soil, relief, climate or a combination of these. Grade 3 land is subdivided into Subgrade 3a (good quality land) and Subgrade 3b (moderate quality land). Land which is classified as Grades 1, 2 and 3a is identified as BMV within the National Planning Policy Framework (NPPF) (Ref 1-8).

9.5.15 The land use within the draft Order Limits is principally agricultural, dominated by grazing and arable farming.

9.5.16 The ALC mapping shows that most of the agricultural land located within the draft Order Limits would be Grade 3. At this stage, it is not possible to

Ref 9-9 West Sussex County Council and South Downs National Park Authority (2020). West Sussex Joint Minerals Local Plan, West Sussex Waste Local Plan: Minerals and Waste Safeguarding Guidance. March 2020.
Ref 9-10 Highways England (August 2019). Appendix 9-2. A27 Arundel Bypass Agricultural Land Report. Included within the Geology and Soils - A27 Arundel Bypass – PCF Stage 2 Further Consultation
Ref 9-11 Natural England (January 2013). Agricultural Land Classification: protecting the best and most versatile agricultural land (TIN049).

ascertain if the land is Subgrade 3a (good quality land) or Subgrade 3b (moderate quality land). This will be determined through an ALC and soils survey to be undertaken as part of the EIA, which will be reported in the ES. Existing detailed ALC data is available only for small areas, east of Fontwell and west of Binsted, where the agricultural land that would be affected by the Scheme is indicated to be Subgrade 3b. Agricultural land mapped as Grade 2 is also present and will be crossed by the Scheme, north-east of Walberton, south-east of Binsted and at Tortington. Land mapped as Grade 2 is also indicated across the draft Order Limits at Binsted and north of Poling. Land mapped as Grade 1 is present within the draft Order Limits, east of Walberton. ALC mapping is indicated on Figure 9-2.

9.5.17 As indicated in Figure 1 of the Agricultural Land Report (Ref 9-10), the draft Order Limits cross Wigton Moor and Batcombe soils (fine loams), which are likely to be of BMV quality. Other soils series encountered are of the Newchurch, Wickham and Binsted series. These soils are classified as heavy loams.

9.5.18 The 1:250,000 soil map of South East England published by the Soil Survey of England and Wales in 1983 (Ref 9-12) shows the soils within the draft Order Limits to be slightly acid loamy soils, with loamy and clayey soils within the River Arun floodplain.

Land contamination

9.5.19 Data obtained from the Environment Agency and the local authority, historical Ordnance Survey mapping that are contained as part of the Groundsure Report GIS data (Ref 9-4), and aerial photography, have been reviewed to identify current and historical possible contaminative land uses. A summary of areas at potential risk of land contamination within the study area are detailed in Table 9-3.

Table 9-3 Summary of possible sources of land contamination within the study area

Possible Sources Within the Study Area	Number of Features Within the draft Order Limits
Sixteen farms/farm buildings	Not within the draft Order Limits.
Three historical landfills: a. Days landfill, which includes two distinct areas (WD27/110 and WA/10/87), along the southern boundary of the existing A27 Arundel	Two within the draft Order Limits: Days landfill Hooe Farm landfill

Ref 9-12 Soil Survey of England and Wales (1983) - 1:250,000 scale Soil Map of South East England. Rothamsted Experimental Station, Harpenden.

Possible Sources Within the Study Area	Number of Features Within the draft Order Limits
Road, at the western extent of the Scheme. The landfill is located at Fontwell (approximately centred at National Grid Reference (NGR) 496889, 106820 and NGR 496618, 106852) and it was licensed between 27/04/1988 and 30/09/1988. The licence holder was Wyatt of Snetterton Limited. The receiving waste was recorded to be Inert. b. Hooe Farm landfill (WD27/223), located at Tye Lane, Walberton, (approximately centred at NGR 496839, 106718), 30 m south of the existing A27 Arundel Road, at the western extent of the Scheme. The landfill received waste between 31/12/1955 and 31/12/1960. The operator/license holder is not provided. The receiving waste was Inert, Commercial and Household. c. Westlands Copse landfill (WD27/260 and WD13/163), located along the southern boundary of the existing A27 Arundel Road, east of Crossbush, at the eastern extent of the study area (approximately centred at NGR 504280 105746). The landfill received waste between 31/12/1940 and 31/12/1993. The operator/licence holder is not provided. The receiving waste was recorded to be Commercial and Household. This landfill is partially located on a former brick works.	
Industrial/commercial uses (current and former) including: a. Current woodcraft furniture frames. b. Former brick works (1938 to 1946) and unspecified works (1957). c. Current timber yard/firewood supplier (Stubbs Copse Woodyard). The Groundsure Report (Ref 9-4) indicates	Two within the draft Order Limits: Current woodcraft furniture frames. Former brick works (1938 to 1946) and unspecified works (1957).

Possible Sources Within the Study Area	Number of Features Within the draft Order Limits
that this is a licensed waste site (a composting facility (license number: ROB001), issued in March 1994). d. Current and former tanks. e. Current and former garages. f. Current construction company (Fordingbridge plc). g. Current industrial estate, including current granite supplier (County Stone Granite Ltd) and current vehicle repair shop (K L Motors). h. Current builder yard. i. Current warehouses (The Vinery Fields). j. Current tanks (within the Binsted Lane Nursery). k. Former timber yard (1970 to 1990). l. Current vehicle repair and service. m. Former windmill. n. Former brewery. o. Former smithy. p. Former hospitals (The Arundel Equine Hospital LLP and Equine Veterinary Hospital). q. Former filter bed. r. Former flour mill. s. Former engineering works (1977 to 1990).	
Current Arun Valley railway (also known as the Mid Sussex line) and historical railway sidings (1896 to 1974).	Present within the draft Order Limits.
One current petrol filling station (Crossbush petrol filling station) and two former petrol filling stations.	Not within the draft Order Limits.

Possible Sources Within the Study Area	Number of Features Within the draft Order Limits
One pumping station.	Not within the draft Order Limits.
Eight current electricity substations.	One within the draft Order Limits.
Two graveyards.	One within the draft Order Limits.
Three areas of potentially infilled ground/pits (>0.5 ha).	One within the draft Order Limits.

9.5.20 The Groundsure Report (Ref 9-4) shows the following features to be notably absent from the study area:

a. Authorised landfills.

b. Sites determined as contaminated land under Part 2A Environment Protection Act (EPA).

c. Regulatory explosive sites.

d. Historical licenced industrial activities.

e. Control of Major Accident Hazards facilities.

f. Hazardous substance consents.

9.5.21 According to the Groundsure Report (Ref 9-4), two pollution incidents have been recorded in the study area, with one located within the draft Order Limits as follows:

9.5.22 A pollution incident within the draft Order Limits, east of Fontwell, in June 2003, relating to commercial waste impacting land (Category 3, minor incident). No impact (Category 4) was indicated to air and water for this incident.

9.5.23 A pollution incident was recorded in the study area to the north of Tortington in July 2001, relating to sewage sludge impacting air (Category 3, minor incident). No impact (Category 4) was indicated to land and water for this incident.

Unexploded ordnance risk

9.5.24 A detailed Unexploded Ordnance (UXO) Threat & Risk Assessment (Ref 9-13) identified very high risk areas across the eastern extent of the study area (from Ford Road eastwards) and low risk areas across the central and western parts of the study area. The most probable UXO threat items

Ref 9-13 Alpha Associates (October 2020). Detailed Unexploded Ordnance (UXO) Threat & Risk Assessment.

identified in the assessment are British high explosive bombs that may be encountered to a maximum depth of 16 m bgl; and abandoned explosive ordnance/land service ammunition/small arms ammunition. The latter, if present, are likely to be encountered in previously undisturbed ground to depths of approximately 2.0 m.

9.5.25 The assessment concluded that *'given the types of UXO that might be present on-site, all types of aggressive intrusive engineering activities may generate a significant risk pathway in the very high risk zone'*. Mitigation measures were recommended in the very high risk zones prior to any intrusive works, including an UXO Emergency Response Plan, an UXO Safety and Awareness Briefing and Intrusive or Non-intrusive Magnetometer Surveys. Adoption of these mitigation measures would reduce the risk to as low as reasonably practicable. No further action was recommended for the low risk zones.

Identified receptors

9.5.26 Human receptors to possible ground and groundwater contamination are considered to comprise residents, workers in and visitors to commercial properties, and members of the public accessing areas of open space (including a golf course – Avisford Park Golf Club, north of Walberton). Construction and maintenance workers have been scoped out as any risk to these receptors would be controlled by health and safety legislation, as agreed in the *EIA Scoping Opinion* (Appendix 1-B) received.

9.5.27 Controlled waters receptors in the study area comprise groundwater and surface water. Groundwater within most of the superficial deposits, which directly underlie the draft Order Limits and the study area, are classified by the Environment Agency as Secondary A aquifers. Secondary (undifferentiated) aquifers are also indicated in the western parts of the study area, associated with the Alluvium along the Binsted Rife; and in the central part of the study area, associated with the Head Deposits. The bedrock beneath the superficial deposits is classified as unproductive strata (London Clay Formation), Secondary A aquifer (Lambeth Group) and Principal aquifer (various chalk formations).

9.5.28 There are two groundwater Source Protection Zones (SPZ) for public drinking water supply abstractions within 1 km of the draft Order Limits, which are applicable to the study area. These are presented on Figure 9-3, and detailed as follows:

a. One SPZ located north and east of Fontwell that includes:

   i. SPZ3 (total catchment), SPZ2 (outer catchment) and SPZ2c (outer catchment within confined aquifer) across the western extent of the draft Order Limits

   ii. SPZ1 (inner catchment) and SPZ1c (inner catchment within confined aquifer) located approximately 460 m west and 440 m west of the draft Order Limits, respectively

b. One SPZ located east of Warningcamp that includes:

i. SPZ3 and SPZ2, located approximately 470 m north of the draft Order Limits

ii. SPZ1 located approximately 900 m north of the draft Order Limits.

9.5.29 Environment Agency information indicates that there are five groundwater and seven surface water abstraction licences within 1 km of the draft Order Limits, for spray irrigation, horticultural watering and fish farm/cress pond throughflow. There are no potable water supply abstractions within 1 km of the draft Order Limits. A summary of the abstraction licence details is provided in Table 9-4 (groundwater) and Table 9-5 (surface water) and indicated on Figure 9-3.

9.5.30 ADC Private Water Supply Register (Ref 9-14) indicates that there is one private water abstraction (supply type: Regulation 9 Supply) in the study area, located approximately 700 m north of the draft Order Limits at Havenwood Caravan Park.

Table 9-4 Groundwater abstractions within 1 km of the draft Order Limits

Abstraction Borehole Name	Type of Use	Licence Number	Location
Sercombe	Spray irrigation – direct	10/41/542210	Gaston Farm, Slindon, approximately 970 m north of the draft Order Limits.
Toddington Nurseries Limited	Spray irrigation – direct	10/41/542209	Lake Lane Nurseries, Barnham, approximately 980 m south of the draft Order Limits.
Walberton Nursery LLP	Spray irrigation – direct	27/194A/R01	Yapton Lane, Walberton, approximately 260 m south of the draft Order Limits.
Walberton Nursery LLP	Horticultural watering	10/41/412006	Birdham Road, Barnham, approximately 500 m south of the draft Order Limits.

Ref 9-14 Arun District Council Private Water Supply Register Arun | Environmental Health Online Services. Accessed July 2021.

Abstraction Borehole Name	Type of Use	Licence Number	Location
Biddlecombe	Fish farm/cress pond throughflow	24/060	North-west of Lyminster, approximately 840 m south of the draft Order Limits.

Table 9-5 Surface water abstractions within 1 km of the draft Order Limits

Abstraction Name	Type of Use	Licence Number	Location
Fleurie Nursery Limited	Spray irrigation - spray irrigation definition order	27/176	Fleurie Nursery, Barnham, approximately 730 m south of the draft Order Limits.
Keith Langmead ltd	Spray irrigation - spray storage	27/190	Manor Farm, Pooling, approximately 740 m south of the draft Order Limits.
Luckin & Son	Spray irrigation - direct	10/41/411020	Manor House, Tortington, within the draft Order Limits, 100 m north of the Scheme.
Luckin & Son	Spray irrigation - direct	10/41/411022	Manor Farm, Decoy, 460 m south of the draft Order Limits.
Luckin & Son	Spray irrigation - direct	10/41/411020	Ford Road, Tortington, 250 m south of the draft Order Limits.
Longhurst Esq	Spray irrigation - direct	10/41/411010	River Arun, adjacent south of the draft Order Limits.
A M Harriot & Son	Spray irrigation - direct	10/41/411102	Broomhurst Farm, 350 m east of River Arun, 80 m south of the draft Order Limits.

9.5.31 The EIA will also consider any other wells and springs identified as part of ongoing water feature surveys. These are described further in *Chapter 13: Road Drainage and the Water Environment* and will be addressed within the ES.

9.5.32 Surface water receptors within the study area include the River Arun (eastern extent of the study area), and the Binsted Rife and Tortington Rife watercourses (western and central extent of the study area). All these watercourses cross the draft Order Limits.

9.5.33 There are several surface water features within the study area (such as small channels, ponds and ditches), which are likely to be in hydraulic connectivity with the underlying aquifers and with the watercourses as detailed above. A detailed review of the water environment is provided in *Chapter 13: Road Drainage and the Water Environment* of this PEI Report. The location of relevant water bodies is presented on Figure 9-3.

9.5.34 Sensitive land uses have been identified in the study area. These include ancient woodland, the SDNP and the Binsted Wood Complex LWS, which are potential receptors to land contamination from construction dust, surface water runoff and groundwater flow if controls are not in place. A detailed review of potential ecological receptors is presented in *Chapter 8: Biodiversity* of this PEI Report.

9.5.35 Property receptors within the study area comprise residential and commercial properties, agricultural crops, livestock and infrastructure such as below ground utilities.

9.5.36 Based on a review of the baseline conditions, Table 9-6 presents the receptors likely to be affected by the Scheme.

Table 9-6 Sensitive receptors

Issue	Receptors	Receptors Descriptions
Land Contamination	Human health	Residents, workers in, and visitors to, commercial properties, members of the public accessing areas of public open space.
	Groundwater	Principal aquifer (various chalk formations), associated with the bedrock geology. Secondary A aquifers, associated with the superficial deposits and with the bedrock geology (Lambeth Group). Secondary (undifferentiated) aquifers associated with the superficial deposits.

Issue	Receptors	Receptors Descriptions
		Unproductive strata of the London Clay Formation.
	Surface water	River Arun watercourse. Binsted Rife and Tortington Rife watercourses. Small channels, ponds and ditches.
	Sensitive land uses	Ancient woodland, the SDNP and the Binsted Wood Complex LWS.
	Property receptors	Residential and commercial properties, agricultural crops, livestock and infrastructure such as below ground utilities.
Soil	Soil resources	ALC Grade 3, 2 and 1.
Geology	Geological designations and sensitive/valuable non-designated features	Standard geological site SU90/86.

9.6 Potential impacts

9.6.1 Mitigation measures being incorporated into the Scheme design and likely to be implemented during the Scheme construction phase, are set out in *Section 9.7*. Prior to implementation of mitigation, potential impacts of the Scheme with regard to geology and soils are presented below.

Geology

9.6.2 There are no geological SSSI or LGS within the study area (see paragraph 9.5.10). The standard geological site reference SU90/86 is present within the draft Order Limits. During construction, there is the potential for physical damage to, or loss of this asset.

9.6.3 Consultation will be undertaken during the remainder of the EIA process with the Sussex Geodiversity Partnership, and the local authority to agree an approach to address any potential impacts to this site.

Soil resources

9.6.4 During construction of the Scheme, there is the potential for physical damage to soil and soil compaction as a result of heavy construction vehicle movements and exacerbation of soil erosion through handling and storage of soils.

9.6.5 The Scheme will also result in the permanent loss of agricultural land. The extent and quality of the agricultural land lost will be assessed and reported within the ES.

Land contamination

9.6.6 An assessment of the risks posed by land contamination has been undertaken by first assigning a 'risk score' to each identified historical or current area of possible contamination identified from the baseline review within the study area (refer to Table 9-3). The risk score has been determined using the tables within Appendix 9-A. The risk score is based on the relationship between the identified area of possible land contamination and its proximity to the draft Order Limits (Appendix Table 9-A.1) together with the vertical alignment of the Scheme design at its closest point (Appendix Table 9-A.3). The risk score also considers the nature of the current and/or historical land use where certain land uses typically result in greater levels of contamination of the ground to have occurred (Appendix Table 9-A.2). The lower the score then the lower the risk. Generally, risk scores of two or less are not be considered for further assessment. Risk scores of three or more will be considered for further impact assessment as described in Table 9-7 and shown in Figure 9-4, depending on their actual or potential relationship with defined receptors. This approach sets out a risk-based approach, that is consistent with the principles established in the Environment Agency guidance, Land contamination risk management (2020), which has been developed and applied successfully on other linear schemes.

Table 9-7 Possible areas of contamination (baseline risk scores 3 to 5)

Site ID	Site Name	Proximity Zone[1]	Land Use Class	Vertical Alignment	Baseline Risk Score[2]
CL001	Current garage	1	2	At grade	4
CL003	Current farm (Clear Spring Farm) and former engineering/unspecified works (1977-1990)	2	2	At grade	3
CL004	Current works/industrial estate	2	2	At grade	3
CL005	Current industrial estate, including granite	1	2	Embankment	3

Site ID	Site Name	Proximity Zone[1]	Land Use Class	Vertical Alignment	Baseline Risk Score[2]
	supplier and vehicle repair shop				
CL008	Current farm (Fairmeads Farm)	1	1	At grade	3
CL009	Current farm (New Barn)	1	1	Cutting	3
CL015	Current Arun Valley railway and historical railway sidings (1896 – 1974)	1	2	Viaduct/ Embankm-ent	3
CL020	Current petrol filling station (Crossbush petrol filling station)	1	3	At grade	5
CL024	Current construction company (Fordingbridge plc)	1	1	At grade	3
CL032	Current electrical substation	1	1	At grade	3
CL033	Historical landfill - Days landfill (WD27/110 and WA/10/87)	1	3	Cutting	5
CL034	Historical landfill - Hooe Farm landfill (WD27/223)	1	3	Cutting	5
CL036	Former timber yard	1	1	At grade	3

Site ID	Site Name	Proximity Zone[1]	Land Use Class	Vertical Alignment	Baseline Risk Score[2]
CL041	Former engineering/unspecified works (1977-1990)	1	2	At grade	4
CL042	Current electrical substation	1	1	At grade	3
CL043	Current woodcraft furniture frames	1	1	Cutting	3
CL046	Unspecified historical tank	1	3	At grade	5
CL051	The Arundel Equine Hospital LLP	1	1	At grade	3
CL052	Unspecified ground workings	1	1	At grade	3
CL063	Unspecified historical tank	3	3	Cutting	3

[1] Proximity zone definition is included within Table 9-A.1.

[2] Baseline risk scoring method is defined within Table 9-A.3.

Construction impacts

9.6.7 In the locations of the identified potential contamination in Table 9-7, and in the event of disturbance of contaminated soils/groundwater, there is the possibility, in the absence of any mitigation measures, that construction may affect human, ecological or controlled waters receptors, and for the ground conditions to impact on the design of the Scheme.

9.6.8 Potential impacts include but are not limited to:

a. Mobilising existing contaminants in soil and groundwater as a result of ground disturbance (due to the installation of foundations/retaining walls/structures/piling) and dewatering during construction.

b. Increasing the potential for contaminants in unsaturated soils to leach to groundwater in open excavations during construction, for example, any ground contamination that may be present at the cutting in the area of the historical landfills.

c. Increasing the potential for contaminated surface run-off to migrate to surface water and groundwater receptors as a result of leaching from uncovered stockpiles.

d. Discharge of water from dewatering to surface watercourses.

e. Introducing new sources of contamination, such as fuels and oils used in construction plant.

f. Creating preferential pathways for the migration of contamination and ground gases, for example along new below ground service routes, service ducts and as a result of dewatering.

Operational impacts

9.6.9 By the operation stage of the Scheme, conditions may have altered from the baseline as a result of, but not limited to:

a. Introducing the road infrastructure and its users as new receptor.

b. Contamination that has been encountered having been removed or remediated.

c. New road drainage and discharge routes.

d. Reduction in soil erosion through new drainage design.

9.7 Design, mitigation and enhancement measures

9.7.1 Further ground investigation including an ALC and soils survey will be undertaken as part of the EIA and to assist with Scheme design development. These further studies will enable a robust assessment of risks from possible historical contamination areas, notably within the former landfill sites (Days landfill and Hooe Farm landfill), and they will also assess the potential for migration of possible contaminants from the Crossbush petrol filling station.

9.7.2 Where risks are deemed to be significant (refer to the *EIA Scoping Report* contained within Appendix 1-A and the *EIA Scoping Opinion* contained within Appendix 1-B), remediation options and strategies will be developed accordingly. An approach will be agreed with the Sussex Geodiversity Partnership, and the local authority, to address any potential impacts to the standard geological site SU90/86 identified within the draft Order Limits. A first iteration EMP will be prepared as part of the EIA of the Scheme and submitted with the DCO application.

9.7.3 The EMP will contain measures to ensure compliance with relevant standards and legislation. The EMP will set out the environmental mitigation requirements and also the project level expectations on how the Scheme will be constructed. Measures contained within the EMP will be designed to limit the possibility for dispersal and accidental releases of potential contaminants, soil derived dusts and uncontrolled run-off to occur during construction activities. For example, the EMP will set out how material is to be excavated, segregated and stockpiled to minimise the possibility for run-off, soil quality degradation and wind dispersal of dust.

The EMP will also establish procedures for dealing with unexpected soil or groundwater contamination that may be encountered.

9.7.4 Subject to the results of the assessment to be undertaken and presented in the ES, a Soils Management Plan (SMP) will be included as part of the EMP to ensure delivery of measures necessary to protect valuable soil resources.

9.7.5 Defra (Department for Environment, Food and Rural Affairs) has worked with the Department of Trade and Industry to develop a Code of Practice for Sustainable Use and Management of Soils on Construction Sites (2009) (Ref 9-15). The code of practice, which will be adopted and implemented via the SMP, encourages the following:

a. Identification of soil resources at an early stage in the development process.

b. Improved planning of soil use.

c. A better level of soil management during project implementation, including sustainable use of surplus soil.

d. Maintenance of soil quality and function both on and off site.

e. Avoidance of soil compaction and erosion (with a consequent reduction in flooding and water pollution).

f. An improved knowledge and understanding of soil at all levels in the construction industry, including soil amelioration techniques.

9.7.6 Topsoil and subsoil will need to be removed during construction in order to prevent permanent burial beneath other earthworks. Such soils will be stockpiled and re-used, subject to acceptability, in the general earthworks such as landscaping and noise bunds. In particular, topsoil excavated from areas of known high quality agricultural land will be stored separately and, where possible, will be re-used on site in areas that will be returned to agricultural use.

9.7.7 The effects on soil resources will be mitigated by employing high standards of soil handling and management during construction, and by avoiding the creation of bare areas of permanently exposed soil that would be vulnerable to erosion processes.

9.7.8 Topsoil stripped during the construction of the Scheme will be re-used as soon as is practicable and stored in such a way as to minimise structural damage from weathering, construction traffic movements, and multiple handling, and which will also minimise the potential for leaching of nutrients from soils.

9.7.9 All materials proposed for re-use will be required to meet risk-based acceptability criteria. Soils will be protected from accidental contamination during storage and transit. Methods of soils handling and storage, including

Ref 9-15 DEFRA, Code of Practice for Sustainable Use and Management of Soils on Construction Sites, 2009

measures to prevent erosion by wind and surface water, will be detailed in method statements that will be prepared prior to the commencement of construction activities.

9.7.10 The re-use of excavated soils during construction would be governed by either a Materials Management Plan (forming part of the EMP) developed in accordance with the CL:AIRE. Definition of Waste: Development Industry Code of Practice (Ref 9-16), hereafter referred to as the CL:AIRE Code of Practice, an environmental permit or a relevant exemption. The CL:AIRE Code of Practice is a voluntary framework for excavated materials management and re-use. Following this framework results in a level of information being generated that is sufficient to demonstrate that excavated material has been re-used appropriately and is suitable for its intended use. It demonstrates that unsuitable material or waste has not been used in the development. The Materials Management Plan would detail the procedures and measures that will be taken to classify, track, store, reuse and dispose of all excavated materials that will be encountered during the construction works.

9.7.11 Where there is a requirement to dispose of surplus soils off site as waste, the material will be characterised to determine firstly whether it is Hazardous or Non-Hazardous waste in accordance with the Environment Agency's Technical Guidance WM3 (Ref 9-17). Once this is established, the appropriate disposal facility will be determined through Waste Acceptance Criteria (WAC) analysis, as required.

9.7.12 The EMP will include relevant measures to address risks to construction workers as defined by the findings of the ground investigation.

9.7.13 Any remediation works, or the removal of contaminated soils associated with the construction of the Scheme would be expected to result in the enhancement of the local environment.

9.7.14 No mitigation measures are available to address the permanent loss of agricultural land resulting from land take required for the Scheme, other than minimising land take. However, land temporarily required for site compounds and temporary access roads will be returned to agricultural use post construction.

9.7.15 No specific mitigation, over and above that included in the design of the Scheme, is considered necessary for geology and soils during the operation of the Scheme.

Ref 9-16 CL:AIRE (2011). The Definition of Waste: Development Industry Code of Practice. Version 2

Ref 9-17 Environment Agency (2021). Guidance on the Classification and Assessment of Waste. Technical Guidance WM3. 1st Edition v1.2.GB.

9.8 Assessment of effects

9.8.1 The section below comprises a preliminary assessment of potential geology and soils impacts, taking into account the potential impacts as outlined in *Section 9.6* and the mitigation measures in *Section 9.7*.

Construction effects

Geology

9.8.2 There are no geological SSSI or LGS within the study area (see paragraph 9.5.10). The standard geological site (reference SU90/86) is located within the draft Order Limits and the Scheme may have significant adverse effects on this feature. As part of the preparation of the ES, engagement will continue with the Sussex Geodiversity Partnership and the local authority, to agree an approach to address any potential impacts to this site.

Soil resources

9.8.3 With regard to soil resources (excluding agricultural land), no significant adverse effects are anticipated provided the mitigation measures as outlined in *Section 9.7* are implemented.

9.8.4 The agricultural land that would be affected by the construction of the Scheme will be surveyed to determine its ALC grade. This preliminary assessment has determined that, of the agricultural land which will be required for Scheme construction (located within the draft Order Limits), the majority is likely to be Grade 3 (subgrade not available at this stage), with areas of Grade 2 and Grade 1; and will therefore include BMV agricultural land. Loss of soils due to the Scheme (albeit some areas will be restored) will likely result in a permanent significant adverse effect where agricultural land is required for the Scheme, with potential temporary significant adverse effects where agricultural land is used for construction activity.

Land contamination

9.8.5 With regard to land contamination, mitigation measures include undertaking a ground investigation and land contamination risk assessment to support the Scheme design; and where unacceptable risk from land contamination is identified, undertaking a review of available remediation options and developing remediation strategies. It is predicted that there will be some temporary minor adverse effects during construction, from ground disturbance or groundwater controls which may inadvertently mobilise contamination or create preferential pathways, in particular for ground gas or groundwater. This may result in a temporary worsening in groundwater quality or increased ground gas risk compared to the baseline conditions. However, it is unlikely that these would be significant effects as the EMP is expected to contain measures to reduce any adverse effects to an acceptable level. Therefore, with regards to land contamination, minor adverse effects (as a worst-case scenario) (not significant) are anticipated, provided the mitigation measures as outlined in *Section 9.7* are implemented.

9.8.6 There is the potential for significant beneficial effects should any existing land contamination require remediation or removal as part of the Scheme construction works. Detailed assessment, which will be undertaken as part of the ES, will confirm if the beneficial effects are likely to be significant.

Operational effects

9.8.7 No significant operational effects on geology and soils are anticipated as the design of the Scheme includes measures that will contain and control any releases of contaminants along the highway and its associated infrastructure.

9.8.8 The mitigation measures detailed in *Chapter 13: Road Drainage and the Water Environment* (refer to *Section 13.7*) would prevent the pollution of controlled waters during the Scheme operational phase. Routine maintenance measures to mitigate potential operational phase impacts would include:

9.8.9 Pollution treatment measures such as settlement via attenuation storage incorporated into the drainage design where a risk of pollution has been identified.

9.8.10 Maintenance of drainage features to be undertaken in line with an operational management plan that will include training of personnel, frequency of inspections, maintenance and replacement of drainage systems.

9.8.11 Drains will be designed in such a way to ensure no loss of habitat or flood conveyance, and where practicable to enhance biodiversity, geomorphology and flood storage.

9.8.12 Any discharge of drained groundwater from cuttings will be balanced alongside drainage from the road and attenuated before discharge to surface water.

Summary of preliminary assessment

9.8.13 Based on the preliminary assessment outlined above, there is potential for significant effects to result from the construction of the Scheme. A summary of these potentially significant effects is reported below in Table 9-8.

9.9 Scheme options

9.9.1 As described in *Chapter 2: The Scheme*, options are still being considered for the potential reprovision of Avisford Park Golf Club. In addition, a potential alternative option from the current proposed alignment where the Scheme passes between Avisford Park, the new housing development at Avisford Grange and the existing Yapton Lane is being considered. This would raise the vertical alignment of the Scheme, with an offline Yapton Lane overbridge. The sections below discuss these in turn and outline whether adopting either of these would change anything stated in the preceding baseline conditions, potential impacts and assessment of effects sections and consider the potential for different effects of the options.

Options for Avisford Park Golf Club reprovision

Option 1: 9 hole golf course with driving range or practice facilities

9.9.2 On the whole, the reprovision of an amended golf course is unlikely to result in changes to the information already provided in the baseline conditions and potential impacts sections presented above, as this chapter has considered the draft Order Limits which already cover this area. The exception is the standard geological site (reference SU90/86) identified in the baseline conditions. This is unlikely to be directly impacted by this particular option and so there would be no potential for a permanent adverse significant effect to this asset. Otherwise, the preliminary conclusions in terms of the potential for likely significant environmental effects presented above remain the same. In this regard it is considered that Option 1 is the better option from a geology and soils perspective.

Option 2: Replacement 18 hole golf course

9.9.3 Full reprovision of the existing golf course would not result in any changes to the information already provided in the baseline conditions, potential impacts and assessment of effects sections presented above, as this chapter has considered the draft Order Limits that already cover this area. It should be noted that the standard geological site (reference SU90/86) would likely be affected by this option; therefore, there is the potential for physical damage to, or loss of this asset, which has been acknowledged in *Section 9.8.*

Option for raised vertical alignment with offline Yapton Lane overbridge

9.9.4 This option is considered to be a minimal change in respect of geology and soils against the current proposed alignment and it would not result in any changes to the information already provided in the baseline conditions, potential impacts and assessment of effects sections presented above, as this chapter has considered the draft Order Limits, which already cover this area. There are no geological sites in this location and whilst there would be very slightly more permanent land take from agricultural land which means this option is considered less preferable from this perspective, it is considered minimal in the context of the overall Scheme. The preliminary conclusions in terms of the potential for likely significant environmental effects remains the same as for the current proposed alignment.

Table 9-8 Summary of potential significant effects

Receptor	Scheme impact	Potential significant effects (following embedded mitigation)	Further mitigation to be explored
Standard geological site SU90/86	This asset is located within the draft Order Limits, in an area which may be used for golf course reprovision, if required.	Permanent adverse effects due to potential for physical damage to, or loss of this asset.	As part of the preparation of the ES, engagement will continue with the Sussex Geodiversity Partnership and the local authority, to agree an approach to address any potential impacts to this site.
Agricultural land	Loss of agricultural land located within the draft Order Limits.	Permanent adverse effects, as a result of loss of agricultural land due to the Scheme.	The agricultural land that would be affected by the construction of the Scheme will be surveyed to determine its ALC grade. Appropriate mitigation will be outlined.
Human and controlled water receptors to possible ground and groundwater contamination	Remediation or removal of existing land contamination, as part of the Scheme construction works.	Potential for beneficial effects, should any existing land contamination require remediation or removal as part of the Scheme construction works. Detailed assessment, which will be undertaken as part of the ES, will confirm if the beneficial effects are likely to be significant.	None required.

10. Material Assets and Waste

10.1 Introduction

10.1.1 This chapter addresses the potential impacts and effects on material assets and waste during construction of the Scheme. This assessment has been undertaken in accordance with the guidance in *DMRB LA 110 Material Assets and Waste* (*LA 110*) (Ref 10-1).

10.1.2 Material use and waste arising is expected to be very small during operation of the Scheme. Waste arising from routine maintenance activities is expected to be generally the same (in both type and quantity) as that generated by the existing road; whilst the wastes generated will be managed using the established procedures and facilities that are used across the strategic highway network. For these reasons, impacts on material assets and waste during the Scheme operational phase have been scoped out of the assessment which has been confirmed within the *EIA Scoping Opinion* (Appendix 1-B).

10.1.3 There may be interrelationships related to the potential effects on material assets and waste and other disciplines. In particular, reference should be made to the following chapters:

a. Chapter 9: Geology and Soils

b. Chapter 14: Climate

10.1.4 For the purpose of this chapter, material assets and waste are defined as comprising:

a. The consumption of materials and products (from primary, recycled or secondary and renewable sources).

b. The generation and management of waste.

10.1.5 Waste is defined as per the Waste Framework Directive (2008/98/EC) (Ref 10-2) as *"any substance or object which the holder discards or intends or is required to discard"*.

10.1.6 The Scheme aims to prioritise waste prevention, followed by preparing for waste reuse, recycling and recovery and lastly disposal to landfill, in accordance with the waste hierarchy.

10.1.7 The assessment of materials and waste impacts and the design of appropriate mitigation is informed by the legislation and policies in the following:

Legislation

a. Waste (England and Wales) Regulations 2011 (as amended)

Ref 10-1 Highways England (2019). Design Manual for Roads and Bridges (DMRB), LA 110 Material Assets and Waste. Revision 0.
Ref 10-2 Directive 2008/98/EC of the European parliament and of the council of 19 November 2008 on waste and repealing certain directives.

b. *The Environmental Permitting (England and Wales) Regulations 2016*
c. *Hazardous Waste (England and Wales) Regulations 2005 (as amended)*
d. *Environmental Protection Act 1990 (as amended)*

National Policy

a. *Waste Management Plan for England* (Ref 10-3)
b. *Our Waste, Our Resources: a Strategy for England* (Ref 10-4)
c. *A Green Future: Our 25 Year Plan to Improve the Environment* (Ref 10-5)
d. *A Strategy for Hazardous Waste Management in England* (Ref 10-6)
e. *NPSNN* (Ref 1-7)
f. *NPPF* (Ref 1-8)
g. *PPG* (Ref 10-7, Ref 10-8)
h. *National Planning Policy for Waste* (Ref 10-9)

Local Policy

a. *West Sussex Joint Minerals Local Plan 2018* (Ref 1-19)
b. *West Sussex Waste Local Plan 2014* (Ref 1-18)
c. *Review of the West Sussex Waste Local Plan 2014 (May 2019)* (Ref 10-10)
d. *West Sussex Waste Local Plan. Minerals and Waste Safeguarding Guidance* (Ref 10-11)
e. *Arun Local Plan 2011-2031* (Ref 1-12)
f. *South Downs Local Plan 2014–2033* (Ref 1-13)

Ref 10-3 Department for Environment, Food and Rural Affairs (2021). Waste Management Plan for England. January 2021.
Ref 10-4 Department for Environment, Food and Rural Affairs (2018). Our waste, our resources: a strategy for England. December 2018.
Ref 10-5 Department for Environment, Food and Rural Affairs (2018). A Green Future: Our 25 Year Plan to Improve the Environment.
Ref 10-6 Department for Environment, Food and Rural Affairs (2010). A Strategy for Hazardous Waste Management in England. March 2010.
Ref 10-7 Ministry of Housing, Communities and Local Government (2014). Planning Practice Guidance: Minerals. 17 October 2014.
Ref 10-8 Ministry of Housing, Communities and Local Government (2015). Planning Practice Guidance: Waste. 15 October 2015.
Ref 10-9 Department for Communities and Local Government (2014). National Planning Policy for Waste. October 2014.
Ref 10-10 West Sussex County Council and South Downs National Park Authority (2019). Review of the West Sussex Waste Local Plan 2014 (May 2019).
Ref 10-11 West Sussex County Council and South Downs National Park Authority (2020). West Sussex Joint Minerals Local Plan, West Sussex Waste Local Plan: Minerals and Waste Safeguarding Guidance. March 2020.

g. *SDNPA Position Statement on A27 corridor* (Ref 10-12)

10.2 Stakeholder engagement

10.2.1 To inform the development of the material assets and waste assessment, consultation was undertaken as part of the scoping exercise as set out within the *EIA Scoping Report* (Appendix 1-A) and *EIA Scoping Opinion* (Appendix 1-B). The scoping exercise included consultation with WSCC and the SDNPA as the minerals and waste planning authorities. Further consultation will include mineral resources and mineral safeguarding aspects, as well as waste management infrastructure.

10.3 Assessment assumptions and limitations

10.3.1 The information presented in this chapter is based on the information available at the time of writing and the emerging Scheme design as described in *Chapter 2: The Scheme*. The findings reported in this chapter may be subject to change as the design of the Scheme is developed and refined.

10.3.2 Data on the type and quantity of materials required to construct the Scheme, and the type and quantity of waste generated from Scheme construction, are not currently available. This information will be generated as the Scheme design continues to develop and will be reported in the ES. However, for the purpose of identifying potentially significant effects the following assumptions regarding materials and waste quantities have been used, based on the preliminary design for the statutory consultation process:

a. The preliminary design estimates the total quantity of earthworks cut material to be approximately 450,000 m^3.

b. Topsoil and subsoil to be reused on site is conservatively assumed to comprise 5% of total earthworks cut (22,500 m^3).

c. As a worst-case scenario, assuming no further reuse, the remaining earthworks cut material requiring disposal would comprise 427,500 m^3, and assuming a material bulking factor for disposal of 1.2, would comprise 513,000 m^3 of material for disposal.

10.3.3 Information on the current permitted landfill capacity in the waste management study area is given in Table 10-1. There are no known changes to this permitted capacity anticipated prior to construction of the Scheme.

10.3.4 This chapter does not consider the environmental impacts associated with the extraction of raw materials and the manufacture of products, or the impact of the management of waste at third party waste management facilities. It is assumed that any such issues would have been subject to the applicable environmental assessment, permitting and planning approval for

Ref 10-12 South Downs National Park Authority (2019). South Downs National Park Authority Position Statement on A27 corridor.

the relevant facilities and would have their own waste management plans. For these reasons, such impacts have been scoped out of the assessment, which has been confirmed within the *EIA Scoping Opinion* (Appendix 1-B).

10.4 Study area

10.4.1 The study areas for material assets and waste are defined using the guidance within *LA 110* (Ref 10-1).

10.4.2 The study area for the consideration of the sterilisation of mineral safeguarding sites and peat resources and for the use of material assets during the construction of the Scheme is defined by the draft Order Limits (Figure 1-1).

10.4.3 The study area for alternative materials (secondary and recycled aggregates) is the south east England region (comprising Berkshire, Buckinghamshire, East Sussex, Hampshire, Isle of Wight, Kent, Oxfordshire, Surrey and West Sussex), as set out within *LA 110* (Ref 10-1).

10.4.4 The study area for waste arising from the construction of the Scheme is defined by the draft Order Limits (Figure 1-1), within which construction waste would be generated.

10.4.5 The study area for waste management is defined by consideration of the proximity principle and value for money and comprises the wider region within which waste management infrastructure (specifically landfill capacity) is located. For the management of non-hazardous waste, the study area therefore comprises the south east England region as defined above. For hazardous waste management, the study area comprises the whole of England, as planning for hazardous waste management is undertaken at a national level (Ref 10-6).

10.5 Baseline conditions

10.5.1 The types and quantities of material use and waste arising associated with the operation of the existing road network and the existing site are currently unknown. Existing material use comprises the materials required for routine maintenance and also for intermittent repairs and refurbishment, with associated waste arisings. The quantity of these materials and waste arisings are likely to be small when compared to total regional and national data and therefore the baseline conditions consider the wider regional and national geographic context.

10.5.2 Information on previously developed land and potential sources of contamination that could give rise to materials and waste that require specific handling, storage and management arrangements, are set out in *Chapter 9: Geology and Soils* of this PEI Report.

Material assets: safeguarded mineral sites and peat resources

10.5.3 The *West Sussex Joint Minerals Local Plan* (Ref 1-19) covers the period to 2033 and sets out the vision and strategic objectives associated with minerals supply developments in West Sussex. The development plan

states that mineral resources must be safeguarded, as well as mineral infrastructure including wharves and railheads. Policy M9: Safeguarding Minerals states that existing mineral extraction sites will be safeguarded against non-mineral development that prejudices their ability to supply minerals in the manner associated with the permitted activities. Policy M9 also states that soft sand (including potential silica sand), sharp sand and gravel, brick-making clay, building stone resources and chalk reserves are safeguarded against sterilisation. Policy M10: Safeguarding Minerals Infrastructure details limitations for development on, or near to sites hosting permanent minerals infrastructure.

10.5.4 The *West Sussex Joint Minerals Local Plan and Waste Local Plan*: *Monitoring Report 2019/20* (Ref 10-13) identifies 67 mineral sites, of which 49 are active and 57 are safeguarded. These sites include sharp sand and gravel, soft sand, clay/brickworks, building stone, chalk, oil and gas, concrete batching, coated roadstone, mineral wharves and railheads. None of the safeguarded sites are located within the draft Order Limits.

10.5.5 Mineral Safeguarding Areas (MSAs) are defined in the *West Sussex Joint Minerals Local Plan* (Ref 1-19) as areas of known mineral resources that are of sufficient economic or conservation value to warrant protection for generations to come. Sand and gravel, chalk, clay and sandstone are considered to have economic importance in West Sussex and are safeguarded in order to prevent potential sterilisation. An MSA for sharp sand and gravel is present across the western part of the Scheme, extending from the western end of the Scheme eastwards to where the new dual carriageway approaches Tortington Rife.

10.5.6 The *West Sussex Joint Minerals Local Plan* (Ref 1-19) also identifies a Petroleum Exploration and Development Licence area across the western part of the Scheme, extending from the western end of the Scheme eastwards to where the new dual carriageway approaches Tortington Lane.

10.5.7 The *West Sussex Minerals and Waste Safeguarding Guidance* (Ref 10-11) sets out the locations of Mineral Consultation Areas. The Mineral Consultation Areas define when the Minerals Planning Authority should be consulted on proposals for non-mineral development, on or close to (including a 250 m buffer) minerals infrastructure and MSAs, as identified in the *West Sussex Joint Minerals Local Plan* (Ref 1-19) and *The West Sussex Joint Minerals Local Plan and Waste Local Plan: Monitoring Report 2019/20* (Ref 10-13).

10.5.8 The *West Sussex Minerals and Waste Safeguarding Guidance* (Ref 10-11) confirms that:

a. There are no Minerals Infrastructure Consultation Areas within the draft Order Limits.

Ref 10-13 West Sussex County Council and South Downs National Park Authority (Undated). West Sussex Joint Minerals Local Plan and Waste Local Plan: Monitoring Report 2019/20.

b. A Sharp Sand Resource Consultation Area is present across the western part of the Scheme, extending from the western end of the Scheme eastwards to where the new dual carriageway approaches Tortington Rife.

c. An Oil and Gas Sites Mineral Consultation Area arising from Petroleum Exploration and Development Licence areas is present across the western part of the Scheme, extending from the western end of the Scheme eastwards to where the new dual carriageway approaches Tortington Lane.

10.5.9 WSCC and the SDNPA undertook a Soft Sand Review (SSR) as required by Policy M2 of the *West Sussex Joint Minerals Local Plan July 2018*, that resulted in changes to the Plan, which were adopted in March 2021 (Ref 1-19). The key changes included a revised strategy for the supply of soft sand, a revised figure for the amount of soft sand needed during the Plan period, and the allocation of three sites for soft sand extraction in Policy M11: Strategic Minerals Site Allocations, none of which are located within the draft Order Limits.

10.5.10 The *British Geological Survey GeoIndex Onshore* (Ref 10-14) indicates that there are no peat resources located in proximity to the Scheme.

Material assets: recovery of non-hazardous construction and demolition waste

10.5.11 The national target for recovery of construction and demolition waste is 70% by weight, as set out in the *Revised European Waste Framework Directive* (Ref 10-2) and the *Waste Management Plan for England* (Ref 10-3). Uncontaminated excavated soil and stones (European Waste Catalogue code 17 05 04) are specifically excluded from this target.

10.5.12 *LA 110* (Ref 10-1) Annex E/2 states that projects in England should aim to achieve at least 90% (by weight) material recovery of non-hazardous construction and demolition waste.

10.5.13 Defra reports on performance against the national target for the recovery of non-hazardous construction and demolition waste. The most recent report (Ref 10-15) estimates that, in England, in 2018, 93.8% of non-hazardous construction and demolition waste was recovered, comprising approximately 57.5 million tonnes of the 61.4 million tonnes generated.

Material assets: alternative aggregates

10.5.14 The baseline guidelines for alternative aggregates comprising both secondary aggregates (by-products from industrial and mining operations) and recycled aggregates (produced from construction waste) are set out in the *National and Regional Guidelines for Aggregates Provision in England*

Ref 10-14 British Geological Survey. GeoIndex Onshore – Mineral resources: Peat.
Ref 10-15 Department for the Environment Food and Rural Affairs (2021). UK Statistics on Waste, 15 July 2021.

2005 to 2020 (Ref 10-16) and in *LA 110* (Ref 10-1) Annex E/1. The relevant target for the Scheme is the 26% guideline for the south east England region.

10.5.15 Data on the production of aggregates is published by the Mineral Products Association and, in 2018 (Ref 10-17), it estimated that the supply of aggregates in Great Britain totalled 251 million tonnes, of which 71 million tonnes (28%) were from recycled (25%) and secondary (3%) sources.

10.5.16 The *West Sussex Minerals and Waste Safeguarding Guidance* (Ref 10-11) identifies Mineral Consultation Areas in West Sussex for active and permitted aggregate recycling sites (including 250 m buffer). No Mineral Consultation Areas for aggregate recycling sites are identified within the draft Order Limits.

Waste: landfill capacity and inputs

10.5.17 The Environment Agency's *2020 Waste Data Interrogator* (Ref 10-18) *2020 Waste Summary Tables for England (Version 1)* summarises landfill capacity (for all landfill types) at the end of 2020, as set out in Table 10-1 and landfill inputs for 2020, as set out in Table 10-2.

10.5.18 For the south east England region, total landfill capacity at the end of 2020 was approximately 63 million m3, with just over 0.55 million m3 of that capacity located within West Sussex.

10.5.19 Although non-hazardous landfill capacity has depleted to near zero in West Sussex, an allocation for further landfill remains in the *West Sussex Waste Local Plan 2014* (Ref 1-18) and the authorities continue to monitor the situation in the south east region (Ref 10-13).

10.5.20 The *West Sussex Joint Minerals Local Plan and Waste Local Plan: Monitoring Report 2019/20* (Ref 10-13) also identifies 3.14 million tonnes of recovery capacity for inert waste in deposit for recovery operations, which may be used for suitable material exported from the construction of the Scheme.

Table 10-1 Remaining permitted landfill capacity at the end of 2020 ('000s m^3) (Ref 10-18)

Landfill type	West Sussex	South East region	England
Hazardous Merchant	0	146	15,571
Hazardous Restricted	0	117	809

Ref 10-16 Ministry of Housing, Communities and Local Government (2009). National and regional guidelines for aggregates provision in England 2005 - 2020.
Ref 10-17 Mineral Products Association (2020). The Contribution of Recycled and Secondary Materials to Total Aggregates Supply in Great Britain in 2018.
Ref 10-18 Environment Agency (2021), 2020 Waste Data Interrogator. Revision published 14 October 2021.

Landfill type	West Sussex	South East region	England
Non-hazardous with SNRHW* cell	0	22,197	66,969
Non-hazardous	295	13,556	137,457
Non-hazardous Restricted	0	0	27,368
Inert	260	27,174	140,192
Total	555	63,190	388,366
*Some non-hazardous sites can accept some Stable Non-Reactive Hazardous Waste (SNRHW) into a dedicated cell, but this is usually a small part of the overall capacity of the site			

Table 10-2 Landfill inputs in 2020 ('000s tonnes) (Ref 10-18)

Landfill type	West Sussex	South East region	England
Hazardous Merchant	0	13	826
Hazardous Restricted	0	19	19
Non-hazardous with SNRHW* cell	0	2,704	6,458
Non-hazardous	124	1,729	16,488
Non-hazardous Restricted	0	0	527
Inert	258	3,571	15,485
Total	382	8,036	39,803
*Some non-hazardous sites can accept some stable non-reactive hazardous waste (SNRHW) into a dedicated cell, but this is usually a small part of the overall capacity of the site.			

Waste: waste management infrastructure

10.5.21 The *West Sussex Minerals and Waste Safeguarding Guidance* (Ref 10-11) sets out the locations of Waste Infrastructure Consultation Areas for allocated and permitted waste sites (including a 250 m buffer). There is one waste infrastructure consultation area adjacent to the eastern end of the Scheme (Stubbs Copse Wood Yard Composting Facility).

10.5.22 The Environment Agency's *2020 Waste Data Interrogator* (Ref 10-18) *Wastes Received (Version 1)* data set collates the operator waste returns information as reported for the year 2020. Table 10-3 provides a summary of the types of waste management facility located in south east England that reported receiving construction, demolition or excavation waste (waste code chapter 17) during 2020, and the quantity of waste (tonnes) that was received. This data provides an indication of the operational capacity of the waste management infrastructure located in south east England that can manage construction, demolition or excavation wastes.

Table 10-3 Construction, demolition and excavation waste (waste code chapter 17) received by waste management facilities in the south east of England in 2020 (tonnes) (Ref 10-18)

Waste management facility type		Construction, demolition and excavation waste (waste code chapter 17) received by waste management facilities located in the south east of England (tonnes)		
Site category	Facility type	Waste code 17 05 04 soil and stones (not containing hazardous substances)	Other non-hazardous waste (excluding 17 05 04)	Hazardous waste
Storage	Temporary/In-house storage	-	84,952	8
Transfer	Waste transfer	502,483	1,646,326	27,051
Treatment	Waste transfer/ treatment	178,464	1,043,100	5,130
	Biological treatment	0	0	700
	Composting	4,000	2,039	-
	Material Recycling Facility	194,287	576,554	4,479
	Physical/ Physical-chemical treatment	689,316	2,172,109	824

Waste management facility type		Construction, demolition and excavation waste (waste code chapter 17) received by waste management facilities located in the south east of England (tonnes)		
Site category	**Facility type**	**Waste code 17 05 04 soil and stones (not containing hazardous substances)**	**Other non-hazardous waste (excluding 17 05 04)**	**Hazardous waste**
Metal recycling site	Metal recycling site	1,129	203,363	201
Mobile Plant	Mobile plant - landspreading	-	35,208	-
	Mobile plant - treatment	2,852	26,183	2,384
	Mobile plant – unknown	11,654	-	74,555
Use of Waste	Construction	651	-	-
On/in land	Deposit of waste to land (recovery)	1,685,103	31,574	-
	Lagoon	-	58,530	-
Incineration	Incineration	-	76,406	46
Combustion	Combustion	-	40,895	-
Landfill	Hazardous (merchant)	3,660	-	9,342
	Non-hazardous (SNRHW)*	890,575	105,346	39,535
	Non-hazardous	1,008,856	37,013	-
	Inert	3,360,451	189,254	28

Waste management facility type		Construction, demolition and excavation waste (waste code chapter 17) received by waste management facilities located in the south east of England (tonnes)		
Site category	Facility type	Waste code 17 05 04 soil and stones (not containing hazardous substances)	Other non-hazardous waste (excluding 17 05 04)	Hazardous waste
*Some non-hazardous landfill sites can accept some Stable Non-Reactive Hazardous Waste (SNRHW) into a dedicated cell, but this is usually a small part of the overall capacity of the site. Note: Waste can move through the waste management supply chain and can therefore be reported as being received by more than one facility. For example, where it is moved from a transfer facility to a treatment facility, or a treatment facility to a recovery or disposal facility. Total waste arising does not equal the sum of all wastes received. Some waste that is received by facilities located in the south east of England will have arisen outside of the south east region, and some waste that arises in the south east of England will be received by facilities located outside the south east region.				

10.6 Potential impacts

Construction impacts

10.6.2 There is potential for the following impacts on material assets and waste to occur during construction of the Scheme:

a. Impacts on sites designated for the availability of primary material resources (minerals safeguarding sites within West Sussex).

b. Impacts on the availability and use of reused, recycled and secondary aggregate materials.

c. Impacts from on-site generated materials (such as excavated materials and soils) and waste arisings on the remaining capacity of landfill infrastructure.

d. Impacts on the operation and capacity of existing and proposed future waste management infrastructure.

10.6.3 Table 10-4 summarises the likely types of materials used and wastes that may potentially be generated during construction of the Scheme. Further design development will enable the quantification of material use and waste

arising from Scheme construction and an assessment of the likely significant effects will be detailed within the ES.

Table 10-4 Potential material use and waste arising from the construction of the Scheme

Project activity	Material use	Waste arising
Site remediation/ preparation/ earthworks	Fill material for construction purposes. Primary/secondary/recycled aggregates for ground stabilisation. Topsoil and subsoil for landscaping and restoration.	Surplus excavated materials. Surplus topsoil and subsoil. Unsuitable and contaminated soils and excavated materials. Vegetation/wood from site clearance. Clearance of redundant highway infrastructure.
Demolition	Materials are not required for demolition works.	Waste arisings from the demolition of any existing buildings or structures.
Site construction	Construction materials including: a. aggregates b. asphalt and bituminous materials c. in-situ cast concrete d. precast concrete products e. structural steelwork f. steel reinforcing bar g. timber and timber products h. geotextile i. drainage systems j. fencing and barriers.	Packaging from materials delivered to site. Excess, offcuts and broken/ damaged construction materials. Existing highway infrastructure and technology removed during works. Construction worker wastes from offices and rest areas/ canteens. Waste oils from construction plant.

10.7 Design, mitigation and enhancement measures

Construction

10.7.2 The Scheme will aim to prioritise waste prevention, followed by preparing for re-use, recycling and recovery and lastly disposal to landfill in accordance with the waste hierarchy (see Plate 10-1).

Plate 10-1: Waste hierarchy

10.7.3 The following mitigation measures are being considered as part of the design development and construction phases where appropriate:

a. Waste is being prevented and designed out where practicable.

b. The earthworks cut and fill requirements are being optimised to achieve a balance, where practicable.

c. Opportunities to re-use material resources are being sought where practicable, such as the reuse of excavated materials and the recycling of demolition materials within the Scheme.

d. Opportunities to support the circular economy are being considered during the design phase, including using recycled and secondary materials during construction, where practicable.

e. Where waste prevention or re-use are not possible, waste arisings will be managed in line with the waste hierarchy.

10.7.4 As stated in *Chapter 2: The Scheme*, a first iteration EMP, will be prepared (in line with *DMRB LA 120 Environmental management plans* (Ref 10-19)) as part of the EIA of the Scheme and submitted with the DCO application. The EMP content will be developed in parallel with the development of the Scheme design and construction methodology. Measures within the EMP will include design, construction and operational mitigation, which have been defined in part by the requirements arising from the technical assessments undertaken. The first iteration EMP will include an outline Site Waste Management Plan that will set out how the waste hierarchy is being adopted on the Scheme, including waste reduction measures and

Ref 10-19 Highways England (2020). Design Manual for Roads and Bridges (DMRB), LA 120 Environmental management plans. Revision 1.

procedures and controls for the storage, handling and management of materials and waste.

10.7.5 Subject to the granting of approval, the construction of the Scheme will be subject to measures and procedures defined within a second iteration EMP (Ref 10-19). The second iteration EMP will be based on the measures contained in the first iteration EMP, and will include the implementation of industry standard practice and control measures for environmental impacts arising during construction, for example:

a. All hazardous materials including fuels, chemicals, cleaning agents, solvents and solvent containing products will be handled, used and stored in accordance with regulatory and manufacturer requirements.

b. The segregation of waste at source, where practical, to facilitate a high proportion of high quality recycling.

c. Reviewing material quantity requirements to avoid over-ordering and the generation of surplus materials that may become waste.

d. Implementing agreements with material suppliers to reduce the amount of packaging, or to participate in a packaging take-back scheme.

e. Materials requiring removal from the site will be transported using licensed carriers, and records kept detailing the types and quantities of waste moved and the destinations of this waste.

10.7.6 The second iteration EMP will be produced prior to works commencing, in accordance with relevant guidance, noting that the EMP will include secondary plans, including an updated Site Waste Management Plan.

10.8 Assessment of effects

10.8.1 The assessment of effects on material assets and waste is being undertaken in accordance with *LA 110* (Ref 10-1), as set out within the *EIA Scoping Report* (Appendix 1-A). The methodology applies a simplified significance framework, comprising significance categories and significance criteria, to assess the significance of effects.

10.8.2 A preliminary assessment of the effects on material assets and waste is presented below. Further work will be undertaken as part of the ongoing EIA to quantify, where applicable, the use of material resources and the generation and management of waste and to assess the significance of effects.

10.8.3 The assessment of likely significant effects will be reported within the ES.

Material assets: safeguarded mineral sites and peat resources

10.8.4 A Sharp Sand Resource Consultation Area and an Oil and Gas Sites Mineral Consultation Area (arising from Petroleum Exploration and Development Licence areas) are present across the western part of the Scheme, extending eastwards to where the new dual carriageway approaches Tortington Rife and Tortington Lane respectively.

10.8.5 However, no active or allocated mineral sites, Minerals Infrastructure Consultation Areas or peat resources are located within the draft Order Limits (Figure 1-1), and therefore, no significant effects on mineral sites or peat resources are anticipated.

Material assets: recovery of non-hazardous construction and demolition waste

10.8.6 Site-specific information on the likely quantities of non-hazardous construction and demolition waste likely to arise from construction of the Scheme and the associated management routes is not currently available. Ongoing design development will enable estimates to be developed for the on-site and off-site recovery of non-hazardous construction and demolition waste and associated mitigation measures for assessment within the ES.

10.8.7 As set out in *LA 110* (Ref 10-1) Annex E/2, if a development is not able to achieve a target of 70% (by weight) recycling or recovery of non-hazardous construction and demolition waste then it would result in a moderate/large adverse effect which is significant. However, as required by *LA 110* (Ref 10-1), the Scheme will set a target (within the EMP) to achieve at least 70% (by weight) recycling or recovery of non-hazardous construction and demolition waste, with the aim of achieving at least 90% (by weight). National data on the recovery of non-hazardous construction and demolition waste in England (Ref 10-15) estimates that 93.8% was recovered in 2018. This data indicates that the application of good practice mitigation measures will enable the minimum 70% recovery target to be met, and therefore, no significant effects are anticipated.

Material assets: alternative aggregates

10.8.8 *LA 110* (Ref 10-1) sets a target for the south east England region for 26% of the aggregates required to be imported to site to comprise reused, recycled or secondary content. If the target is not achieved, this would result in a moderate/large adverse effect which is significant. Where primary materials are mandated within DMRB, they are excluded from this target. The Scheme will set a target (within the EMP) for 26% of the aggregates required to be imported to site to comprise reused, recycled or secondary content. National data on the supply of aggregates in Great Britain (Ref 10-17), estimates that, in 2018, 28% comprised alternative aggregates. This data indicates that the application of good practice mitigation measures will enable the 26% target to be achieved and therefore no significant effects are anticipated.

Waste: landfill capacity and inputs

10.8.9 For road construction projects the largest quantities of materials used, and waste arising are usually from the management and use of excavated earthworks materials, especially in those cases where a balance between excavation (cut) and material placement (fill) cannot be achieved.

10.8.10 The Scheme design is aiming to produce a balance of earthworks cut and fill materials and will promote the reuse of suitable earthworks materials within the construction of the Scheme.

10.8.11 For the purpose of identifying the potential for significant effects on landfill capacity, a worst-case scenario requiring the disposal to landfill of 95% of earthworks cut material (as set out in paragraph 10.3.2) has been assessed, comprising approximately 513,000 m^3 of material for disposal (assuming a bulking factor of 1.2). This quantity of material equates to approximately 0.81% of total regional landfill capacity (see Table 10-1), which would result in a slight effect, which is not significant. It is likely that the proportion of earthworks cut material that would require disposal to landfill would be much less than 95% of total earthworks cut because material reuse, recycling and recovery (on or off site) would be prioritised for suitable materials, in line with the waste hierarchy (Plate 10-1).

10.8.12 The ongoing Scheme design development and ground investigation will continue to inform the earthworks cut and fill balance, the suitability of earthworks materials for reuse, recycling or recovery (on or off site) and the assessment of effects on landfill capacity.

Waste: waste management infrastructure

10.8.13 The *West Sussex Minerals and Waste Safeguarding Guidance* (Ref 10-11) identifies one waste infrastructure consultation area at the eastern end of the Scheme that is partially within the draft Order Limits (Figure 1-1) (Stubbs Copse Wood Yard Composting Facility). The construction of the Scheme is not expected to directly impact the operation of this waste management facility due to the limited extent of the construction works required within the waste infrastructure consultation area. Therefore, no significant effects are anticipated.

Summary of preliminary assessment

10.8.14 In summary, based on the preliminary assessment outlined above, it is considered unlikely at this stage that potentially significant effects on material assets and waste would occur during construction of the Scheme.

10.9 Scheme options

10.9.1 As described in *Chapter 2: The Scheme*, options are still being considered for the potential reprovision of Avisford Park Golf Club. In addition, a potential alternative option from the current proposed alignment where the Scheme passes between Avisford Park, the new housing development at Avisford Grange and the existing Yapton Lane is being considered. This would raise the vertical alignment of the Scheme, with an offline Yapton Lane overbridge. The sections below discuss these in turn and outline whether adopting either of these would change anything stated in the preceding baseline conditions, potential impacts and assessment of effects sections and consider the potential for different effects of the options.

Options for Avisford Park Golf Club reprovision

Option 1: 9 hole golf course with driving range or practice facilities

10.9.2 The reprovision of an amended golf course is unlikely to result in any changes to the information already provided in the baseline conditions and potential impacts sections of this chapter. Increased amounts of construction materials used and waste arisings from the construction of the Scheme would be likely due to the increased level of development associated with the golf course. However, the proposed mitigation measures contained within the EMP and the relatively natural form of a golf course, would mean that the preliminary conclusions in terms of the potential for likely significant environmental effects remains the same.

Option 2: Replacement 18 hole golf course

10.9.3 Full reprovision of the existing golf course is unlikely to result in any changes to the information already provided in the baseline conditions and potential impacts sections of this chapter. Increased amounts of construction materials used and waste arising from the construction of the Scheme would be likely. Given the increased level of development, it would be expected that overall Option 2 would be likely to have a greater impact than Option 1. However, as with Option 1 the proposed mitigation measures within the EMP would mean that the preliminary conclusions in terms of the potential for likely significant environmental effects remains the same.

Option for raised vertical alignment with offline Yapton Lane overbridge

10.9.4 This option is considered unlikely to result in any changes to the baseline conditions and potential impacts outlined in this chapter. There would likely be a slight increase in materials used for the construction of the Scheme compared to the current proposed alignment due to the elevated nature of the offline Yapton Lane Overbridge, but there would likely be a reduction in the quantity of earthworks cut required. The proposed mitigation measures included within the EMP would mean that the preliminary conclusions in terms of the potential for likely significant environmental effects remains the same as for the current proposed alignment.

11. Noise and Vibration

11.1 Introduction

11.1.1 This chapter presents the findings of a preliminary assessment of temporary noise and vibration impacts during the Scheme construction phase and the permanent noise impacts during the Scheme operational phase. It was agreed, see Appendix 1-B, by the Planning Inspectorate (the Inspectorate) at the scoping stage that vibration effects are unlikely during operation and therefore can be scoped out.

11.1.2 Potential noise and vibration effects also require consideration for other disciplines and so, for the following topics, refer to the associated chapter as follows:

a. For impacts on cultural heritage assets, see *Chapter 6: Cultural Heritage*

b. For impacts on tranquillity and setting, see *Chapter 7: Landscape and Visual*

c. For impacts on ecologically sensitive receptors, see *Chapter 8: Biodiversity*

d. For impacts on human health, see *Chapter 12: Population and Human Health*

11.1.3 The assessment contained in this report has been carried out in accordance with *DMRB LA111 Noise and vibration Revision 2* (Ref 11-1) with due regard to the requirements of the following legislation, policy and guidance:

a. *The Environmental Noise (England) Regulations (2006)* (Ref 11-2)

b. *The Land Compensation Act (1973)* (Ref 11-3)

c. *The Noise Insulation Regulations (1975)* (Ref 11-4)

d. The Control of Pollution Act (1974) (Ref 11-5)

e. *NPSNN* (Ref 1-7)

f. National Planning Policy Framework (NPPF) (Ref 1-8)

g. Noise Policy Statement for England (NPSE) (Ref 11-6)

Ref 11-1 Highways England, Design Manual for Roads and Bridges (DMRB) LA 111 Revision 2 Noise and Vibration, 2020.
Ref 11-2 The Environmental Noise (England) Regulations (2006) Statutory Instrument No. 2238 (as amended 2008, 2009, 2010)
Ref 11-3 HM Government (1973) Land Compensation Act 1973
Ref 11-4 The Noise Insulation Regulations (1975), Statutory Instrument No. 1763 (as amended 1988)
Ref 11-5 Her Majesty's Stationery Office (1974) Control of Pollution Act 1974
Ref 11-6 Noise Policy Statement for England (NPSE), Defra, 2010.

h. Practice Guidance – Noise (PPG-N) (Ref 11-7)

i. Arun Local Plan 2011-2031 (Ref 1-12)

11.1.4 The full assessment will be presented as part of the EIA and reported within the ES, based on the methodology detailed in the *EIA Scoping Report* (Appendix 1-A).

11.2 Stakeholder engagement

11.2.1 Preliminary discussions have been held with representatives from relevant authorities, responsible for areas that could potentially experience changes in noise as a result of the Scheme. WSCC, ADC, HDC, CDC, AWC and SDNPA were engaged regarding the approach to the noise and vibration assessment (including the proposed baseline sound survey), as presented in the *EIA Scoping Report*, and to gather information relating to:

a. Local noise sources other than road traffic.

b. Future developments in the area, which will be considered within the assessment.

c. Noise Sensitive Receptors (NSRs) in the local area.

d. Any concerns that the local authorities have with respect to noise and vibration.

e. Specific requirements relating to construction.

f. Local knowledge of, and current mitigation proposals (if any) for Noise Important Areas (NIAs) for which ADC or WSCC are responsible.

11.2.2 Following these initial discussions, the Environmental Health Officers of the relevant local authorities were provided with details of proposed noise monitoring locations for comment. Responses indicated that the proposed noise monitoring locations were suitable.

11.3 Assessment assumptions and limitations

Construction noise and vibration

11.3.1 Details of the construction traffic, diversion routes, construction schedule, construction methodology and plant requirements are not yet confirmed. Therefore, a qualitative assessment has been carried out at this stage, based on professional judgment and experience of other nationally significant road schemes, of the likely noise and vibration effects of the activities described in *Chapter 2: The Scheme*, following the application of best practicable means to minimise noise and vibration levels. This approach identifies the location of NSRs most at risk from temporary significant effects from construction noise and vibration. A quantitative assessment of noise and vibration impacts arising from Scheme construction works, including details of the sound power levels, location

Ref 11-7 Ministry of Housing, Communities and Local Government (MCHLG) Planning Practice Guidance, 2019.

and operating times of construction equipment, will be undertaken as part of the EIA and reported within the ES.

Operation

11.3.2 The operation of the Scheme will affect traffic noise levels experienced by NSRs, including occupiers of residential properties in the vicinity of the Scheme and along affected roads on the wider road network. Other NSRs include several schools, community and medical facilities, scheduled monuments, Public Rights of Way (PRoW) and the SDNP. This chapter details the potential changes in traffic noise levels during Scheme operation on the basis of the current Scheme design as described in *Chapter 2: The Scheme* and associated traffic data, derived from a validated traffic model of the local region. A detailed operational phase noise and vibration assessment will be reported in the ES based on the submitted Scheme design and final traffic modelling data following consultation.

11.3.3 The conclusions of this preliminary assessment do not account for the proposed, indicative mitigation measures and as such, the effects reported here may be considered reasonably worst-case. These measures will be subject to consultation and further refinement following stakeholder feedback.

11.3.4 For the PEI Report, the available traffic forecasts used are “fixed trip” assignments, which means the total level of demand does not change. The traffic model forecasts changes in travel times, congestion and flows (due to re-routing), but does not currently take account of changes in the level of travel demand, which is sometimes called induced traffic. Induced traffic is caused by travellers changing their choice of destination, frequency of travel or the time at which they undertake their journey.

11.3.5 For the noise and vibration assessment to be reported in the ES, traffic data will be generated by the traffic model which will include a component called a Variable Demand Model (VDM). This model will forecast demand changes in response to the opening of the Scheme, which is a representation of induced traffic responses. This could lead to increases or decreases of up to 15% in traffic flows. However, a 15% change in traffic flow would result in a change to noise exposure of less than 1 dB and therefore, with reference to *DMRB LA 111* (Ref 11-1), may be considered negligible. As such, these changes are not expected to alter the conclusions of the preliminary noise assessment.

11.3.6 The strategic traffic model that informs the noise model forecasts a range of travel demand movements over a wide geographic area. As such, the smaller and more local the road in the model, the greater the uncertainty of the forecast traffic flows. Therefore, rural roads with likely low traffic flow are discounted from the model due to the low likelihood of accurate representation in forecast years. This means that the existing calculated road traffic noise levels in some locations, particularly south of the Scheme between Lake Lane and Ford train station, are underpredicted by the preliminary noise model. The consequence of this is that the adverse

impact of the Scheme on road traffic noise in these areas is overpredicted since, in practice, the traffic noise from the Scheme will be masked by the existing sound environment. Baseline sound monitoring has been conducted in these areas to confirm the underprediction of existing levels.

11.3.7 Similarly, the noise model only accounts for road traffic noise sources and therefore in areas where other noise sources dominate the sound environment (and so have the potential to mask traffic noise from the Scheme), the model will overpredict the adverse impact of the Scheme.

11.3.8 Current OS Address Base data and planning documents for proposed developments have been used to identify potentially sensitive buildings.

11.3.9 National Highways' Pavement Management System has been used to identify the current road surfacing on the A27, which is a mixture of Hot Rolled Asphalt and a thin surface course system. The assumption has been made that all other existing roads in the study area are surfaced with standard Hot Rolled Asphalt.

11.4 Study area

11.4.1 The study areas, as described in paragraphs 11.4.2 and 11.4.3, have been defined in accordance with *DMRB LA 111* (Ref 11-1), and aim to capture all potentially significant noise and vibration effects associated with the Scheme.

11.4.2 The study area for the preliminary qualitative assessment of construction phase noise and vibration impacts focuses on the closest identified sensitive receptors to the various construction works described in paragraph 11.6.2. This enables the NSRs most at risk from significant adverse effects to be identified since NSRs further away from the construction activities will be subject to lower levels of noise and vibration. The quantitative assessment of construction phase noise and vibration impacts to be reported in the ES will be based on the study area defined in the *EIA Scoping Report* (Appendix 1-A). This includes consideration of construction noise within 300 m of the works and vibration from construction activity within 100 m of the works. This will include additional receptors selected to represent impacts further away from the construction works, including within the SDNP. A study area for construction traffic will be adopted encompassing dedicated haul roads, existing roads identified as experiencing at least a 1 dB change in traffic noise and any existing roads affected by night-time diversions (23:00-07:00) due to the closure of an existing road.

11.4.3 The study area for the preliminary assessment of operational phase road traffic noise impacts comprises an area extending to a minimum of 600 m from the Scheme and the bypassed section of the existing A27 and also includes all areas subject to potentially significant effects from operational road traffic noise. The study area for the operational phase road traffic assessment to be reported in the ES will be based on the study area defined in the *EIA Scoping Report* (Appendix 1-A). This will include NSRs

within 50 m of road links expected to experience a non-negligible change in roadside noise level of 1 dB or more as a result of the Scheme in the opening year.

11.5 Baseline conditions

11.5.1 The majority of the Scheme passes through open countryside or agricultural land. However, there are several NSRs in close proximity to the Scheme and the existing A27. Both the A27 and a number of other minor roads contribute to ambient noise levels at these locations.

11.5.2 The Scheme will pass close to residential properties in Walberton, Binsted, Tortington and Crossbush.

11.5.3 There are several non-residential NSRs in the study area including:

a. Arundel C of E Primary School, Walberton and Binsted C of E Primary School and Walberton Pre-School

b. A range of community facilities, including places of worship, village halls and medical facilities

c. Four identified scheduled monuments, see *Chapter 6: Cultural Heritage*

d. Several PRoW

e. Sensitive ecological receptors as presented in *Chapter 8: Biodiversity* of this PEI Report

11.5.4 There are 15 NIAs (those areas across England identified as being most exposed to noise) within the 600 m study area, all located near to the A284 in Lyminster and Wick or the existing A27 spread between Arundel station and the Fontwell roundabouts. These are shown on Figure 11-1 and from east to west are NIA 12487, NIA 12486, NIA 6157, NIA 5484, NIA 5486, NIA 5485, NIA 12488, NIA 5488, NIA 5487, NIA 12489, NIA 12490, NIA 5490, NIA 6158, NIA 5491 and NIA 12491. Further details on the impact that the Scheme will potentially have on traffic noise levels at NSRs within these areas will be considered as part of the EIA.

Baseline noise survey

11.5.5 A baseline noise survey has been conducted at a selection of NSR locations in the vicinity of the Scheme route. Monitoring locations were identified following discussions with the Environmental Health Officers of the applicable local authorities and taking account of the findings of the preliminary road traffic noise modelling. Monitoring locations are shown on Figure 11-1, whilst sound levels recorded are presented in Table 11-1.

11.5.6 Unattended measurements were collected for one week at 16 locations (LT1 to LT16), except for LT7 and LT12 where equipment failure meant that one day and four days' worth of data was captured respectively. Despite this, the collected data is considered sufficient to characterise the baseline environment and validate the road traffic noise model. At a further three locations, 3-hour long, attended short-term measurements were collected

at the roadside during the daytime (ST1 to ST3). All measurements were carried out during November 2021.

11.5.7 The daytime sound levels presented in Table 11-1 are given in terms of the level exceeded 10% of the time between 06:00 and 00:00, whilst the night-time sound levels are given in terms of the average level between 23:00 and 07:00. These are the standard metrics used to describe road traffic noise, as required by *DMRB LA 111* (Ref 11-1).

Table 11-1 Baseline sound survey levels

Reference	Description	Measured free-field sound level (dB)	
		Day ($L_{A10, 18h}$)	Night ($L_{Aeq, 8h}$)
LT1	Woodacre Cottage	61 - 62	50 - 55
LT2	Potwell Lodge	64 - 65	54 - 57
LT3	Walberton and Binsted C of E Primary School	47 – 54*	36 - 43
LT4	Avisford Grange	48 - 53	40 - 46
LT5	Avisford Grange (Yapton Lane)	51 - 54	42 - 47
LT6	1 Yapton Lane	57 - 61	48 - 52
LT7	Glebe House (Binsted Lane)	46**	42**
LT8	Oakley Cottages (Binsted Lane)	43 - 50	36 - 44
LT9	Binsted Manor (Binsted Lane)	42 - 48	39 - 42
LT10	New Barn (Tortington Lane)	44 - 54	35 - 44
LT11	Tortington Priory (Tortington Lane)	64 - 70	53 - 61
LT12	196 Fitzalan Road	50 - 52	41 - 42

Reference	Description	Measured free-field sound level (dB)	
		Day ($L_{A10, 18h}$)	Night ($L_{Aeq, 8h}$)
LT13	Broomhurst Farm	49 - 52	40 - 45
LT14	Maynards Lodge	67 - 69	58 - 61
LT15	Thelton House (Crossbush Lane)	48 - 56	40 - 48
LT16	Marsh Farm (Binsted Lane)	40 - 50	36 - 44
ST1	The Street (Walberton)	63	-
ST2	Lyminster Road (Lyminster)	76	-
ST3	Lake Lane (Walberton)	65	-
*Some occasional construction noise associated with the Avisford Grange housing development could be detected during weekdays meaning that typical baseline levels may not reach the upper end of this range **Only 24 hours of data were collected at LT7, so it is not possible to provide a range of sound levels			

11.5.8 The monitoring data reflects a range of sound levels across the study area. Levels in Binsted are below the Lower Observed Adverse Effect Level (LOAEL), the level above which adverse effects on the health and quality of life can be detected. This reflects the quiet ambient environment of the area. Sound levels at properties on Yapton Lane and close to the existing A27 are between the LOAEL and Significant Observed Adverse Effect Level (SOAEL), the level above which significant adverse effects on health and quality of life can occur, whilst levels at Tortington Priory, close to Ford Road, and Maynards Lodge, close to Crossbush Roundabout, are around the SOAEL. Measured levels at the three short-term locations are relatively high due to these positions being at the roadside, with traffic noise from the A284, in particular, being above the SOAEL.

11.5.9 The sound monitoring results obtained are being used to characterise the noise climate in the study area and complement the calculated levels obtained from the road traffic noise model currently being progressed.

11.5.10 A weather station installed at one of the monitoring locations recorded weather conditions throughout the baseline survey period. Weather conditions during the survey period were generally suitable in that there were no prolonged periods of high winds or rain that would influence the recorded sound levels.

Future baseline

11.5.11 In the absence of the Scheme, most areas, including the Avisford Grange housing development, are expected to experience small increases in road traffic noise levels in the fifteen years after Scheme opening due to increasing traffic volumes. However, some areas close to the existing A27 are expected to experience small reductions in road traffic noise as higher flows can lead to a reduction in speeds on some parts of the A27.

11.6 Potential impacts

Construction noise and vibration

11.6.1 The main construction activities associated with the Scheme will be site clearance, earthworks, bridgeworks, installation of services, road construction works and operation of site compounds. Further details are provided in *Chapter 2: The Scheme.*

11.6.2 There is the potential for temporary adverse noise impacts at the closest receptors to the construction works. The potential for temporary construction vibration impacts is dependent on the need for construction activities that are potential significant sources of vibration. These include:

a. Rotary piling for the viaduct

b. Rotary piling for each of the structures

c. Compaction plant for the road construction and backfill to structures

d. Demolition of existing residential structures and the Avisford Park Golf Club house

e. Breaking out of existing junctions at the tie-ins to construct the new alignment

f. Sheet piling for temporary works

11.6.3 The addition of construction traffic onto existing roads can have a temporary impact on NSRs located along existing roads used by these vehicles. The potential impact is dependent on the volume and routes used by construction traffic and the proximity of NSRs. Diversions or night-time road closures, if required, can also cause short-term changes in traffic conditions and therefore traffic noise levels. Details of any required diversions would be provided within the Construction Traffic Travel Plan submitted as part of the DCO application and, as described in paragraph 11.4.2, an assessment of potential impacts arising from traffic using these diversion routes will be reported in the ES. In addition, re-routing of existing traffic onto alternative roads during the construction works is a potential source of temporary impact.

Operation

11.6.4 The proposed dual carriageway will be approximately eight kilometres (five miles) long. The new dual carriageway will re-join the existing A27 west of Tye Lane and east of the Fontwell East roundabout. At the eastern end, the new dual carriageway will re-join the existing A27 to the east of the reconfigured Crossbush Junction. Road traffic noise along the length of the new dual carriageway will be the main source of potential adverse noise impacts at nearby NSRs during Scheme operation.

11.6.5 Conversely, the Scheme will reduce traffic flows (and therefore road traffic noise) along the existing A27 between Yapton Lane and the Crossbush roundabout on the B2139 and A283 through Storrington and the A259 in Wick, providing potential beneficial impacts at NSRs in these areas.

11.7 Design, mitigation and enhancement measures

11.7.1 A range of measures will be implemented during the Scheme construction phase to minimise the risks of adverse noise and vibration impacts, whilst several features have been embedded into the Scheme design that aim to mitigate operational phase impacts. Embedded mitigation features are presented below and shown on Figure 2-1.

Construction noise and vibration

11.7.2 As reported in Section 12.6 of the *EIA Scoping Report* (Appendix 1-A), application of Best Practicable Means (BPM) during the Scheme construction phase will minimise noise and vibration impacts and will be secured within the first iteration EMP, which will be subject to a DCO requirement. Potential BPM measures include:

a. A programme of community engagement to communicate with local residents, parish councils, etc., including online, a newsletter and works notices.

b. A complaints management system to investigate any noise and vibration complaints and ensure appropriate action is taken as required.

c. A noise insulation policy.

d. Selection of quiet and low vibration equipment and methodologies, appropriate for nearby NSRs and any buildings identified through pre-construction condition surveys that may be susceptible to vibration.

e. Selection of appropriate piling methods.

f. Review of construction programme and methodology to consider low noise and low vibration methods (including non-vibratory compaction plant where required).

g. Optimal location of equipment on site to minimise noise disturbance.

h. The provision of acoustic enclosures around static plant or temporary hoarding, where necessary.

i. Installation of operational traffic noise barriers as soon as is reasonably practicable in order to provide noise mitigation during the construction works.

j. Use of less intrusive alarms, such as broadband vehicle reversing warnings.

k. Compliance with working hours agreed with the Local Authority and set out in the EMP.

l. Liaising with ADC on night-time works and limiting out of hours works to those that cannot be reasonably carried out during the daytime.

m. Designation and enforcement of appropriate routes for construction traffic.

Operation

11.7.3 Environmental mitigation measures embedded in the Scheme design are described in *Chapter 2*: *The Scheme*. Specific measures that would minimise operational noise impacts include:

a. Landscape contouring of embankments and cuttings in the vicinity of Walberton and Binsted.

b. Use of low noise surfacing throughout the Scheme.

c. The restriction of traffic on the western end of the Scheme to 50 mph.

11.8 Assessment of effects

11.8.1 The noise and vibration effects associated with the Scheme have been assessed following consideration of the potential impacts outlined in *Section 11.6* and informed by the results of a preliminary noise model of the study area reflecting the current Scheme design. This includes consideration of the embedded mitigation measures as presented in *Section 11.7*.

11.8.2 At present the operational phase noise assessment does not take into account the potential additional mitigation measures, such as the use of bunds, noise barriers and very low noise surfacing. These indicative additional mitigation measures to avoid or reduce potential increases are currently being investigated as the Scheme design and traffic modelling progresses. They will be discussed through the process of consultation and stakeholder engagement. Indicative locations for these measures are shown on the PLEM, Figure 2-1.

11.8.3 The indicative noise mitigation measures have been carefully selected with due regard to the impacts of the Scheme, the character and nature of the surrounding area, environmental and engineering constraints, and Government policy on sustainable development.

11.8.4 These additional mitigation measures have not been incorporated into the preliminary noise model and as such the noise effects reported herein are considered to represent a reasonably worst-case.

11.8.5 The requirement for such additional mitigation measures, and associated residual effects, will be confirmed in the ES.

11.8.6 Conclusions on the likelihood of significant effects have been made following the methodology outlined in Section 12.8 of the *EIA Scoping Report* (Appendix 1-A). This method accounts for both the magnitude of noise level changes and the absolute noise and vibration levels both with and without the Scheme. The duration of works is also considered in the construction noise and vibration assessment to determine significance of effect. In the operational noise assessment, the context of the surrounding area is also considered. For example, increases in traffic noise are more likely to be significant if they change the character of an area or if existing noise levels are already high.

Construction noise and vibration

11.8.7 The works to construct the Scheme will likely include the following key tasks:

a. Installation and use of temporary offices and welfare facilities, construction compounds, vehicle parking, material storage areas and worksites

b. The potential installation and use of a concrete batching plant

c. Installation and use of temporary access points and haul routes, demolition of existing structures, removal of existing infrastructure, vegetation clearance and soil removal.

d. Ground and excavation works

e. Piling

f. Infrastructure construction activities, routing of services and utilities

11.8.8 The majority of the works will be carried out during the daytime, although isolated night-time works may be required for certain activities.

11.8.9 Many of the works are limited in duration (e.g., sign installation) or relatively fast moving (e.g., drainage installation and carriageway surfacing), resulting in significant adverse noise effects at nearby NSRs for limited periods of time.

11.8.10 Further information on construction works can be found in *Chapter 2: The Scheme.*

11.8.11 The construction of the Scheme would likely result in some significant temporary adverse noise and vibration effects for certain construction activities at sensitive receptors in the vicinity of the works described in paragraph 11.6.2 and in close proximity to the construction compounds. NSRs most at risk of significant adverse effects, primarily from construction noise, include properties between Tye Lane and Yapton Lane close to the section of the Scheme in cutting as well as properties close to the overbridges at Tye Lane, Yapton Lane, Binsted Lane and Tortington Lane.

11.8.12 Industry standard BPM measures will be employed throughout the construction works to minimise the potential for such significant noise and vibration effects.

11.8.13 Construction traffic, including the operation of any required diversion routes, is likely to have significant adverse effects on NSRs located along existing roads with low traffic volumes.

11.8.14 The aim of the Construction Traffic Travel Plan, which would be secured as a requirement of the DCO, is to minimise vehicles travelling on the local road network and, where possible, to avoid travelling through the town of Arundel as well as the surrounding villages, such as Binsted and Walberton. This will minimise adverse effects from construction traffic noise in these areas. Further details on the proposed measures to achieve this can be found in *Chapter 2: The Scheme*.

Operation

11.8.15 Overall road traffic noise levels without the Scheme and calculated for the Scheme opening year are shown in Figure 11-2. Noise levels are relatively high, around the SOAEL, close to existing major roads in the area such as the A27 and A284. Away from these sources of traffic noise large sections of the local environment, including most of Binsted, Tortington and parts of the SDNP, are subject to levels of traffic noise below the LOAEL reflecting the quiet existing ambient sound in the area. Noise levels in Walberton are typically between the LOAEL and the SOAEL close to local roads such as The Street and Yapton Lane, dropping to below the LOAEL further back from these roads.

11.8.16 Overall road traffic noise levels with the Scheme in place but without any additional mitigation measures, calculated for the Scheme's opening year, are shown in Figure 11-3. Noise levels in parts of Binsted and Tortington with the Scheme in operation have been predicted to be typically between the LOAEL and SOAEL, dropping to below the LOAEL around 200 m from the Scheme. Only a small number of the very closest properties to the Scheme are expected to experience noise levels at or above the SOAEL. Similarly, noise levels within approximately 100 m of the Scheme north of Walberton are expected to lie between the LOAEL and SOAEL with the Scheme in place.

11.8.17 An indication of the change in road traffic noise in the study area, in the Scheme opening year, is shown in Figure 11-4. The operation of the Scheme will result in likely road traffic noise increases for the majority of NSRs close to the route of the Scheme, primarily due to the quiet existing sound environment in much of the area as described in paragraph 11.8.15. However, in practice, some of the modelled increases to the south of the Scheme, in the vicinity of the railway line, are not expected to be as high as shown in Figure 11-4 as sound sources other than road traffic would mask some of the road traffic noise from vehicles using the Scheme.

11.8.18 The largest potential increases in noise levels resulting from traffic using the Scheme are expected at NSRs in Walberton (particularly in the vicinity

of Yapton Lane and including properties within the Avisford Grange housing development), Binsted and Tortington. In the absence of additional mitigation measures (e.g., bunds, noise barriers and very low noise surfacing), significant adverse noise effects are expected in these areas.

11.8.19 Increases in road traffic noise (and potentially significant adverse effects at NSRs) are also expected in the vicinity of Dalloway Road and Fitzalan Road in south Arundel from traffic using the viaduct, irrespective of the height of the viaduct. Other increases in road traffic noise, leading to potentially significant effects, are expected as a result of an increase in traffic on The Street and Eastergate Lane in Walberton, and the A284 Lyminster Road and an increase in traffic speed on the A27 westbound east of the Crossbush roundabout.

11.8.20 Some smaller increases in road traffic noise, causing potential adverse (not significant) effects at NSRs, are possible in parts of Fontwell, Slindon, Arundel, Lyminster and Crossbush as a result of the redistribution of traffic with the Scheme in operation.

11.8.21 Additional mitigation measures to avoid or reduce these potential noise effects are currently being investigated as the Scheme design and traffic modelling progress. This includes measures such as bunds, noise barriers and very low noise surfacing. The effectiveness of these measures for a given NSR will depend on both the design parameters of the mitigation (for example, barrier position and height) and the position of the NSR with respect to the Scheme. These mitigation measures have the potential to reduce noise levels by several decibels in areas close to the Scheme, however it is possible that some properties may still experience significant adverse effects after mitigation. Potential operational phase road traffic noise effects with these measures in place will be reported in the ES.

11.8.22 Large reductions in road traffic noise (leading to potentially significant beneficial effects) are anticipated for all the NSRs in Havenwood Park and parts of Arundel including Canada Road and the north end of Jarvis Road. These anticipated reductions are largely due to expected reductions in traffic using the existing A27 once the Scheme is operational. Minor road traffic noise reductions are anticipated along Ford Lane to the south of the Scheme since it is expected that some of the westbound traffic from Littlehampton would use the A27 Arundel bypass instead of Ford Lane.

Summary of preliminary assessment

11.8.23 In advance of detailed quantitative consideration of impact avoidance and mitigation measures (other than the use of a thin surface course system), potentially significant noise and vibration effects resulting from the Scheme are summarised below for both the construction and operational phases.

11.8.24 Preliminary construction phase assessment:

a. Construction activities will have likely significant temporary adverse noise and vibration effects for nearby sensitive receptors in close proximity to the construction compounds and the works described in

paragraph 11.6.2. Those most at risk will include properties between Tye Lane and Yapton Lane close to the section of the Scheme in cutting as well as properties close to the overbridges at Tye Lane, Yapton Lane, Binsted Lane and Tortington Lane.

11.8.25 Preliminary operational phase assessment:

a. Operation of the Scheme will have potentially significant adverse noise effects at NSRs in and around Walberton, Binsted and Tortington as well as parts of south Arundel and south and east of Crossbush.

b. Operation of the Scheme will have potentially significant beneficial noise effects for residents of Havenwood Park and parts of Arundel close to the existing A27 such as NSRs on Canada Road and the north end of Jarvis Road.

11.8.26 A quantitative construction noise and vibration impact assessment will be undertaken and reported in the ES. In addition, a further quantitative operational phase assessment will be undertaken using updated traffic modelling data, taking into account the mitigation measures already embedded in the Scheme design as well as any additional bunds, noise barriers and very low noise surfacing considered to be necessary.

11.8.27 Based on the preliminary assessment outlined above, there is potential for significant effects to result from the construction and operation of the Scheme. A summary of these potentially significant effects is reported below in Table 11-2.

11.9 Scheme options

11.9.1 As described in *Chapter 2: The Scheme*, options are still being considered for the potential reprovision of Avisford Park Golf Club. In addition, a potential alternative option from the current proposed alignment where the Scheme passes between Avisford Park, the new housing development at Avisford Grange and the existing Yapton Lane is being considered. This would raise the vertical alignment of the Scheme, with an offline Yapton Lane overbridge. The sections below discuss these in turn and outline whether adopting either of these would change anything stated in the preceding baseline conditions, potential impacts and assessment of effects sections and consider the potential for different effects of the options.

Options for Avisford Park Golf Club reprovision

Option 1: 9 hole golf course with driving range or practice facilities

11.9.2 The reprovision of an amended golf course could have potentially significant temporary adverse effects for properties on Binsted Lane north of the Church of St Mary's, Binsted during construction. It is unlikely to result in any other changes to the assessment presented above, or change the preliminary conclusions in terms of the potential for likely significant operational noise effects.

Option 2: Replacement 18 hole golf course

11.9.3 Full reprovision of the existing golf course would have potentially likely significant temporary adverse effects for properties on Binsted Lane north of Church of St Mary's, Binsted, during construction. It is unlikely to result in any other changes to the assessment presented above, nor change the preliminary conclusions in terms of the potential for likely significant operational noise effects.

11.9.4 The extended construction programme and greater geographical area associated with an 18 hole golf course means that Option 1 is likely to have fewer temporary adverse noise and vibration impacts than Option 2.

Option for raised vertical alignment with offline Yapton Lane overbridge

11.9.5 This potential option would result in a raised mainline in the vicinity of Yapton Lane, leading to a relative increase in road traffic noise of up to 1.5 dB at the rear of the properties on Yapton Lane, north of Avisford Park Road compared to the current proposed alignment. However, the mainline would be lower west of Yapton Lane, leading to a relative reduction in road traffic noise of up to 2 dB for properties within the Avisford Grange development. Additionally, the realignment of the Yapton Lane overbridge itself would result in relative reductions of up to 3 dB in traffic noise at the front of the properties on Yapton Lane closest to the overbridge. Overall, this option is considered to be slightly better than the current proposed alignment in terms of the impact of traffic noise, but the preliminary conclusions in terms of the potential for likely significant noise effects remain the same.

Table 11-2 Summary of potential significant effects

Receptor	Scheme impact	Potential significant effects (following embedded mitigation)	Further mitigation to be explored
NSRs in and around Walberton	Construction at the Western tie-in, Tye Lane overbridge and Yapton Lane realignment	Temporary adverse effects associated with piling for the structures, earthworks for the cutting and use of the construction compounds	The mitigation measures set out in the EMP are expected to meet the aims of the NPSNN during Scheme construction. No further mitigation measures will be required.
	Operational road traffic	Permanent adverse effects from an increase in traffic on local roads as well as traffic using the A27 Arundel bypass	a. Noise barriers b. Noise bunds c. Very low noise surfacing Preliminary locations for these measures are shown on Figure 2-1. These will be refined following stakeholder consultation. Discussions with WSCC regarding potential traffic management measures in affected locations outside of the scheme extents
NSRs in Binsted and Tortington	Construction of the overbridges at Binsted Lane and Tortington Lane	Temporary adverse effects associated with piling for the structures	The mitigation measures set out in the EMP are expected to meet the aims of the NPSNN during Scheme construction. No further mitigation measures will be required.

Receptor	Scheme impact	Potential significant effects (following embedded mitigation)	Further mitigation to be explored
	Operational road traffic	Permanent adverse effects from traffic using the A27 Arundel bypass	a. Noise barriers b. Noise bunds c. Very low noise surfacing. Preliminary locations for these measures are shown on Figure 2-1. These will be refined following stakeholder consultation.
NSRs close to the existing A27 between Yapton Lane and Arundel	Operational road traffic	Permanent beneficial effects from a reduction in traffic using the existing A27	None
NSRs in south west Arundel	Operational road traffic	Permanent adverse effects from traffic using the viaduct	Identify where very low noise surfacing would be suitable and practicable to include within the Scheme design
NSRs south and east of the Crossbush Junction	Operational road traffic	Permanent adverse effects from traffic using Crossbush Junction, an increase in traffic on the A284 and an increase in speed for A27 westbound traffic approaching Crossbush Junction	No sustainable mitigation measures without adverse visual and access issues have been identified at this stage

12. Population and Human Health

12.1 Introduction

12.1.1 This chapter addresses the likely significant effects of the Scheme on population and human health, both during construction and operation. In accordance with *DMRB LA 112 Population and Human Health* (Ref 12-1), this chapter considers the following:

a. Land use and accessibility:

i. Private property and housing

ii. Community land and assets

iii. Development land and businesses

iv. Agricultural land holdings

v. Walkers, cyclists and horse riders (WCH)

b. Human health:

i. Environmental conditions relevant to human health (including changes to noise, air quality and landscape amenity)

ii. Severance/accessibility and the ability of communities to access community land, assets and employment

12.1.2 Both *DMRB LA 112* (Ref 12-1) and *DMRB LA 104* (Ref 4-1) have been applied in the assessment to identify the value and sensitivity of land use and accessibility receptors and human health determinants likely to be affected by the Scheme. These standards have also been used to identify and evaluate the impacts and effects due to Scheme construction and operation on these receptors.

12.1.3 There may be interrelationships related to the potential effects on population and human health and other disciplines. Reference should be made to the following chapters:

a. Chapter 5: Air Quality

b. Chapter 7: Landscape and Visual

c. Chapter 11: Noise and Vibration

12.1.4 The following legislation and planning policy framework are of direct relevance to population and human health and have been considered as part of the assessment. The below legislation and planning policy framework will be further referred to within the ES:

a. *Localism Act 2011* (Ref 12-2)

Ref 12-1 Highways England, (2020), Design Manual for Roads and Bridges Volume LA112 Population and human health.
Ref 12-2 Her Majesty's Stationery Office (2011), Localism Act 2011

b. *Commons Registration Act 1965* (Ref 12-3)

c. *Countryside and Rights of Way Act 2000* (Ref 12-4)

d. *Health and Social Care Act 2012* (Ref 12-5)

National policy

a. *NPSNN* (Ref 1-7)

b. *NPPF* (Ref 1-8)

c. *PPG* (Ref 12-6)

d. *Public Health England Strategy 2020-2025* (2019) (Ref 12-7)

Local policy

a. *Adopted Arun Local Plan 2011-2031* (Ref 1-12)

b. *South Downs Local Plan 2014-2033* (Ref 1-13)

c. *West Sussex Plan 2017-2022* (Ref 1-10)

d. *West Sussex Joint Health and Wellbeing Strategy 2019-2024* (Ref 12-8)

12.2 Stakeholder engagement

12.2.1 A range of stakeholders have been engaged as part of the scoping process to obtain their views on the Scheme and the assessment of the population and human health scope, the results of which are presented within the *EIA Scoping Opinion* (Appendix 1-B). An explanation of how these views and comments have been taken into account within the EIA, both as part of this PEI Report and going forward as part of the DCO application, is presented in Appendix 1-C.

12.2.2 Engagement with affected owners of private properties and agricultural holdings are ongoing as part of the Scheme design development process to obtain baseline information, which will inform the assessment of effects and the further development and incorporation of mitigation measures into the Scheme design.

12.3 Assessment assumptions and limitations

12.3.1 The information presented in this assessment is based on data available at the time of reporting and on an emerging design for the Scheme and the draft Order Limits, as presented in Figure 2-1 sheets 1-6.

Ref 12-3 Her Majesty's Stationery Office (1965) Commons Registration Act 1965.
Ref 12-4 Her Majesty's Stationery Office (2000) Countryside and Rights of Way Act 2000.
Ref 12-5 Her Majesty's Stationery Office (2012) Health and Social Care Act 2012.
Ref 12-6 Department for Levelling Up, Housing and Communities (2019) Planning Practice Guidance.
Ref 12-7 Public Health England (2019) PHE Strategy 2020 to 2025.
Ref 12-8 West Sussex Health and Wellbeing Board (2019) Start Well, Live Well, Age Well: West Sussex Joint Health and Wellbeing Strategy 2019-2024.

12.3.2 The following assumptions relating to the assessment of impacts and effects (and their mitigation) on land and land use interests have been applied:

a. The assessment has been undertaken on a community basis. Any impacts on individual residential properties do not constitute a significant community effect

b. Where access to private, commercial or community land and assets is impacted by the Scheme, it is assumed that access will be maintained through the provision of suitable alternatives, if required

c. Information on the quantity of land take required by the Scheme options for each impacted receptor is unknown at this current stage. The assessment of potential land take has therefore been based on available information and professional judgement. Further information on this will be provided at ES

12.3.3 The assessment of impacts on walkers, cyclists and horse riders (WCHs) provided herein is preliminary and qualitative, given that the Non-Motorised Users (NMU) surveys of the WCH Assessment Report (WCHAR) are not currently available. This is due to COVID-19 restrictions, which has meant that the surveys could not be completed. The surveys will provide details of the frequency of use of the WCH provisions within the study area. A full assessment of the Scheme impacts on WCHs will be provided in the ES taking into account the survey findings. Professional judgement has been used to determine the magnitude of impact, which has been based on the availability of suitable alternative routes, any changes to user safety and the impact of the Scheme on the route's recreational value. Where the Scheme cuts across a walking, cycling or horse-riding route, endeavours will be made where possible to ensure that all routes are kept in place by offering safe and well-planned diversions during the construction phase. At this stage, it is not possible to confirm the length of time that each route would be temporarily closed. It is also not possible to determine whether the proposed diversions are appropriate replacements. Further information will be provided in the ES.

12.3.4 Information obtained from interviews with agricultural holding landowners is required to assess the Scheme impacts on agricultural land holdings. Interviews with agricultural landowners determines the identification (and type) of agricultural holdings within the study area and the characteristics of their use. Whilst initial discussions regarding agricultural holdings have been held as part of the wider landowner engagement process, the specific interviews to be used for the EIA will be undertaken as part of the ongoing landowner engagement during and post statutory consultation. As the findings from such interviews are not yet available and there is not sufficient baseline information available, it is not currently possible to undertake a robust assessment of Scheme impacts on agricultural land holdings at this stage. Therefore, it is not possible to determine whether significant effects on agricultural land holdings are likely to be identified. Going forward,

interviews with agricultural landowners will be undertaken, which will inform the assessment to be presented in the ES.

12.3.5 The human health aspect of the assessment presented herein relies on findings from the following other topics:

a. Chapter 5: Air Quality

b. Chapter 7: Landscape and Visual

c. Chapter 11: Noise and Vibration

12.3.6 There is no consolidated methodology or practice for a quantitative assessment of effects on human health. Therefore, the impacts of the Scheme on human health will be assessed qualitatively using professional judgement, taking into account the guidance provided in LA 112. The findings may be subject to change as the design of the Scheme is refined through the design-development and consultation processes, and as further research and investigative surveys are completed. The results of this assessment will be confirmed in the ES.

12.3.7 The assessment has relied, in part, on data provided by third parties (for example, the Office for National Statistics (ONS) and Public Health England): this is the most up-to-date, available data at the time of the assessment.

12.4 Study area

12.4.1 The study area has been defined in accordance with *DMRB LA 112* and based on the type of receptor being assessed and the area over which potential impacts due to the Scheme are likely to occur. The study area defined is shown in Figure 12-1.

12.4.2 When assessing impacts on land use and accessibility, the study area has been defined as shown in the draft Order Limits with an additional 500 m extension beyond the Scheme (the study area). Where specific impacts on receptors that are located beyond the study area could result in significant effects, these have been included within the assessment.

12.4.3 The human health baseline study area is Arundel and Walberton Ward and the district of Arun, which includes the areas of relevance that are likely to be either directly or indirectly affected by the Scheme.

12.5 Baseline conditions

Overview

12.5.1 Land use within the study area is marked by a contrast of urban development to the south of the Scheme against the more open agricultural landscapes of the SDNP to the north. The preferred route was designed to remain outside the SDNP as far as possible which is an important consideration in planning policy terms. However, the eastern end of the Scheme proposals cannot be constructed without some minor incursions into the National Park. This is, primarily, related to works within the existing

highway boundary of the A27, which are a direct consequence of the need to connect the new route with the existing highway infrastructure. In addition, some minor incursions are required to provide ecological mitigation measures enhancements in line with the statutory purposes of the National Park designation.

12.5.2 The main urban areas within the study area comprise the villages of Walberton, Binsted and Tortington. The Scheme bypasses the town of Arundel, however there are residential properties in the south of Arundel and around Arundel Station (located to the east of the town) which are included within the study area.

12.5.3 The Scheme runs through mostly agricultural land holdings, but there is a small number of businesses and recreational land (including Avisford Park Golf Club and Arundel Cricket Club) located throughout the study area.

12.5.4 Community facilities and assets are distributed across the study area. These include a primary school, recreational facilities, health centres, religious facilities, community land and Public Rights of Way (PRoW).

Population

12.5.5 The Scheme is located within the local district of Arun and the Arundel and Walberton ward. The population of the ward was 8,106 in 2020, whilst the population of Arun was 161,123 (Ref 12-9). The populations of the Arundel and Walberton ward and Arun are considerably more elderly than the regional (South East of England) and national (England) averages. Around 32.9% of residents in the ward are aged 65 and over; compared to 29.1% in Arun, 19.7% in the South East of England and 18.5% in England.

12.5.6 The population of Arundel and Walberton has experienced a slight population decline over the last decade. Between 2011 and 2020, the number of residents in the ward has decreased by 0.6%. In comparison, Arun has experienced population growth in line with the regional and national averages. Between 2011 and 2020, the number of residents in Arun increased by 7.6%. This percentage increase is slightly larger than the averages recorded for the South East (6.5%) and England (6.5%) (Ref 12-9).

Land use accessibility

Private property and housing

12.5.7 The Scheme crosses through mostly agricultural land to the north of the village of Walberton and in proximity to Binsted.

12.5.8 Minor elements of the eastern section of the Scheme are within the SDNP. This is due to works within the existing highway boundary of the A27 and are a direct consequence of the need to connect the new route with the existing highway infrastructure. Further minor incursions are required elsewhere along the route of the Scheme to provide ecological mitigation

Ref 12-9 Office for National Statistics (2021) Mid-Year Population Estimates - Local Authority by Single Year Age, 2020

measures and enhancements in line with the statutory purposes of the National Park designation. From west to east, the Scheme will diverge from the existing A27 west of Tye Lane and east of the Fontwell East roundabout and reconnect to the existing A27 to the east of the new Crossbush Junction.

12.5.9 There are residential properties located alongside and in close proximity to the Scheme as it passes adjacent to or through Walberton, Binsted and Tortington. The residential roads of Copse Lane, Tye Lane, Yapton Lane, Binsted Lane and Tortington Lane are all crossed by the Scheme. Several residential properties are located on each of these roads. In addition, as the route passes north of Walberton, the Scheme runs adjacent to the Avisford Grange housing development, located to the east of Tye Lane. The Scheme encroaches the curtilage of the site boundary of the development along Avisford Park.

12.5.10 The Scheme bypasses the town of Arundel. Therefore, the residential properties in the town are further away from the Scheme than the existing A27. There are, however, residential properties in the south of Arundel and around Arundel Station (located to the east of the town) which are located within the Scheme's study area.

Community facilities

12.5.11 The Scheme directly crosses Avisford Park Golf Club, and the Church of St Mary's, Binsted is located directly alongside the Scheme alignment. There are currently several facilities located alongside the existing A27 such as Arundel District Hospital, Havenwood Park retirement home, Arundel Cricket Club, Arundel Library and Arundel Baptist Church. Additionally, there are several community facilities that can be found in the local villages of Walberton, Binsted and Tortington. These facilities are in near vicinity of the Scheme and within the study area.

12.5.12 Other accessible community facilities within 500 m of the Scheme include the Walberton Baptist Church Hall located approximately 285 m away, the Walberton Village Hall approximately 325 m away and St Mary's Church on Tortington Lane located approximately 430 m away.

12.5.13 The nearest school to the Scheme route is Walberton and Binsted Church of England (C of E) Primary School. This school is located approximately 170 m from the Scheme, immediately to the south of the Avisford Grange housing development site. The nearest healthcare facilities to the proposed route are Flintcroft Surgery (General Practice (GP)) and the Walberton Dental Surgery, both located approximately 400 m south of the Scheme in Walberton.

Community land

12.5.14 Some formal open and leisure spaces are located near to the Scheme. As previously mentioned in *Chapter 2: The Scheme*, the Scheme crosses the boundary into Avisford Park Golf Club. In addition to this, there are dedicated open spaces at Walberton Cricket Club and Walberton and

Binsted C of E Primary School approximately 170 m from the Scheme. An annual event, the Strawberry Fair, is also held in Binsted on land south of Binsted Nursery.

12.5.15 Binsted Woods are located 500 m north of the Scheme. The woods are publicly accessible and provide walking routes for the local community. According to the stage 2 public consultation undertaken in 2017, Binsted Woods are also used by pagan witches as a place of worship and, in conjunction with the adjacent parkland, are also known to be used permissively as a recreational asset by the local community for walking.

12.5.16 There is also a narrow strip of common land north of Tortington, known as Broad Green Waste. The details pertaining to its registration are held by the Registration Authority (WSCC). This is a small linear area of land adjacent to the road which is likely to be a remnant of a larger area.

12.5.17 The River Arun runs through the study area and provides opportunities for recreational angling.

Development land

12.5.18 Seven development planning applications have been identified within the study area. In total, there are six residential development land applications and one commercial development land application. Details regarding these are presented in Table 12-1 below.

Table 12-1 Strategic development land

Planning application/Site ID	Site Address	Quantum of development	Status
BN/18/21/RES	GTR land east of Fontwell Avenue Arundel Road Arundel BN18 0SB	5000 sqm Class B1 (b)/ (c)	Undecided
WA/95/18/RES	Land east of Tye Lane Walberton BN18 0DN	175 dwellings	Approved
WA/80/21/OUT	Land east of Yapton Lane Walberton BN18 0LJ	75 dwellings	Undecided
FON3	Land to west of A27	Not available	Undecided
66	Land south of Stewards Rise	Not available	Undecided

Planning application/Site ID	Site Address	Quantum of development	Status
20WA2	Land west of Yapton Lane	Not available	Unknown
17WA1	Land north of North Pound	Not available	Unknown

Source: Arun.gov.uk Planning Application Search; HELAA Allocation Search

12.5.19 A full assessment will be completed at ES. Such information will also be used in the assessment of cumulative effects (see *Chapter 15: Cumulative, In-combination and Project-wide Effects* of this PEI Report for a summary of how such sites are being identified).

Businesses

12.5.20 The Scheme mostly runs through agricultural land. However, there is a small number of businesses located alongside the Scheme, or within the study area.

12.5.21 There is a cluster of industrial businesses located next to Arundel Road, namely Fordingbridge Construction Company, West Sussex Steel Fabrication and Westbourne Motors vehicle repair shop. These businesses are in close proximity to where the Scheme begins to the east of Fontwell.

12.5.22 Hooe Farm Industrial Estate is located off Tye Lane. Businesses operating within this site include a stonemason and a car servicing and repair firm. In addition, the Scheme also crosses the Avisford Park Golf Club and Hotel and the Billycan Camping to the east of Tortington.

12.5.23 Binsted Nursery is around 200 m north of the Scheme, situated on Binsted Lane.

12.5.24 At the Crossbush roundabout, there are several businesses in close proximity to the Scheme route. A service station containing food and convenience retailers and a hotel is situated off the A284 within 100 m south of the Scheme. Additionally, a hospitality site is located approximately 200 m to the north of the Crossbush roundabout, comprising a hotel, restaurant and caravan park.

12.5.25 There is a cluster of existing businesses located at Manor Farm on Tortington Lane, located approximately 500 m south of the Scheme. These include the Arun Bodyshop (a motor body repair business) and Luckin Kitchens (a cabinet maker company). Additionally, there is a cluster of accommodation businesses located at Priory Farm, off Priory Lane, approximately 420 m north of the Scheme. Brooklands Barn Retreat, a converted barn turned guesthouse and Hanger Down House Bed and Breakfast are based there.

Agricultural land holdings

12.5.26 The Scheme passes through agricultural land, intersecting multiple different land parcels and land holdings. The identified land holdings that are crossed by the Scheme include:

a. Broomhurst Farm
b. Manor Farm
c. Church Farm
d. Littleton Farm
e. Hooe Farm
f. Parcels off Binsted Lane

Walking, cycling and horse-riding

12.5.27 PRoWs are important assets for local areas as they can connect smaller villages and centres to community facilities. They also provide routes on which the local population can exercise, which are often safe from vehicular traffic.

12.5.28 The Scheme runs through an area which contains multiple PRoW. The Scheme crosses or runs alongside multiple WCH facilities in the study area as summarised in Table 12-2 and shown in Figure 12-2. These facilities comprise PRoW (namely footpaths and bridleways), permissive routes and footways provided as part of the highway network.

Table 12-2 WCH facilities in the study area which cross or run alongside the Scheme

PRoW reference	Description
Walberton 392 public bridleway	Approximate 1.4 km bridleway which runs from north of Walberton on West Walberton Lane and continues north to the existing A27.
Walberton 350 public footpath	Approximate 0.7 km footpath runs between Binsted and Walberton across Binsted Rife. The path starts on Yapton Lane in Walberton on Blacksmith's Corner and runs east to Binsted Lane.
Walberton 354 public footpath	Approximate 0.5 km footpath runs across the u-shaped southern end of Binsted Lane from Oakley Cottages east to north of Fairmeads Farm.
Arundel 3403 public footpath	Approximate 0.7 km footpath runs north of Tortington from Tortington Lane to Priory Lane, connecting with public footpath 3404.

PRoW reference	Description
Arundel 206 public footpath	Approximate 6 km footpath runs along the western bank of the River Arun, starting on A259 in Littlehampton, into Arundel and finishes on Surrey Street.
Lyminster and Crossbush 2207 public footpath	Approximate 1.7 km footpath runs between Lyminster and Arundel Station.
Lyminster and Crossbush 2202	Approximate 0.2 km footpath runs from Crossbush Lane south towards the existing A27.

12.5.29 In total there are 27 different PRoW sections located within the 500 m study area, including the PRoW which cross or run alongside the Scheme. These comprise 22 footpaths and five sections of bridleway.

12.5.30 One of the greatest concentrations of PRoW within the study area lies to the south west of the Scheme, near to the urban area of Walberton. The PRoWs in this area are used for recreation, with some being used by local residents to access community facilities in Walberton and neighbouring villages.

Human health

Recreational facilities

12.5.31 Recreational facilities within the study area can contribute to improving local health and wellbeing. Assessment of changes in accessibility and severance between communities and recreational facilities aligns with the scope of human health assessment.

12.5.32 Recreational facilities identified within the study area are presented in Table 12-3.

Table 12-3 Recreational facilities within the study area

Name	Typology	Location	Access
Avisford Park Golf Club	Golf Course	Walberton	Yapton Lane
Puddle Ducks Hants & West Sussex Avisford Park	Swimming School	Hilton Avisford Park	Yapton Lane
Hilton LivingWell Health Club	Fitness Centre	Hilton Avisford Park	Yapton Lane

Name	Typology	Location	Access
Ratpack Archery Range	Archery Range	Binsted	Binsted Lane
River Arun	River for angling	Tortington/Arundel	-

Source: Google Maps, (2021)

Community health profiles

12.5.33 The health baseline study area has analysed the community health profile at ward level. A summary of the community health profile is provided in Table 12-4 below.

Table 12-4 Health baseline study area community health profile

Receptor	Arundel and Walberton Ward	Arun	South East	England
Population	8,106	161,123	9,217,265	56,550,138
Population aged under 16 (%)	14.2	16.2	19.3	19.2
Population aged over 65 (%)	32.9	29.1	19.7	18.5
Income Deprivation (people living in income-deprived household as % of population.)	6.7	10.4	-	12.9
Long-term Unemployment (measured as claimants of Jobseekers Allowance (per 1,000 population aged 16-64) for over 6 months)	1.9	2.3	-	3.2
General Health – bad or very bad (%)	4.3	5.6	4.3	5.5

Receptor	Arundel and Walberton Ward	Arun	South East	England
Long-term illness or disability (limits day-to-day activities) (%)	17.7	21.1	15.7	17.6
Obese adults (%)	7.1	8.7	8.5	9.7
Obese children (reception year) (%)	12.1	19.3	17.8	21.0
Emergency hospital admissions for COPD* (SAR**)	39.1	64.7	72.3	100.0
Deaths from respiratory diseases, all ages (SMR***)	95.7	86.1	89.8	100.0

Source: ONS, (2021), Mid-Year Population Estimates; ONS, (2011), Census 2011; Public Health England, (2020), Public Health Profiles; Ministry of Housing, Communities and Local Government, (2019), The English Indices of Deprivation

*Chronic *Obstructive Pulmonary Disease*

** Standardised Admission Ratio

*** Standardised Mortality Ratio

Obesity

12.5.34 Data from Public Health England (Ref 12-10) for the year 2019/20 shows that the prevalence of obesity in adults in Arundel and Walberton is also lower than the local district, regional and national averages. In all, 7.1% of the adult population in the ward are classified as obese, compared to 8.7% in Arun, 8.5% in the South East and 9.7% in England as a whole.

Childhood obesity

12.5.35 Data from Public Health England (Ref 12-10) for the year 2019/20 shows that the prevalence of obesity in children (agreed 10-11 years) in Arundel and Walberton is lower than the local authority, regional and national average. Around 12.1% of children in year 6 (20 children) in Arundel and Walberton are classified as obese, which is a lower rate when compared to 19.3% in Arun, 17.8% in the South East and 21% across England.

Ref 12-10 Public Health England, (2020). Local Authority Health Profiles.

Emergency Hospital Admissions for Chronic Obstructive Pulmonary Disease (COPD)

12.5.36 COPD is a common respiratory disease in the UK, usually affecting people over the age of 35.

12.5.37 Over the 5-year period between 2015/16 and 2019/20 (Ref 12-11), hospital admissions for COPD in Arundel and Walberton were considerably lower than the national average (100.0 SAR). Arundel and Walberton had a hospital admission ratio for COPD of 39.1 SAR, which was also significantly lower than the district level average of 64.7 and the regional average of 72.3.

Deaths from respiratory diseases

12.5.38 Data from Public Health England (Ref 12-12) shows that between 2015 – 2019, the SMR for deaths caused by respiratory diseases in Arundel and Walberton (95.7 SMR) was higher than both Arun (86.0) and the South East (89.8) but was marginally lower than the national average (100.0).

General health classification

12.5.39 Data from the 2011 Census (Ref 12-13), the latest available in respect of health status, shows that the general health of residents in the Arundel and Walberton ward was slightly better than the district and national averages, but broadly in line with the regional average, with 83.6% of residents assessing their health to be good or very good. This proportion is the same as the rate across the South East (83.6%) and higher in comparison to both Arun (78.8%) and the national average (81.4%).

12.5.40 Some 4.3% of residents in the ward assessed their health to be bad or very bad. This proportion is the same rate as the South East (4.3%) and lower than both the rate in Arun (5.6%) and across England (5.5%). In addition, 6.4% of residents in the ward are limited a lot in their day-to-day activities due to their health, which is similar to the rate across the South East (6.9%) and lower than in Arun (9.4%) and across England (8.3%).

Long-term unemployment

12.5.41 Public Health England measures long-term unemployment as claimants of Jobseekers Allowance (per 1,000 population aged 16-64) for over 6 months. Arundel and Walberton has a lower rate of claimants of Jobseekers Allowance than Arun and England as a whole. In all, 1.9 per 1,000 population in the ward claim for Jobseekers Allowance compared to 2.3 per 1,000 population in Arun and 3.2 per 1,000 population in England.

Ref 12-11 Public Health England, (2020). Local Health Online Mapping Tool: Emergency hospital admissions for Chronic Obstructive Pulmonary Disease (COPD).
Ref 12-12 Public Health England, (2020). Local Health Online Mapping Tool: Deaths from respiratory diseases.
Ref 12-13 Office for National Statistics, (2011). Census 2011.

Ethnicity

12.5.42 ONS Census 2011 data (Ref 12-13), the latest available in respect of ethnicity, shows the population proportion by ethnicity for Arundel and Walberton against the local authority, regional and national averages – see Table 12-5 below.

Table 12-5 Ethnicity breakdown by local authority

Local authority	White	Mixed/ Multiple ethnic group	Asian/ Asian British	Black/ African/ Caribbean /Black British	Other
Arundel and Walberton	98.2%	0.6%	0.8%	0.3%	0.03%
Arun	97.1%	1.0%	1.4%	0.4%	0.2%
South East	90.7%	1.9%	5.2%	1.6%	0.6%
England	85.4%	2.3%	7.8%	3.5%	1.0%

Source: ONS (2011), Census 2011

12.5.43 The population within the health baseline study area is shown to be mostly White, with the Asian/Asian British population being the second largest ethnic group by population proportion. Arundel and Walberton and Arun are significantly less ethnically diverse than the regional and national average.

Life expectancy

12.5.44 The life expectancy for men in Arundel and Walberton is higher than the local authority, regional and national average. At birth, males in the ward are expected to live to 81.2 years, compared to 79.7 years in Arun, 80.7 years regionally and 79.6 years nationally. The life expectancy for women in Arundel and Walberton is marginally lower than the regional average but higher than the rate in Arun and England as a whole. Females in the ward are expected to live to 83.8 years at birth, compared to 83.5 years in Arun, 84.1 years regionally and 83.2 years nationally.

Deprivation

12.5.45 The data is obtained from the Department for Levelling Up, Housing and Communities (2019) English Indices of Deprivation which analyses deprivation at Lower Layer Super Output Areas (LSOA) level. Out of 317 local authority districts, Arun is ranked as the 149th most deprived local authority in the country (Ref 12-14). As part of this, 19.1% of Arun's LSOAs are judged to be in the 30% most deprived parts of the country.

Ref 12-14 Ministry of Housing, Communities and Local Government, (2019), English Indices of Deprivation 2019.

12.5.46 When assessing only the health deprivation and disability domain indicator, 24.5% of LSOAs in Arun are ranked in the 30% most health deprived parts of the country, compared to 12.6% across the South East (Ref 12-15).

12.5.47 When assessing only the income deprivation domain indicator, 13.9% of LSOAs in Arun rank in the most deprived 30% of LSOAs nationally. This is marginally lower than the regional average of 14.5% of LSOAs for the South East. Within the Arundel and Walberton ward, 6.7% of the population live in income-deprived households, which is lower than the rate in Arun (10.4%) and England as a whole (12.9%).

12.5.48 Equally, about 13.2% of children under the age of 16 (3,195 children) in Arun come from low income families, which is considerably lower than the national (17.0%) average and similar to the regional average (12.9%).

Health determinants

12.5.49 Further determinants of health are outlined below including air quality, noise sensitivity, landscape amenity and road safety information.

Air quality

12.5.50 The main pollutant of concern in the human health study area is nitrogen dioxide (NO_2), the primary source of which is road traffic emissions. Pollutants build up in locations where traffic volumes are slow to disperse. For this reason, locations of the greatest concern for poor air quality are generally town centres and major road junctions.

12.5.51 There are two Air Quality Management Areas (AQMA) within the study area; namely the Worthing AQMA and the Horsham AQMA No1 in Storrington. These have been declared due to the exceedances of the annual mean nitrogen dioxide (NO_2) objective.

12.5.52 Further information on the air quality baseline, assessment and impacts can be found in *Chapter 5: Air Quality.*

Noise sensitivity

12.5.53 There are a number of Noise Sensitive Receptors (NSRs) in close proximity to the Scheme and the existing A27. As outlined in the Land Use and Accessibility baseline subchapter, the Scheme is close to residential properties in Walberton, Binsted and Tortington and a range of community facilities including schools, village hall and medical facilities. Road traffic is a major source of noise in the study area. Both the A27 and a number of other minor roads contribute to ambient noise levels in the study area.

12.5.54 There are 15 Noise Important Areas (NIAs) (those areas across England identified as being most exposed to noise) within the study area, all located near to the existing A27.

Ref 12-15 Ministry of Housing, Communities and Local Government, (2019), English Indices of Deprivation 2019.

12.5.55 Further information on the noise baseline, assessment and impacts can be found in *Chapter 11: Noise and Vibration*.

Landscape amenity

12.5.56 The study area lies in the transitional area between the steeper landform of the South Downs and the more gently undulating coastal plain. The landscape elements within the study area are principally agricultural with varied areas of woodland, village settlement and small commercial uses. The landscape in the northern part of the study area retains a more rural character and land uses, whilst there is more development and more commercial uses in the southern part of the study area around Barnham Yapton and Littlehampton.

12.5.57 The SDNP was designated in 2010 in recognition of its exceptional natural beauty, as well as for the opportunities to learn about and appreciate its special qualities, and as a landscape of national importance. The SDNP extends across the northern part of the study area, including the Binsted Woods Complex to the south of the existing A27 dual carriageway, and across the northern part of Arundel and to the north of the Crossbush roundabout. The Scheme was designed to remain outside the SDNP as far as possible. However, the eastern end of the Scheme cannot be constructed without some minor incursions into the National Park. These incursions are primarily related to works within the existing highway boundary of the A27 and are a direct consequence of the need to connect the new route with the existing highway infrastructure. In addition, some minor incursions are required to provide ecological mitigation measures in line with the statutory purposes of the National Park designation.

12.5.58 Further details can be found in *Chapter 7: Landscape and Visual*.

Road safety

12.5.59 Incidents and collisions between vehicles and people using the UK's road network can cause serious injuries and death. As shown in Table 12-6, the number of people either Killed or Seriously Injured (KSI) on England's roads per 100,000 population (2016-18) in Arun was worse than the national average, but less than the county and regional averages.

Table 12-6 KSI statistics for Arun and comparative geographies

	Arun	West Sussex	South East	England
Killed or Seriously Injured (KSI) casualties on England's roads 2016-18 per 100,000 population	46.4	56.5	49.6	42.6*

Source: Public Health England, (2020); Local Authority Health Profiles

*Aggregated from all known lower geography values

12.6 Potential impacts

Construction

*Land use and accessi*bility

12.6.1 The Scheme has the potential to impact on land required temporarily and/or permanently that is used for private property or housing, community land and assets, including land or assets used for recreation (this comprises impacts to open space and blue space e.g., play space and rivers), development land and businesses. Land required temporarily is due to construction works which is returned to the landowner and permanent land take is in relation to the Scheme crossing the land.

12.6.2 The Scheme runs south of Binsted Nursery and across rural land towards Tortington, mostly avoiding private property and housing. However, five residential properties on Binsted Lane are on land within the draft Order Limits, which would be required for the Scheme and therefore they are likely to be demolished.

12.6.3 The Scheme runs across agricultural land to the north-east of Tortington where the Billycan Camping is located. This land would be required for the Scheme.

12.6.4 The construction of the Scheme would also require land from Avisford Park Golf Club and the parcel of land known as Broad Green Waste. The construction of the Scheme is unlikely to require land from other community assets such as schools, healthcare facilities, libraries or local centres.

12.6.5 The construction of the Scheme could potentially impact on accessibility (both directly and indirectly) or result in severance for communities and people when accessing private property or housing, community land and assets and development land and businesses. For example:

a. Access to the industrial businesses located at Arundel Road could be impacted as a result of the Scheme.

b. Businesses located at the Hooe Farm Industrial Estate and around the Crossbush roundabout junction could experience accessibility issues during the construction of the Scheme.

c. Equally, access may be constrained to the Hilton Avisford Park, where the Hilton LivingWell Health Club and Puddle Ducks Hants & West Sussex Avisford Park swimming school are located.

Agricultural land holdings

12.6.6 The effects on agricultural land holdings during Scheme construction relate to the loss of land and any buildings or infrastructure required to construct the Scheme, both temporarily and permanently. The Scheme would require land take from agricultural land, including best and most versatile land, and potentially result in severance within holdings or access restrictions to

agricultural infrastructure, for example, agricultural buildings, equipment, machinery, water resources and private means of access.

Walking, Cycling and Horse-riding

12.6.7 Potential impacts during construction of the Scheme would include temporary land take, the temporary or permanent diversion of PRoW, walking and cycling routes and temporary disruption to PRoW, resulting in severance or increased journey times to access community facilities. Where the Scheme cuts across a walking, cycling or horse-riding route, endeavours will be made where possible to make sure that all routes are kept in place by offering safe and well-planned diversions during the construction phase to avoid temporary severance.

12.6.8 The Scheme would have a direct impact on the following PRoW, where permanent land take is required:

a. PRoW 392 (bridleway), which runs from north of Walberton to the existing A27. The Scheme is proposing a bridleway bridge which crosses over the new dual carriageway.

b. PRoW 350 (footpath), which runs between Binsted and Walberton across Binsted Rife. This PRoW would be realigned beneath Binsted Rife underbridge.

c. PRoW 354 (footpath), which runs across the u-shaped southern end of Binsted Lane. This PRoW would be realigned to pass over Binsted Lane green bridge.

d. PRoW 3403 (footpath), which runs north of Tortington. This PRoW would be realigned to pass over Tortington Lane green bridge.

e. PRoW 2207 (footpath), which runs between Lyminster and Arundel Station. This PRoW would be realigned with the Scheme and would pass beneath the railway bridge.

Human health

12.6.9 Scheme construction activities have the potential to have direct impacts on the health, well-being and the quality of life of the local population due to potential changes in access to community land and assets (recreational facilities, healthcare facilities and employment opportunities), open space and activity on WCHs.

12.6.10 Additionally, potential impacts on human health determinants during Scheme construction include changes in air quality, landscape amenity and noise and vibration. Some communities will be subject to a combination of effects due to the Scheme, known as in-combination effects. Potential impacts could affect residential or commercial/employment receptors. Further information on how in-combination effects will be addressed as part of the EIA are reported in *Chapter 15: Cumulative, In-combination and Project-wide Effects*.

Operation

Land use and accessibility

Private property; community land and assets and development land and businesses

12.6.11 Operation of the Scheme may require further land from residential or private properties, community land and assets or from development land and businesses located within the study area for maintained access. A full assessment of the operational effects on land take will be undertaken and reported in the ES. Accessibility to these assets could be enhanced during the operation of the Scheme. However, permanent road and PRoW diversions or closures could result in changes in journey length or severance.

12.6.12 Potential impacts on severance and accessibility during the operation of the Scheme include:

a. Changes to travel patterns via sustainable modes of transport, such as walking and cycling, through the provision of new routes for walkers, cyclists and horse riders and changes to accessibility.

b. Impacts on accessibility to local centres and areas where healthcare facilities are located resulting from reduced or increased delays, congestion and potential changes in severance.

c. Impacts on local employment opportunities and activity through changes in access to employment resulting from reduced or increased delays for motorised users, reduced or increased congestion and potential changes in severance.

d. Impacts on access to open space and recreation space including impacts through provision of new walking and cycling routes.

Walking, Cycling and Horse-riding

12.6.13 Potential impacts on WCH during operation of the Scheme include:

a. Changes to severance and connectivity and local travel patterns through provision of new WCH facilities.

b. Changes to the safety of existing WCH routes within the study area.

c. Changes to journey times for WCH accessing community resources, through the provision of new WCH routes, connections and crossing provisions.

Human health

12.6.14 The Scheme would result in changes to the levels of traffic congestion on the road network through the redistribution of traffic. This could potentially have effects on noise, landscape amenity, air quality and may potentially result in positive, negative or neutral outcomes on the health of local communities depending on the location of the receptors. Impacts could occur in either a residential or commercial/employment setting.

12.6.15 Potential impacts on human health determinants during Scheme operation also include any changes to the accessibility of open spaces, nature and recreation facilities, healthcare facilities, employment opportunities and existing WCH routes as a result of the Scheme.

12.6.16 The Scheme is anticipated to improve road safety for both vehicular travellers and for WCH. For example, the Scheme proposes the construction of multiple overbridges including at Tye Lane, Binsted Lane and Tortington Lane. The purpose of these is to enable safe passage and provide connection for WCH across the Scheme. The Binsted Lane Overbridge would also provide a road connection for vehicular travellers, thus providing a safer and improved experience.

12.7 Design, mitigation and enhancement measures

Embedded mitigation measures

12.7.1 The Scheme has been designed, as far as practicable, to avoid and minimise impacts and effects relating to population and human health through the process of design development, and by embedding mitigation measures into the design.

12.7.2 The Scheme has been designed to ensure that access for motorised vehicles to the Avisford Grange housing development is permanently retained.

12.7.3 National Highways is currently looking at ways it can mitigate the impact on the Avisford Park Golf Club to maintain a viable facility in close proximity to the Scheme. Currently, National Highways is actively considering two potential mitigation options to maintain golfing facilities in this location. Option 1 would involve the reprovision of a 9 hole golf course with driving range or practice facilities. Land has been included within the draft Order Limits around the boundary of the existing golf course to re-provide a new access to the golf club off Yapton Lane, allowing the reconfiguration of holes within the existing golf course to maintain at least 9 holes and to allow the reprovision of car parking, clubhouse facilities and the potential additional facilities such as a driving range and practice course. Option 2 would involve the full replacement of the 18 hole golf course. In addition to including land currently used for the golf course to re-provide the golfing facilities affected by the Scheme, the draft Order Limits has been extended to include land to the east/north-east of the back 9 holes of the golf club, surrounding Binsted Farm, to also allow for the creation/re-provision of a further 9 holes to maintain Avisford Park Golf Club as an 18 hole facility.

12.7.4 Appropriate provisions are being included in the design to enable WCH to safely cross the Scheme and ensure that the existing connectivity between PRoW, local roads and communities is retained. The designs of these provisions are currently under development; however, the Scheme incorporates a combination of new bridges, underpasses, footpaths and bridleway diversions, crossings and new provision for walkers, cyclists and

horse riders to maintain and where possible enhance access along existing and new routes.

12.7.5 The development of the Scheme design has sought to minimise the extent of land required permanently to accommodate the Scheme; only land which is necessary for the purposes of delivering the Scheme will be taken.

12.7.6 Measures to mitigate the severance of agricultural holdings would be incorporated into the Scheme design and would aim to allow the continuance of private means of access. Other mitigation measures for individual land holdings relate to the reinstatement of land used temporarily during the construction period to an agricultural use.

12.7.7 Further details on specific mitigation measures relating to air quality, noise and vibration and landscape amenity can be found in the relevant topic chapters of this PEI Report.

Standard mitigation measures

12.7.8 Standard measures would be implemented to mitigate the impacts of Scheme construction on the local population and human health. The first iteration of the EMP will define the mitigation measures to be implemented during construction of the Scheme and will be secured by way of a DCO requirement. The first iteration EMP will be submitted alongside the ES and will include a PRoW Management Plan for the Scheme.

12.7.9 Measures to be included in the EMP are likely to include the following:

a. Careful planning of the construction works to minimise the need to close/divert existing routes and facilities used by WCH, and to minimise closure or diversion durations. Where the Scheme cuts across a walking, cycling or horse-riding route, endeavours will be made where possible to make sure that all routes are kept in place by offering safe and well-planned diversions during the construction phase to avoid temporary severance.

b. The Scheme will be designed to maintain access where practicable and that works that may affect accesses will be done in consultation with the landowners.

c. Sites used temporarily during the construction phase will be appropriately restored and returned to the applicable landowner wherever practical.

d. Requirements relating to traffic management during the construction phase will be developed, which will take account of local, public and business access requirements to reduce severance and disruption to local traffic movements.

e. Regular community liaison in advance of, and during the construction works, will be undertaken to help keep local communities informed of any potentially disruptive activities and to assist with journey planning.

12.7.10 Relevant standard measures relating to air quality, noise and vibration and landscape amenity will be implemented to mitigate the effects of the Scheme on these disciplines, as described in those topic chapters of this PEI Report. This will also help mitigate the impacts of the Scheme on local population and human health. Details on these standard mitigation measures can be found in *Chapter 5: Air Quality, Chapter 7: Landscape and Visual and Chapter 11: Noise and Vibration*.

12.8 Assessment of effects

12.8.1 The effects of the Scheme have been assessed following consideration of the potential impacts outlined in *Section 12.6* and both the embedded and standard mitigation measures outlined in *Section 12.7*.

Construction

Private property and housing

12.8.2 Construction of the Scheme would require permanent land take from five residential properties on Binsted Lane, resulting in the loss of these properties. Whilst this loss of residential property is acknowledged to have an impact on the occupants and owners, it is not anticipated to result in significant adverse effects at the community level. Land would also be required from within the curtilage of Avisford Park House, although this is also not anticipated to result in a significant adverse effect at the community level. As the Scheme design develops, the use of land within the Order Limits may vary. A full assessment will be completed in the ES.

12.8.3 The Scheme has been designed to ensure that access for motorised vehicles to the Avisford Grange housing development is permanently retained. During construction of the Scheme, access to the Avisford Grange housing development may be altered or restricted. For example, the access road to the Avisford Grange housing development may be subject to traffic control measures or reduced to single lane flow. Access from the direction of the existing A27 would be restricted during construction meaning there is potential for temporary diversions. However, these temporary construction restrictions and alterations are not anticipated to result in significant adverse effects. A full assessment will be completed in the ES.

12.8.4 No other private properties and housing are anticipated to be directly affected by the construction of the Scheme. Construction of the Scheme may temporarily disrupt access via traffic control measures or reduced to single lane flow, where these lie in proximity to construction activities although this is not anticipated to result in significant adverse effects. The Scheme will be designed to maintain access where practicable and those works that may affect accesses will be done in consultation with the landowners.

Community land and assets

Community land and assets – temporary effects

12.8.5 Avisford Park Golf Club would be unable to operate during construction of the Scheme. Therefore, the community would be unable to use Avisford Park Golf Club golf course for the duration of the Scheme construction programme (approximately 3.5 years). Whilst it is recognised there are alternative golf courses located in the study area, they are not considered to be viable alternatives for all users of the Avisford Park Golf Club, as these users would have likely chosen to join this club as a member. On this basis, this would result in a temporary significant adverse effect on the users of the golf club. As described in *Chapter 2: The Scheme*, land has been identified within the draft Order Limits, should it be determined that additional land is required to mitigate the Scheme's effects on the golf course by way of reprovision. A full assessment would be undertaken and reported in the ES, taking into account any proposed mitigation.

12.8.6 No other community lands or assets are currently anticipated to be directly affected by the construction of the Scheme. The Church of St Mary's, Binsted and Walberton and Binsted C of E Primary School are not anticipated to be directly affected by the Scheme.

12.8.7 The construction of the Scheme would result in some indirect accessibility impacts on community assets across the study area due to severance associated with construction traffic. For example, Hilton LivingWell Health Club and Puddle Ducks Hants and West Sussex Avisford Park swimming pool. Disruption would be minor, and with appropriate traffic management, is not anticipated to result in significant adverse effects on community facilities in the study area. A full assessment will be completed in the ES.

Community land and assets – permanent effects

12.8.8 Construction of the Scheme would require permanent land take from a small area of the common land at Broad Green Waste. This is not anticipated to result in significant adverse effects as an equivalent area of replacement common land is to be provided contiguous to the land taken, as detailed on Figure 2-1 Preliminary Landscape and Environmental Masterplan.

12.8.9 Construction of the Scheme would require an area of permanent land take from Avisford Park Golf Club and the demolition of the club house. This is likely to result in a permanent significant adverse effect on the community and their user experience of a sports facility. As described above, proposed mitigation is being explored and a full assessment will be undertaken and reported in the ES, taking into account any proposed mitigation.

Development land and businesses

Development land

12.8.10 No areas with planning applications/permissions or allocations would be significantly affected by the Scheme. As mentioned above, Avisford Grange housing development may experience temporary access restrictions, but no significant effects e.g., land take is anticipated for development land. A full assessment will be undertaken and reported in the ES, taking into account

any new or amended planning applications or allocations identified after the publication of the PEI Report.

Businesses - temporary effects

12.8.11 As detailed above, the golf course at the Avisford Park Golf Club would experience a temporary significant adverse effect as the business would be unable to operate for the duration of Scheme construction phase (approximately 3.5 years). No other existing businesses, excluding agricultural businesses, included in the study area would be directly temporarily impacted by the Scheme.

12.8.12 Access to the industrial businesses located at Arundel Road could be impacted as a result of the Scheme; however, this is not anticipated to result in significant adverse effects. A full assessment will be completed in the ES.

12.8.13 Businesses at Hooe Farm Industrial Estate would be impacted as access would be temporarily severed. This has the potential to result in a significant adverse in the absence of mitigation. Proposed mitigation is being considered to retain access during the Scheme construction phase, which would remove the significant effect. A full assessment will be completed in the ES.

12.8.14 Businesses at the Hilton Avisford Park Hotel complex and at the Crossbush Service Station (including the fuel station, restaurant and hotel) could also experience temporary access restrictions. Through appropriate mitigation relating to maintained access, it is not anticipated that either receptor will experience significant effects. A full assessment will be completed at ES.

12.8.15 Both businesses at Manor Farm and the accommodation businesses at Priory Farm may experience temporary access restrictions due to construction works. However, these are not anticipated to result in significant adverse effects.

Businesses - permanent effects

12.8.16 Construction of the Scheme would require permanent land take from the Billycan Camping. This is likely to result in a permanent significant adverse effect. A full assessment will be reported in the ES taking into account any proposed mitigation.

12.8.17 As detailed above, the Scheme would require permanent land take from the Avisford Park Golf Club and the demolition of the club house which would result in a permanent significant adverse effect. Proposed mitigation is being explored and a full assessment will be undertaken and reported in the ES, taking into account any proposed mitigation.

Agricultural land holdings

12.8.18 There is the potential for the Scheme to have temporary and permanent adverse effects on agricultural land holdings during construction due to land take required for the Scheme. This is specifically land within the Scheme boundary, construction activity and any off-site compensation. The Scheme

also has the potential to have adverse effects on holding access or access to agricultural infrastructure.

12.8.19 Findings from the interviews with agricultural landowners will be used to validate the assessment of Scheme impacts on agricultural land holdings. A full assessment of potential Scheme effects on agricultural land holdings will be undertaken and reported in the ES.

Walking, Cycling and Horse-riding

12.8.20 During the Scheme construction phase, it would be necessary to temporarily close some sections of footpaths and bridleways. Temporary closures during the construction phase would be necessary to ensure that segregation is maintained between construction activities and members of the public. As a result of construction, there would also be permanent changes along some of the WCH routes within the study area.

Temporary effects

12.8.21 Temporary closures of PRoW 206, 350, 354, 392, 3403 and 2207 may be required to construct the Scheme. Where the Scheme cuts across a walking, cycling or horse-riding route, endeavours will be made where possible to ensure that all routes are kept in place during the construction phase by offering safe and well-planned diversions. At this stage, it is not possible to confirm the length of time that each route would be temporarily closed. It is also not possible to determine whether the proposed diversions are appropriate replacements. A full assessment of the effects of the Scheme on users of these PRoW will be undertaken and reported in the ES with mitigation measures suggested where practicable.

Permanent effects

12.8.22 PRoW 2207 would be permanently diverted to accommodate the Scheme. This route provides access to Arundel Station and therefore has the potential to be used for commuting and recreational purposes. The extent of the diversion is unknown at this stage and will be fully assessed at ES.

12.8.23 PRoW 350, 354 and 3403 are recreational footpaths that would be permanently diverted to accommodate the Scheme. This is not anticipated to result in significant adverse effects on users of these PRoW.

12.8.24 PRoW 392 is a bridleway that would be reprovided along its original alignment as part of the Scheme. This is not anticipated to result in significant adverse effects on users of this PRoW.

12.8.25 A full assessment of the effects of the Scheme on users of these PRoW will be undertaken and reported in the ES.

Anglers

12.8.26 There is potential for Scheme construction to cause temporary accessibility issues for anglers wanting to access areas of the River Arun where the Schemes crosses over the river. This is not anticipated to result in significant adverse effects as there will be nearby alternative access points for angling. A full assessment will be undertaken at the ES.

12.8.27 The Scheme is also not anticipated to have any permanent effects on anglers.

Human health

12.8.28 Information from the other EIA topics will be used to determine the likely health outcomes of Scheme construction activities. A full assessment of the effects of Scheme construction on human health will be undertaken and reported in the ES.

Access to healthcare

12.8.29 The nearest healthcare facilities to the proposed route are Flintcroft Surgery (General Practice (GP)) and the Walberton Dental Surgery, both located approximately 400 m south of the Scheme in Walberton, as identified in the baseline subchapter. The Scheme is not anticipated to impact on accessibility to these healthcare facilities during construction and therefore has been assessed to have a neutral health outcome.

Access to open space

12.8.30 Accessibility and severance effects are outlined in the above Land Use and Accessibility assessment subchapter (paragraphs 12.8.5 to 12.8.9) for community land and assets. Users of Avisford Park Golf Club are likely to experience significant adverse effects. These effects could have a negative outcome on the health and well-being of golf club users who rely on the Golf Club as a community asset which allows them to socially network. On this basis, the impact of the Scheme during construction on open space is assessed to have a negative health outcome.

Access to work and training

12.8.31 Accessibility and severance effects are outlined in the above Land Use and Accessibility assessment subchapter (paragraphs 12.8.11 to 12.8.17) for existing businesses. Severance and accessibility effects on businesses could have a negative outcome on the health and well-being of the population within the health baseline study area. The provision of likely mitigation measures such as diversion and management measures would ensure that accessing facilities remains possible. Therefore, the impact of the Scheme during construction on access to work and training is assessed to have a neutral health outcome.

New employment and training opportunities

12.8.32 Construction of the Scheme would generate new employment and training opportunities. The local community will potentially benefit from employment and training opportunities generated by the Scheme during construction stage. Employment provides financial security and can contribute to an individual's well-being. In terms of the generation of new employment and training opportunities, the Scheme is assessed to have a positive outcome on local health.

Access to active travel

12.8.33 During construction, where the Scheme cuts across a walking, cycling or horse-riding route, endeavours will be made where possible to ensure that all routes are kept in place by offering safe and well-planned diversions. On this basis, access to community and recreational facilities and ability to use sustainable transport modes should be maintained. Therefore, in terms of access to active travel during construction, the Scheme is assessed to have a neutral outcome on local health.

Air quality

12.8.34 During Scheme construction, emissions from construction dust, HGVs and construction traffic effects would occur, although these would be temporary in nature. *Chapter 5: Air Quality* identifies a risk of temporary adverse impacts from dust emissions to occur at sensitive receptors located close to the Scheme during the construction works. The locations at greatest risk are:

a. Properties around the Causeway Roundabout and Chichester Road
b. North-east Fontwell
c. Binsted Lane
d. Broad Green Cottages
e. Crossbush, and the intersection of Poling Street and the A27.

12.8.35 In these locations, site specific mitigation measures, in addition to standard mitigation measures, may be required to avoid significant temporary effects on air quality. These measures will be set out as needed within the EMP for the Scheme. The effect of the Scheme on air quality as a determinant of human health during construction is assessed to have a negative health outcome.

Noise and vibration

12.8.36 *Chapter 11: Noise and Vibration* identifies that construction activities will have likely significant temporary adverse noise and vibration effects for nearby sensitive receptors in close proximity to the construction compounds and the works. Receptors most at risk of significant adverse effects include properties between Tye Lane and Yapton Lane which are close to the section of the Scheme in cutting as well as properties close to the overbridges at Tye Lane, Yapton Lane, Binsted Lane and Tortington Lane.

12.8.37 Construction traffic, including the operation of any required diversion routes, is likely to have adverse effects on NSRs located along existing roads with low traffic volumes. Such effects will be mitigated by appropriately controlling construction traffic and implementing an appropriate traffic management system.

12.8.38 The effect of the Scheme on noise and vibration as a determinant of human health during construction is assessed to have a negative health outcome.

Landscape amenity

12.8.39 During construction, the Scheme is likely to result in significant adverse landscape effects on some Local Landscape Character Areas (LLCA) as a result of the extensive and intensive construction activity. *Chapter 7: Landscape and Visual* identifies significant adverse effects on the following LLCAs:

a. LLCA 2: Walberton Settled Woodland.
b. LLCA 3: Hooe Farm.
c. LLCA 4: Avisford Park.
d. LLCA 5: Walberton.
e. LLCA 6: Binsted Farmland.
f. LLCA 7: Binsted Rife.
g. LLCA 8: Binsted.
h. LLCA 9: Tortington Rife.
i. LLCA 10: Tortington Valley Sides.
j. LLCA 11: Lower Arun Valley Floodplain.
k. LLCA 12: Lyminster Arun Valley Sides.

12.8.40 These adverse effects are a result of changes to tranquillity and landscape character. The effect of the Scheme on landscape amenity as a determinant of human health, therefore, is assessed to have a negative health outcome on people who live in and have regular access to the above LLCAs.

Operation

Private property and housing, community land and assets, development land and businesses and agricultural land holdings

12.8.41 No significant adverse effects on private property and housing, community land and assets, development land and businesses are anticipated during Scheme operation due to severance/disruption.

Walking, Cycling and Horse-riding

12.8.42 The Scheme would introduce new PRoW within the study area, which can bring benefits to the local population, including increased access to community facilities, improved safety whilst travelling, encouragement to take part in recreational activity and increased opportunity to travel using sustainable transport modes.

12.8.43 A new PRoW would be introduced on Tye Lane, allowing pedestrians and cyclists to travel safely on the newly constructed overbridge by Tye Lane, over the Scheme. A new PRoW that connects to the existing PRoW 350 footpath would provide a connection to Binsted Lane. The introduction of these PRoW has the potential to result in significant beneficial effects.

Human health

12.8.44 Information from the other EIA topics will be used to determine the likely health outcomes of Scheme operation. A full assessment of the effects of Scheme operation on human health will be undertaken and reported in the ES.

Access to healthcare

12.8.45 The Scheme is not anticipated to impact on accessibility to healthcare facilities during operation. Therefore, accessibility issues resulting from the Scheme at healthcare facilities have been assessed to have a neutral health outcome.

Access to open space

12.8.46 The Scheme is not anticipated to impact accessibility to open space during operation. Therefore, accessibility issues resulting from the Scheme at healthcare facilities have been assessed to have a neutral health outcome.

Access to work and training

12.8.47 Once operational, the Scheme would improve traffic flow across the strategic road network within the study area. Improved traffic flow and transport links could enable better access to employment and training opportunities. Equally, maintenance of the road during operation could create more construction jobs. Employment provides financial security and can contribute to an individual's well-being. In terms of access to employment opportunities during operation, the Scheme is assessed to have a positive outcome on local health.

Access to active travel

12.8.48 Once operational, the Scheme would introduce new PRoW within the study area which can bring benefits to the local population, including providing increased access to community facilities, improved safety whilst travelling, encouragement to take part in recreational activity and increased opportunity to travel using sustainable transport modes. Therefore, in terms of access to active travel during operation, the Scheme is assessed to have a positive outcome on local health.

Air quality

12.8.49 *Chapter 5: Air Quality* does not anticipate any likely significant air quality effects during operation of the Scheme. Air quality is likely to improve through Arundel and Storrington once the Scheme is in use, which will have a positive health outcome for residents within Arundel and Storrington.

Noise and vibration

12.8.50 As detailed in *Chapter 11: Noise and Vibration*, operation of the Scheme will have potentially adverse noise effects at NSRs in Walberton, Binsted and Tortington as well as parts of south Arundel and south and east of Crossbush. Residents living and working nearby these NSRs are likely to

experience increased exposure to noise and vibration pollution which will have a negative impact on their health and well-being.

12.8.51 Operation of the Scheme will have potentially significant beneficial noise effects for residents of Havenwood Park and parts of Arundel close to the existing A27 such as NSRs on Canada Road, the north end of Jarvis Road. Residents living and working nearby these NSRs are likely to experience reduced exposure to noise and vibration pollution which will have a positive impact on their health and well-being.

Landscape amenity

12.8.52 In operation, the Scheme is likely to result in significant adverse landscape effects on some LLCAs. *Chapter 7: Landscape and Visual* identifies significant adverse effects on the following LLCAs:

a. LLCA 3: Hooe Farm.
b. LLCA 4: Avisford Park.
c. LLCA 7: Binsted Rife.
d. LLCA 8: Binsted.
e. LLCA 9: Tortington Rife.
f. LLCA 10: Tortington Valley Sides.
g. LLCA 11: Lower Arun Valley Floodplain.

12.8.53 These adverse effects are a result of changes to tranquillity and landscape character. The effect of the Scheme on landscape amenity as a determinant of human health, therefore, is assessed to have a negative health outcome on people who live in and have regular access to the above LLCAs.

12.8.54 There are not expected to be significant adverse landscape effects to the SDNP as a result of Scheme operation. There is the potential for the Scheme to give rise to beneficial effects to the tranquillity of the SDNP and Arundel through a reduction in traffic as a result of de-trunking of the existing A27 and improvements to NMUs' connectivity.

Summary of preliminary assessment

12.8.55 Based on the preliminary assessment outlined above, there is potential for positive and negative significant effects to result from the construction and/or operation of the Scheme. A summary of these potentially significant effects is reported in Table 12-7 at the end of this chapter.

12.9 Scheme options

12.9.1 As described in *Chapter 2: The Scheme*, options are still being considered for the potential reprovision of Avisford Park Golf Club. In addition, a potential alternative option from the current proposed alignment where the Scheme passes between Avisford Park, the new housing development at Avisford Grange and the existing Yapton Lane is being considered. This would raise the vertical alignment of the Scheme, with an offline Yapton Lane overbridge. The sections below discuss these in turn and outline whether adopting either of these would change anything stated in the preceding baseline conditions, potential impacts and assessment of effects sections and consider the potential for different effects of the options.

Options for Avisford Park Golf Club reprovision

Option 1: 9 hole golf course with driving range or practice facilities

12.9.2 The provision of this amended golf offering is unlikely to result in any changes to the information already provided in the baseline conditions. Land has been identified in the draft Order Limits to mitigate the Scheme's effects on the golf course by way of re-provision. However, Option 1 would not be a direct replacement for users of the affected resource which would be lost. Therefore, it would not remove the significant adverse effect on users of the golf club. There is the potential that Option 1 may require the acquisition of some agricultural land, the loss of which would require assessment. This would be reported in the ES if this option is taken forward.

Option 2: Replacement 18 hole golf course

12.9.3 Full reprovision of the existing golf offering would not result in any changes to the information already provided in the baseline conditions. However, the full reprovision of the existing golf course (designed as a complete replacement and to the same standard) would remove the significant adverse effect on users of the golf club. Option 2 would require more land take and the acquisition of more agricultural land, the loss of which would require assessment. This would be reported in the ES if this option is taken forward.

Option for raised vertical alignment with offline Yapton Lane overbridge

12.9.4 Whilst there would be more land take associated with this offline option than for the current proposed alignment which means it is less preferable from this perspective, it is considered a minimal change in the overall context of the Scheme and would not result in any changes to the baseline conditions, potential impacts and assessment of effects sections of this chapter. Arrangements to maintain access for properties on Yapton Lane and Manser Road would be discussed with stakeholders including homeowners as part of ongoing Scheme development, with details included in the DCO application and reported in the ES. Therefore, the preliminary

conclusions in terms of the potential for likely significant environmental effects remains the same as for the current proposed alignment.

Table 12-7 Summary of potential significant effects

Receptor	Scheme impact	Potential significant effects (following embedded mitigation)	Further mitigation to be explored
Community asset	Construction of the Scheme would directly affect Avisford Park Golf Club golf course (loss of, or direct impact on, approximately 9 of the 18 holes, car parking spaces, the existing golf club access onto Yapton Lane and loss of the clubhouse within the grounds of the hotel).	Temporary and permanent adverse effects associated with Scheme impact on Avisford Park Golf Club which would be unable to operate during construction of the Scheme.	Land has been identified within the draft Order Limits, should it be determined that additional land is required to mitigate the Scheme's effects on the golf course by way of reprovision.
Existing businesses	Construction of the Scheme would directly affect Avisford Park Golf Club golf course (loss of, or direct impact on, approximately 9 of the 18 holes, car parking spaces, the existing golf club access onto Yapton Lane and loss of the clubhouse within the grounds of the hotel).	Temporary and permanent adverse effects associated with Scheme impact on Avisford Park Golf Club which would be unable to operate during construction of the Scheme.	Land has been identified within the draft Order Limits, should it be determined that additional land is required to mitigate the Scheme's effects on the golf course by way of reprovision.

Receptor	Scheme impact	Potential significant effects (following embedded mitigation)	Further mitigation to be explored
	Construction of the Scheme would directly affect Billycan Camping	Permanent adverse effects as a result of permanent land take from the Billycan Camping. This is likely to result in business operations to cease.	After the implementation of the EMP, no further mitigation is likely to be available.
Agricultural land holdings	Land take required for construction and operation of the Scheme.	Temporary and permanent effects due to land take and severance.	Undertaking agricultural landowner interviews to understand how agricultural businesses function in order to facilitate ongoing farm operations within the Scheme design as far as practicable.
Walkers, cyclists and horse riders	Temporary or permanent diversion of PRoW.	Temporary and permanent effects on walkers, cyclists and horse riders due to increased travelling distances and/or changes in user experience from PRoW diversions.	Ongoing inputs to design process and proposed construction methodology.

Receptor	Scheme impact	Potential significant effects (following embedded mitigation)	Further mitigation to be explored
Walkers, cyclists and horse riders	Creation of new WCH infrastructure.	Permanent beneficial effects due to increased access to community facilities, improved safety whilst travelling, encouragement to take part in recreational activity and increased opportunity to travel using sustainable transport modes.	None required.

13. Road Drainage and the Water Environment

13.1 Introduction

13.1.1 This chapter addresses the likely effects of the Scheme on hydrology, surface water quality, groundwater resources (quantity and quality) and flood risk during the construction and operational phases. The assessment methodology is based upon *DMRB LA 113 Road drainage and the water environment* and *DMRB LA 104 Environmental assessment and monitoring*.

13.1.2 There may be interrelationships related to the potential effects on road drainage and water environment and other disciplines. Therefore, also refer to the following chapters:

a. Chapter 8: Biodiversity

b. Chapter 9: Geology and Soils

c. Chapter 12: Population and Human Health

d. Chapter 14: Climate

13.1.3 A Screening and Scoping level Water Framework Directive (WFD) assessment has been undertaken to support the design development and to support the assessment presented in this chapter. The assessment is presented in Appendix 13-A.

13.1.4 This chapter is also supported by the following figures:

a. Figure 13-1: Watercourses, Flood Zones, and Risk of Flooding.

b. Figure 13-2: Water Framework Directive Waterbody Catchments.

c. Figure 13-3: Bedrock and Superficial Geology.

d. Figure 13-4: Groundwater Vulnerability Classification.

e. Figure 13-5: Non-linear Water bodies Relevant to the Scheme.

f. Figure 13-6: Unnamed Watercourses Referencing.

13.1.5 Preparation of the chapter has been completed in line with the following policy and legislation:

a. *The NPSNN* (Ref 1-7) – particularly paragraphs: 4.36 to 4.47 for climate change; paragraphs 4.48 to 4.46 for pollution control; 5.90 to 5.115 for flood risk; and, 5.220 to 5.231 for water quality and water resources.

b. *The National Planning Policy Framework* (NPPF) (Ref 1-8) – particularly section 14 in relation to flood risk and section16 in relation to the protection of the water environment.

c. *The Planning Practice Guidance* (PPG) (Ref 1-9)

d. *Arun Local Plan 2011-2031* (Ref 1-12) – particularly policies in section 18 (Water)

e. *South Downs Local Plan 2014-2033* (Ref 1-13) – particularly policy SD50 (Sustainable Drainage Systems)

f. *The Water Environment (Water Framework Directive) (England & Wales) Regulations 2017* (Ref 13-1)

g. *The Water Resources Act 1991* as amended (Ref 13-2)

h. *The Water Act 2003* (Ref 9-2) and 2014 (Ref 13-3)

i. *The Land Drainage Act 1991* (Ref 13-4)

j. *The Flood and Water Management Act 2010* (Ref 13-5)

k. *The Groundwater Regulations (England and Wales) 2009* (Ref 13-6)

l. *The Water Resources Act 1991 (Amendment) (England and Wales) Regulations* (Ref 13-7)

m. *The Environmental Permitting (England and Wales) Regulations 2016* (Ref 13-8) – particularly aspects which control flood risk activities, and discharges to surface water and to ground

13.2 Stakeholder engagement

13.2.1 Consultation has been undertaken with several stakeholders, including the Environment Agency, WSCC as the Lead Local Flood Authority (LLFA), Littlehampton Harbour Board, ADC and Southern Water.

13.2.2 This engagement identified that the design of the Scheme should consider the following:

a. Ensure no increase in flood risk from the River Arun and other watercourses, as well as from surface water, groundwater, or other flood risk sources.

b. Ensure adequate flood mitigation is provided where the Scheme is required to cross areas of flood risk, particularly the River Arun floodplain.

c. Manage surface water runoff from the road so as not to increase flood risk elsewhere and not impact on water quality of the receiving water bodies.

d. Avoid the need for culverting watercourses wherever practicable.

e. Ensure the Scheme complies with the requirements of the WFD and associated WFD Regulations including protecting water body status

Ref 13-1 The Water Environment (Water Framework Directive) (England & Wales) Regulations 2017.
Ref 13-2 Water Resource Act 1991
Ref 13-3 Water Act 2014
Ref 13-4 Land Drainage Act 1991
Ref 13-5 The Flood and Water Management Act 2010
Ref 13-6 The Groundwater (England and Wales) Regulations 2009
Ref 13-7 The Water Resource Act 1991 (Amendment)(England and Wales) Regulations 2009,
Ref 13-8 The Environmental Permitting (England and Wales) Regulations 2016

and not preventing future target status from being achieved (see Appendix 13-A).

f. Ensure no unacceptable impact on groundwater flow or quality, particularly through piling or cuttings or where groundwater links to baseflow in watercourses and provides a source of water abstraction.

g. Ensure no unacceptable impact on the hydrology or water quality of surface water bodies including the River Arun (and the linked Arun Valley SAC), Binsted and Tortington Rifes and the network of ordinary watercourses on the River Arun floodplain.

h. Encourage design which offers potential for enhancement of the water environment and reduction in flood risk.

13.2.3 The statutory consultees' responses in the *EIA Scoping Opinion* (Appendix 1-B) also identified the following points:

a. To identify all pond receptors with an impact pathway (connected to aquifers or watercourse the Scheme potentially impacts on); this has been considered within this preliminary assessment.

b. Undertake piling risk assessments for impact on aquifers, and foundations and drainage risk assessments where appropriate.

13.2.4 In the absence of detailed Ground Investigation (GI) data, the potential impact of piling has been considered qualitatively in this preliminary assessment. Preliminary drainage assessments have been undertaken using the Highways England Water Risk Assessment Tool (HEWRAT) where baseline data is available. Full piling risk assessments and drainage risk assessments will be completed for (and reported) in the ES using information obtained from the ongoing GI and water-based survey, the outcomes of which are not expected to alter the conclusions on effect significance presented in this chapter.

13.3 Assessment assumptions and limitations

13.3.1 The water environment assessment is based on the design for the Scheme, as described in *Chapter 2: The Scheme*.

13.3.2 The importance of water environment receptors has been defined using published data sources and data obtained from stakeholders. In addition, where published information is limited, initial information from ongoing surveys and monitoring for key water features has been used. In particular, the Binsted Rife and Tortington Rife are not classified under the WFD and are not routinely monitored for flow or quality. A programme of surveys, including flow gauging, water quality sampling, aquatic ecology monitoring (*Chapter 8: Biodiversity*) and hydromorphological walkovers, has commenced for the rifes and initial survey data collected to date for these watercourses has been used to inform their importance for this assessment. Ongoing surveys will further inform the assessments reported in the ES.

13.3.3 Preliminary hydraulic modelling has been undertaken for the River Arun, Binsted Rife and Tortington Rife in liaison with the Environment Agency to support the Scheme design and development of appropriate flood mitigation. In agreement with the Environment Agency, these models are subject to updates from recent surveys, but the models have been used with precautionary parameters in their preliminary development condition alongside published flood extents for the initial design, and to inform the assessment presented in this chapter. Fully updated models will be used to inform the final design and assessment of flood risk reported in the ES and details of the modelling completed will be included in the Flood Risk Assessment (FRA) accompanying the ES.

13.3.4 Groundwater level data is continuing to be collected as part of the GI and will be included in the ES. Long-term data available from the Environment Agency monitoring boreholes has been used to make a qualitative assessment of groundwater level and quality and potential impacts.

13.3.5 Further site surveys, continuing GI as well as further qualitative and quantitative assessment methods will be undertaken as part of the EIA to inform the water environment assessment to be presented in the ES; this will include updates to the hydraulic models and a formal approval process for the improved models with the Environment Agency.

13.3.6 The information gathered to date is considered sufficient to provide the basis for the preliminary assessment set out in this chapter. Every effort has been made to ensure that the existing data collated to inform the preliminary assessment presents an accurate interpretation of the water environment baseline and the potential interactions with water resource receptors. In discussion with key stakeholders, the information has been used to identify and assess all likely significant effects and presents a precautionary assessment scenario.

13.4 Study area

13.4.1 Based on professional judgement and responses received in the *EIA Scoping Opinion* (Appendix 1-B), the spatial scope of the assessment generally includes features of the water environment within 1 km of the proposed centre line of the Scheme construction. With regard to receptors directly linked to the flow in the River Arun which is crossed by the Scheme (including flood risk effects and receptors of changes in flood risk), the study area has been informed by preliminary hydraulic modelling and is extended to 2 km upstream and downstream of the river crossing location.

13.4.2 The study area is located within the surface water body catchments of the River Arun as well as the Lidsey, Tortington and Binsted Rifes and part of the Chalk groundwater body. This encompasses the proposed areas to be used for Scheme construction and the potential ZoI caused by any dewatering associated with Scheme construction and operation.

13.5 Baseline conditions

13.5.1 A several activities have been undertaken to gather baseline information, including identification of the appropriate study area in respect of the Scheme and consideration of issues raised during ongoing engagement and technical consultations with key stakeholders. A desk study was undertaken (including requesting information from third parties) and a gap analysis of data to identify further data gathering requirements, for example, groundwater level and quality data.

13.5.2 Improvements to existing hydraulic models have been undertaken in consultation with the Environment Agency. These models are being used in their preliminary condition to simulate and update baseline flood risks from watercourses where new structures required for the Scheme would be located within the floodplain, and include the River Arun, Binsted Rife and Tortington Rife.

13.5.3 Hydromorphological site walkovers have been undertaken of the River Arun, several ordinary watercourses on the Arun floodplain, the Binsted Rife, Tortington Rife and a tributary of the Lidsey Rife to inform the baseline condition of these watercourses; further detail is included in Appendix 13-A. Additionally, site walkovers of key areas linked to potential drainage, groundwater impacts and mitigation provision have been completed to aid a visual assessment of the study area and develop an understanding of the hydraulic interactions and hydrology of the water environment.

13.5.4 As part of an ongoing programme of baseline monitoring, water quality samples have been taken and analysed for the Binsted Rife, a tributary of Lidsey Rife and Tortington Rife. Sampling is ongoing and will be used to support assessment of drainage impacts on water quality using HEWRAT and also to establish a WFD baseline condition for these watercourses which are not currently monitored or assessed by the Environment Agency as part of the South East River Basin Management Plan (RBMP); further detail is included in Appendix 13-A.

13.5.5 In addition to water quality sampling, a programme of spot flow gauging is ongoing for the Binsted and Tortington Rifes. This data is being collected to verify estimations of river flow generated from industry standard software such as LowFlows 2 and the Flood Estimation Handbook (FEH). To date, two flow readings have been completed for the Tortington Rife, with water levels too low to allow a measurement in the Binsted Rife.

13.5.6 Further site surveys and flow monitoring will be undertaken, as well as analysis of groundwater levels and quality from the ongoing GI. Data from these monitoring activities will be used to inform the assessment to be reported in the ES.

13.5.7 In addition to the hydraulic modelling and initial monitoring, the desk-based assessment for the baseline water environment included obtaining and reviewing all available information sources. The sources accessed included:

a. Environment Agency datasets in relation to abstractions, discharges, water quality, WFD status elements and future objectives, pollution incidents, groundwater levels, and flood risk

b. LLFA and ADC data sets in relation to ordinary watercourses, drainage features, flooding records, unlicensed private abstractions and boreholes

c. OS mapping

d. Topographic data commissioned for the Scheme

e. British Geological Survey Mapping

f. MAGIC Interactive Mapping (Ref 13-9)

g. Information collated for the previous stages of the Scheme

h. Accessible published literature.

Surface water and road drainage

13.5.8 The study area lies within the South East River Basin Management catchment, as set out within the RBMP (Ref 13-10). Monitoring and assessment of surface waterbodies for their chemical and ecological quality are currently directed by the UK WFD Regulations (Ref 13-1), requiring the physical, ecological and chemical condition of waters to be evaluated, with plans to be put in place to outline any required actions to improve the condition of the water body to an agreed target status. A screening and scoping level WFD assessment has been completed to inform this assessment and is included in Appendix 13-A.

13.5.9 The Scheme is situated on the flat Sussex coastal plain between Chichester and Arundel. The low-lying plain reaches a maximum elevation of approximately 15 m Above Ordnance Datum (AOD) and generally slopes gently towards the coast in the south and towards the River Arun in the east. East of the River Arun, the terrain slopes upwards again reaching an approximate elevation of 30 m AOD at Crossbush. The area is intersected by a number of small streams, known as the Western Streams, which occupy relatively wide valleys that were enlarged at the end of the last Ice Age, as well as the tidal River Arun and surrounding floodplain.

The River Arun

13.5.10 The River Arun rises near Horsham and broadly flows north to south. Near Hardham it is joined by a significant tributary, the River Rother (Western),

Ref 13-9 https://magic.defra.gov.uk/
Ref 13-10 Environment Agency Part 1: South East River Basin District River Basin Management Plan (2015)

which is primarily groundwater fed (Ref 13-11), before carrying on south to the English Channel at Littlehampton. The lower reaches of the River Arun are tidal with the transition from freshwater to saltwater conditions beginning near Pulborough, circa 20 km upstream of the Scheme. River stage data for the River Arun at Arundel demonstrates a 2 to 3 m tidal range.

13.5.11 The River Arun is classified as a statutory main river by the Environment Agency (Figure 13-1). There are also a number of small channels and ditches located within its floodplain which are defined as ordinary watercourses and are not classified under the WFD. These include Warning Camp Ditch, Station Ditch, Brookfield Stream and Tortington Upper Ditch. Many of the ordinary watercourses in the floodplain are not named, hence a naming reference system has been adopted for the Scheme in order to facilitate common reference during design and assessment (Figure 13-6). These watercourses are hydrologically connected to the River Arun and therefore contribute to its water quality.

13.5.12 The River Arun is assessed by the Environment Agency against objectives of the WFD (GB540704105000) and is classified as a heavily modified transitional water body, with its current ecological quality assessed to be 'moderate' and chemical quality assessed to be 'fail' (cycle 2, 2019) (Ref 13-12), with an objective status of 'good' by 2027. It is currently in 'moderate' overall status. The reason for not achieving good status and reasons for deterioration are associated with the river's physical modification.

13.5.13 The River Arun is navigable at the point where the Scheme would cross the river and as far upstream as Stopham Road Bridge (Ref 13-13); therefore, maintaining a navigable channel is a key part of the Scheme assessment.

13.5.14 The Arun water body is associated with WFD protected area status, which specifies that areas requiring special protection under other EC Directives and waters used for the abstraction of drinking water are identified as protected areas. The qualifying feature under this requirement is the Arun Valley SPA and SAC which is located several kilometres upstream of the Scheme.

The Western Streams

13.5.15 The study area is intersected by several streams, with several known locally as rifes (a local term for watercourses draining to tidal waterbodies). Flows in these watercourses tend to be low in the summer and the stream bed gradients are typically low. As they near tidal sources, outflow is prevented during high tides when the water cannot flow out to sea or the tidal source. The headwaters of the rifes tend to rise close to the boundary

Ref 13-11 Environment Agency and NRA. (1996). River Arun Catchment Management Plan – Consultation Report.
Ref 13-12 Environment Agency catchment data explorer
Ref 13-13 Littlehampton Harbour board website

with the Chalk of the South Downs and the more recent Palaeogene deposits and superficial deposits of the coastal plain (Ref 13-14).

13.5.16 None of the Western Streams have been classified under the WFD by the Environment Agency. Two of the watercourses, Binsted and Tortington Rife, are intersected by the Scheme and require new structure to cross the watercourses; a third, Lidsey Rife is also connected to the Scheme via a proposal for discharge of drainage to a tributary of the rife where the western extent of the Scheme would tie back into the existing A27. As described in earlier sections of this chapter, an ongoing programme of survey and monitoring is under way to provide a robust baseline for these watercourse and data collected to date has been used to inform the preliminary assessment reported in this chapter. Full survey outputs will be used to inform further assessment to be reported in the ES.

Tortington Rife and Binsted Rife

13.5.17 Tortington Rife is designated a main river at its channel through Spinningwheel Copse at National Grid Reference 498950, 105990. Binsted Rife is designated a main river at Little Danes Wood at National Grid Reference 497800, 106500 before its confluence with the Tortington Rife (498707,104563). Both watercourses discharge into the River Arun just south of the Ship and Anchor Marina Campsite (Figure 13-1). There are several other unnamed watercourses in the Tortington Rife catchment, which have been given a naming reference for the Scheme (Figure 13-6).

13.5.18 There is a secondary channel (AQ_054) draining a small area of the upper Tortington catchment that runs parallel with the Tortington Rife at the bridge crossing location.

13.5.19 Tortington Rife and Binsted Rife have not been assessed against the objectives of the WFD, as they are not WFD waterbodies. Aquatic ecology surveys and hydromorphological walkovers are in the process of being completed to inform the water environment assessment and will be used to determine an indicative status for these waterbodies.

13.5.20 One set of water quality samples was collected on 1 July 2021 for both watercourses. Physico-chemical status for Binsted Rife and Tortington Rife have been classified using water quality data derived from these samples.

13.5.21 Sampling results collated to date for Binsted Rife show the watercourse is slightly alkaline with a pH of 8.12 and has high total hardness dissolved (as calcium carbonate - $CaCO_3$) of 252 mg/l. In the absence of a WFD classification from the Environment Agency, sampling data collated to date would place the watercourse in the Poor Status band for WFD physico-chemical elements. This classification has been attributed to the high phosphorus levels (103 mg/l). No other physico-chemical elements could be classified due to a lack of data; however, this will be refined as further data is collated and used for assessments to be reported in the ES.

Ref 13-14 Alison Matthews (EA). 2012. Aldingbourne Rife Hydrogeological Investigation: Conceptual Modelling Report (Draft).

13.5.22 The results for Tortington Rife show the watercourse is slightly acidic with a pH of 6.87 and has medium total hardness dissolved (as $CaCO_3$) of 105 mg/l. In the absence of a WFD classification from the Environment Agency, sampling data collated to date would place the watercourse in the Poor Status band for WFD physico-chemical elements. This classification has been attributed to very high phosphorus levels (482 mg/l). No other physico-chemical elements could be classified due to a lack of data.

13.5.23 There is no long-term flow monitoring data available for the Binsted and Tortington Rifes. Limited spot flow gauging was undertaken on the Binsted Rife in the 1970s and early 1980s which found very little flow except during wetter winter periods. A round of flow gauging was attempted as part of the Scheme assessment in July 2021. A flow of 0.0023 m^3/s was recorded for the Tortington Rife, with flow gauging on the Binsted Rife prevented by the shallow depth of water in the channel. Further data will be collated from ongoing surveys and will reported in the ES.

13.5.24 Flow conditions of Binsted Rife are characterised by uniform, slow flow through the lower reach through the golf course. Through the upper reach, flow conditions appear to be more varied, including run-riffle flow biotopes more characteristic of a Chalk stream, likely as a result of the closer proximity to the Chalk bedrock rather than the Lambeth Group and London Clay formation of the study area.

13.5.25 Tortington Rife is unlikely to be fed by Chalk groundwater given the relatively thick layer of Lambeth Group, which is clayey, underlying the water body. Flow conditions in the river reach surveyed in proximity to the crossing point were observed to be uniform and characterised by pooled flow and slow flow velocity.

13.5.26 Where the Scheme crosses these watercourses, Binsted Rife downstream of Binsted and Tortington Rife north of Tortington, they flow through relatively narrow corridors of alluvium (clay, silt, sand and gravel). Towards the downstream extent of Binsted and Tortington Rife, the alluvium meets raised marine deposits, which comprise gravel (shingle), sand, silt and clay, and are present in a wide band across the Arun floodplain. The bedrock geology in this area is clay, with some silts and sands, associated with the London Clay formation.

13.5.27 The bed substrate of Binsted Rife appears to vary throughout the study area. In the reaches more strongly influenced by the predominantly clay bedrock (as the point where the Scheme would cross) appear to be slow flowing with a bed substrate dominated by silts with no observable bedform heterogeneity.

13.5.28 The Tortington Rife riverbed through the study area was not visible during the hydromorphology walkovers or subsequent flow gauging visits due to the depth of water and high suspended sediment concentration but is assumed to be predominantly silt given the pooled flow and low velocities observed. Some evidence of poaching of the channel banks by cattle has been observed, which increases the level of silt delivered to the water body.

13.5.29 Analysis of groundwater contribution to the two rife systems is summarised in the groundwater baseline section of this chapter.

13.5.30 There are no known recreational activity designations for the Western Streams.

13.5.31 The location of surface water features associated with both rifes within the Binsted Wood Complex LWS means the features are likely to contribute to the overall value of this designation.

Lidsey Rife

13.5.32 The extent of works required for the Scheme would intersect the upper catchment of the Lidsey Rife on the Western tie-in end of the Scheme along the alignment of the existing A27, although no new crossing structure is required over the watercourse or any of its tributaries. A discharge of attenuated drainage from the Scheme to the tributary (LID-AQ1010) would be required.

13.5.33 The Lidsey Rife is a WFD water body (GB107041012010) with an overall classification of 'Moderate'. Its current ecological quality is assessed to be 'moderate' and chemical quality assessed to be 'fail' (cycle 2, 2019) (Ref 13-15), whilst it has an objective status of 'good' by 2027.

13.5.34 The water body is failing the chemical element with respect to 'priority hazardous substances'. The reason for not achieving good status and reasons for deterioration are associated with pollution from wastewater, and pollution from towns, cities and transport (Ref 13-8).

13.5.35 There are two permanent gauging stations on the Barnham Rife at Barnham and at Bognor Regis below the confluence of the Lidsey Rife and Aldingbourne Rife. Mean flows are approximately 0.04 m^3/s at Barnham and approximately 0.2 m^3/s at Bognor Regis (Ref 13-7). Flows are generally flashy with a rapid response to rainfall events, increasing flow by more than an order of magnitude above baseflow, with little baseflow in summer.

Black Ditch

13.5.36 The extension of the study area for flood risk effects downstream of the Arun transitional water body includes the confluence of the Black Ditch (West Sussex) WFD water body (GB107041012890) where it meets the River Arun (Figure 13-2).

13.5.37 The Black Ditch has a WFD current overall classification of 'poor', with its current ecological quality assessed to be 'poor' and chemical quality assessed to be 'fail' (cycle 2, 2019) (Ref 13-8), with an objective status of 'good' by 2027. The water body is failing the chemical element with respect to 'priority hazardous substances'. The reason for not achieving good status and reasons for deterioration are associated with the water body physical modification.

Ref 13-15 Environment Agency catchment data explorer

Other watercourses

13.5.38 There are numerous unnamed Ordinary Watercourses/drainage ditches in the Arun floodplain, at elevations below 2 m AOD, which are subject to tidal flows. Hydromorphological walkovers of these watercourses have been conducted. Most of the channels, particularly closer to the River Arun, hold water with the water pooled rather than flowing. Several of the watercourses are controlled with sluices, where flow discharges into the River Arun.

13.5.39 In addition to the rifes and floodplain ditches, two ordinary watercourses are intersected by the Scheme. TORT_AQ052 is intersected by the Scheme at Tortington Lane and TORT_AQ053 close to the Tortington Rife crossing (Figure 13-6).

Lakes, ponds and other non-linear surface water features

13.5.40 There are a number of non-linear surface water features within the study area (such as ponds and reservoirs) which are likely to have hydraulic connectivity to watercourses or aquifers intercepted by the Scheme. Some of these features also have associated groundwater and surface water abstraction licences, supporting mainly agriculture uses in these areas. Summary information relating to these is provided in Table 13-1 and in Figure 13-5.

Table 13-1 Non-linear surface water features within study area (as defined in section 14.4.1) summary table

Water body name	Type	Location	Grid reference	Distance from Scheme (approx.) (km)	Source (fed/water level maintained)
Avisford Golf Club ponds	Pond	West of Binsted, intersects Scheme	497459, 106305	Intercepted by scheme	Surface water drainage and groundwater.
Hazel Plantation	Ponds	South of western tie-in.	496335, 106527	0.17	Surface water, fluvial (LID_AQ101).
Priory Farm (Remains of Augustinian Priory and Ponds)	Pond	North of Scheme, Tortington	500694, 105875	0.25	Likely to be groundwater and/or surface drains.
Back Arun Fishery	Ponds	North of Scheme viaduct crossing	502281, 106486	0.5	Surface water and groundwater.
Manor Farm Reservoirs	Pond	South of Scheme, Ford Road	499925, 104874	0.6	Likely groundwater and surface water. Associated surface water abstraction licence.
Madonna Pond	Pond	North of Tortington rife crossing	499270, 106169	0.7	Likely surface water and groundwater fed.
Walberton Allotment Gardens	Ponds	South of Walberton	497233, 105524	0.8	Likely surface water and groundwater fed.

Water body name	Type	Location	Grid reference	Distance from Scheme (approx.) (km)	Source (fed/water level maintained)
Knucker Hole Ponds	Pond	South of Scheme, River Arun floodplain	502264, 105031	0.93	Groundwater abstraction licence for Fish Farm/Cress Pond throughflow, floodplain drains.
Wicks Farm ponds (Marsh Farm)	Pond	South of Scheme, adjacent to Binsted Rife	498834, 104502	0.95	Likely groundwater and surface water. Groundwater associated surface water abstraction licence.
Westlands Ponds	Pond	East of scheme tie-in to A27	504198, 105690	1	Likely groundwater and surface water.
Choller Farm Fishing Lake	Pond	South of Scheme, east bank of a tributary of the Lidsey Rife	496581, 105471	1.4	Likely surface water drainage.
Walberton Plant nursery ponds	Pond	South of Scheme, Walberton	497496, 104436 & 497132, 104756	1.6	Groundwater abstraction licence for horticultural watering and irrigation. Surface water drains.

Water body name	Type	Location	Grid reference	Distance from Scheme (approx.) (km)	Source (fed/water level maintained)
Chalk Springs Trout Fishery ponds (Park bottom lakes)	Pond	North of viaduct crossing River Arun	500910, 107410	1.72	Groundwater abstraction licence for Fish Farm/Cress Pond throughflow.
Arundel Wetland Centre	Wetland	North of Scheme	502200, 107800	1.8	Groundwater abstraction licence, used for lake and pond through flow, and remedial river/wetland support.
Swanbourne Lake	Lake	North of Scheme, opposite wetlands	501774, 107868	1.9	Groundwater and surface water.

13.5.41 The water quality of these features is not assessed by the Environment Agency under the WFD, and no data set is available to define their baseline quality. Their importance has therefore been inferred from their physical characteristics and surrounding land use.

Abstractions and discharges

13.5.42 There are 26 licensed (Ref 13-16) surface water abstraction points from the River Arun within 1 km of the Scheme. Of the licensed abstractions, 25 are for agriculture (five on the Lidsey Rife, two along the Tortington Rife, and one on the Binsted Rife). The remaining licence is listed as being used for industrial, commercial and public services.

13.5.43 There are 39 licensed discharges to surface water and/or groundwater within 1 km of the Scheme. Of these discharges, 20 are classified as sewage (not water company), seven are sewage (water company), seven are classified as miscellaneous, and five are trade discharges.

Contaminated land

13.5.44 There are three historic landfill sites within the study area containing commercial and household waste, classed as inert by the Environment Agency. Two sites (Day's landfill and Hooe Farm landfill) are within the draft Order Limits along the southern boundary of the existing A27 Arundel Road, at the western extent of the Scheme. Further details on land contamination are provided in *Chapter 9: Geology and Soils*.

Existing highway drainage

13.5.45 At the western extent of the Scheme, surface water runoff from a section of the existing A27 carriageway is drained by a combination of filter pipes and gullies leading to a tributary of the Lidsey Rife (LID_AQ101) via existing outfalls. The remaining section of the existing A27 within the Western tie-in area outfalls into existing deep bore soakaways into the Chalk which would become redundant as part of the Scheme.

13.5.46 At the eastern extent of the Scheme, the surface water runoff from a section of the existing A27 carriageway is drained by a combination of filter pipes and gullies and connected to the existing drainage. The existing drainage then discharges to an ordinary watercourse which is a tributary of the Brookfield Stream to the south of the A27 before flowing west towards the River Arun floodplain.

Groundwater

Bedrock geology

13.5.47 The general area comprises Chalk of the South Downs. The South Downs is split into five key Chalk blocks defined by multiple north-south flowing rivers: the Arun, Adur, Ouse, and Cuckmere (Ref 13-17). The study area is

Ref 13-16 Environment Agency water licences abstraction map (accessed June 2021)
Ref 13-17 Allen et al. (BGS). 1997. The physical properties of major aquifers in England and Wales. British Geological Survey Technical Report WD/97/34. 312pp. Environment Agency R&D Publication 8.

within the Arun Chalk Block with the Tarrant Chalk Member and Newhaven Chalk Formation outcropping to the north of the existing A27. The existing A27 approximates the east west line where Chalk becomes overlain by Lambeth Group deposits.

13.5.48 The Lambeth Group outcrop is approximately 500 m wide north to south along the route of the existing A27. It is a highly variable group of sediments comprising the Upnor Formation, Reading Beds, and Woolwich Formation. It is composed mainly of red, brown, orange, and grey laterally and vertically varying sands, silts, clays and gravels which occur in thicknesses of <25 m to 50 m (Ref 13-18). The sands and clays are often interlaminated and contain variable proportions of partially rounded flint.

13.5.49 The Lambeth Group is overlain by London Clay to the south of the existing A27 and hence it forms the bedrock for the majority of the Scheme alignment, with the exception of the Western tie-in and much of the River Arun floodplain crossing, which are underlain by the Lambeth Group. London Clay is a stiff bluish, bioturbated, silty and fine-grained sandy clay with a high fossil content and interbedded seams of nodules of calcareous cement stone and beds of rounded flint pebbles (Ref 13-19), although weathered outcrops often appear browner in colour. The geology of the study area is described in detail in *Chapter 9: Geology and Soils*. A summary of the bedrock geology is shown in Figure 13-3.

Superficial geology

13.5.50 Towards the coast the bedrock geology is overlain by superficial deposits. The existing A27 and the Scheme in their entirety are underlain by superficial deposits, with the exception of the approach into Arundel from the west, adjacent to the area known as The Waterwoods (Figure 13-3).

13.5.51 The Scheme area is characterised by several Raised Beach Deposits and wave cut platforms associated with periods of higher sea level. There are two pronounced periods of deposition. An upper raised beach is located beneath the current route of the A27 which forms a low ridge at the southern margin of the older raised beach platform between Chichester and Arundel (Ref 13-13), and a lower beach to the south on the lower coastal plain.

13.5.52 The Raised Beach Deposits are separated into three units: raised storm beach deposits comprising gravel; raised beach deposits comprising sand and gravel; and raised marine deposits comprising clay, silt, sand and gravel. The Scheme would pass alongside the southern margins of the raised storm beach deposits near Binsted, raised beach deposits west of Tortington and west of Crossbush, with raised marine deposits across the Arun valley.

Ref 13-18 Entwhisle et al. (BGS). 2013. Engineering Geology of British Rocks and Soils - Lambeth Group. British Geological Survey Open Report, OR/13/006. 316pp.
Ref 13-19 Allen et al. (BGS). 1997. The physical properties of major aquifers in England and Wales. British Geological Survey Technical Report WD/97/34. 312pp. Environment Agency R&D Publication 8.

13.5.53 The older raised beach deposits are primarily marine sands and gravels up to 6 m in thickness while the lower raised beach deposits are generally around 4 m thick calcareous, silty, fine to medium grained sand and contain some flint and Chalk pebbles (Ref 13-20).

13.5.54 Many of the raised beach deposits are covered by head gravel and brickearth, present beneath the existing A27 and along the Scheme west and south east of Binsted. The head gravel is a coarse angular flint gravel in a matrix of sandy, silty, or chalky clay which is thickest along the buried clifflines and becomes thinner and finer grained to the south. The brickearth is typically less than 2 m thick and deposits are non-calcareous silt and clay silt (Ref 13-21).

13.5.55 Other superficial deposits in the area include alluvium in the watercourse valleys. There are also small outcrops of River Terrace Deposits, comprising sand, silt and clay south east and south west of Binsted along the bypass route.

13.5.56 Deposits of alluvium have been mapped along the rife valleys. In general, the deposit is fine-grained and thin, usually between 1 m and 3 m in thickness.

13.5.57 A geological cross-section following the Scheme generated from available borehole logs is presented in Plate 13-1. Until the Scheme GI is available, there are few deep boreholes penetrating the Chalk along the route, so additional existing borehole logs in the area have been used to infer the Chalk depth for the purposes of this chapter.

13.5.58 Either side of the River Arun floodplain, the Scheme is anticipated to be underlain by brickearth, head gravel and raised beach deposits. Superficial deposits are interpreted to thin towards the River Arun floodplain, replaced by deep estuarine alluvial deposits. Borehole logs also indicate that the London Clay is likely to be absent below much of the River Arun floodplain. The depth of the Chalk below much of the Scheme is not known directly, but based on available data is likely to be in excess of 20 m.

Ref 13-20 Alison Matthews (EA). 2012. Aldingbourne Rife Hydrogeological Investigation: Conceptual Modelling Report (Draft)
Ref 13-21 Hopson, P.M. 2010. The geology of the Portsmouth region: a perspective of the Wessex and Hampshire Basins. Pp. 11-23 in Hunger, E. and Walton, G. (Eds.)

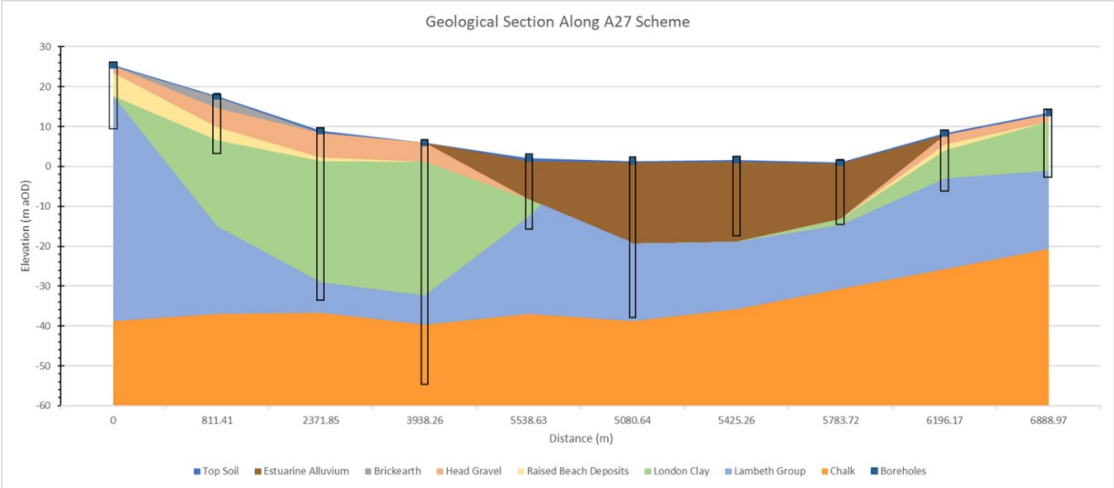

Plate 13-1: Geological section along the Scheme route

Structural geology

13.5.59 The Chichester Syncline (a downward bend in the geology) extends from Worthing to Chichester (Plate 13-2). The Syncline has a strong influence on the geology and the hydrogeology of the area, with the deep infill acting as a barrier to Chalk groundwater flowing south. Groundwater flow discharges at several discrete locations along the Syncline, including at Arundel, Fishbourne Springs and Bedhampton Springs to the west.

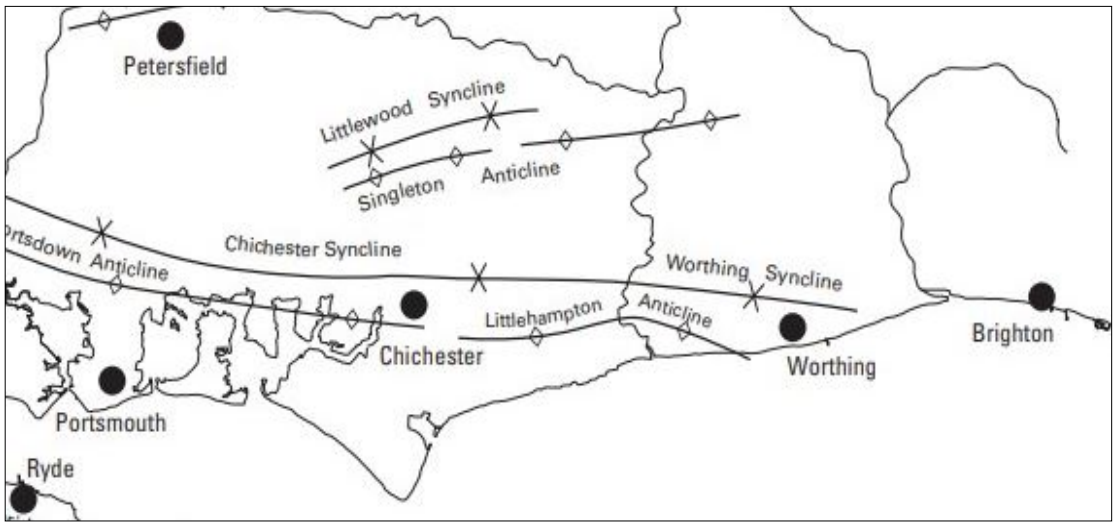

Plate 13-2: Structural geology (Ref 13-14)

Aquifer classification and properties

13.5.60 The Groundsure data details the aquifer vulnerability classifications in the area immediately surrounding the Scheme which identifies aquifer vulnerability to pollution (Figure 13-4).

13.5.61 The majority of the Scheme overlies secondary superficial aquifers, however, the area surrounding the River Arun may be particularly vulnerable. The Chalk aquifer is protected from pollution by the overlying

London Clay across much of the Scheme except in the Arun valley where London Clay is largely absent. Here, alluvium and Lambeth Group overlie the Chalk aquifer.

Chalk

13.5.62 Groundwater flow in the area is typically north to south towards the coast, reflecting the surface topography. Variations in hydraulic conductivity (a measure of how easily water can pass through soil or rock) and geological structures have a marked effect on groundwater flow.

13.5.63 The Chichester Syncline restricts Chalk groundwater flow to the south due to the low hydraulic conductivity of deeply buried Chalk in the Syncline and also the low hydraulic conductivity of the London Clay and Lambeth Group that infill the Syncline. Groundwater flow in the Chalk is largely diverted in an easterly direction towards the River Arun and Swanbourne Lake. However, there is some potential for Chalk groundwater to overtop the Lambeth Group and contribute to flows in the rifes (Plate 13-3).

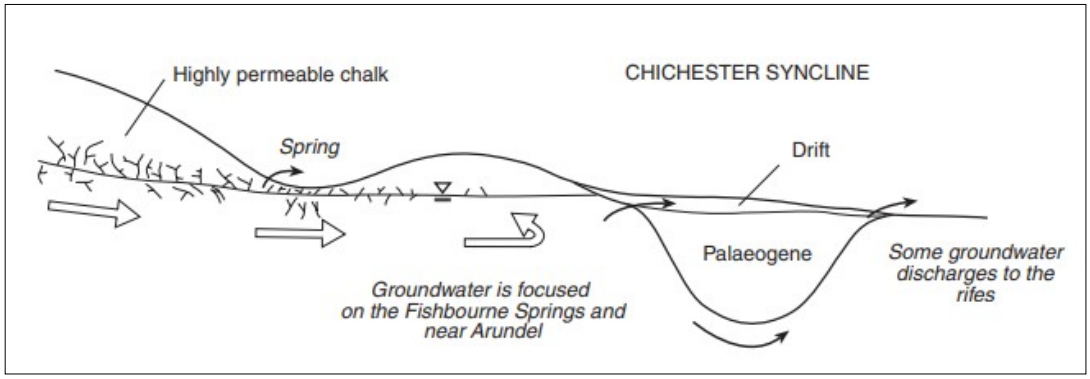

Plate 13-3: Diagram representing the role of the Chichester Syncline in controlling groundwater flow (Ref 13-22)

13.5.64 Available Environment Agency data indicate that under high groundwater level conditions in the Chalk, the levels can reach 14 to 15 m AOD near the heads of the Binsted Rife and Tortington Rife. Ground elevation data (LiDAR) suggest that Chalk groundwater will only directly enter the Binsted Rife during rare periods of exceptionally high groundwater levels, potentially focused on the location of the 'spring' marked on the OS map at Danes Wood. The emergence of Chalk groundwater flow in the Binsted Rife will have occurred perhaps two or three times in the past 20 years. The available data also demonstrates that Chalk groundwater will not contribute to flows in the Tortington Rife. Therefore, flows in the Binsted and Tortington Rife will be dominated by rainfall runoff, with lesser groundwater contributions from the superficial deposit aquifers.

13.5.65 The findings described above agree with a previous Environment Agency study (Ref 13-14) where only rifes further to the west (e.g., Aldingbourne Rife) have the potential to receive more frequent Chalk groundwater flow. Furthermore, the Environment Agency's East Hampshire Chichester Chalk

Ref 13-22 Jones and Robins, 1999

groundwater model (Ref 13-23) predicts no Chalk groundwater contributions to flows in the Binsted Rife and Tortington Rife.

13.5.66 South of the Scheme where Chalk is confined by London Clay and Lambeth Group, groundwater levels are between approximately 5 m AOD and close to sea level across a large area. Over much of this area ground elevation is approximately 5 m AOD, with superficial deposits typically in excess of 4 m thick. Therefore, at high groundwater levels, Chalk groundwater is likely to be discharging into the superficial secondary aquifers.

Lambeth Group

13.5.67 Lambeth Group is designated as a 'Secondary A' aquifer by the Environment Agency and is only capable of supporting water supplies at a local rather than a strategic scale.

13.5.68 Lambeth Group deposits along the A27 and the western parts of the Scheme alignment are dominated by clayey horizons according to available borehole logs (Ref 13-24).

13.5.69 The clayey horizons within the Lambeth Group act to confine the underlying Chalk aquifer, i.e., they hold back the Chalk groundwater, preventing it from rising. They also confine more sandy (aquifer) horizons within the Lambeth Group, where present. Furthermore, where overlain by superficial deposit aquifers, they allow perched water tables to develop.

Superficial Deposits

13.5.70 The majority of the superficial deposits that overlie the bedrock geology between the existing A27, the Scheme alignment and the coast (Head and Brickearth deposits, River Terrace Deposits and Raised Beach Deposits) are also designated as 'Secondary A' aquifers. They are expected to provide local baseflow to the Western Rifes in the study area.

13.5.71 Recharge is anticipated to occur across the superficial deposits. It may vary locally depending on the clay content of alluvium and head deposits.

13.5.72 Groundwater in the superficial deposits is anticipated to flow southward toward the sea, and locally south easterly to south westerly toward the rifes to discharge as baseflow. There are expected to be groundwater flow divides between Binsted and Tortington Rifes, and between Tortington Rife and the River Arun.

13.5.73 There are no groundwater level monitoring sites in the superficial deposits in the study area. Any groundwater encountered during the GI for the Scheme will be used to add detail to the conceptual understanding as reported herein and will be presented in the ES.

Ref 13-23 Amec (2012). East Hampshire and Chichester Chalk Groundwater Model Update and Refinement. Technical Note 28425N133i1 for Environment Agency. October 2012
Ref 13-24 BGS Geoindex

13.5.74 The lack of flow recorded in the rifes in July 2021 indicates that groundwater levels in the superficial aquifers is generally at or below bed level. Therefore, in summer groundwater may flow to the south with limited discharge to the rifes.

13.5.75 Along the Scheme alignment there are ponds associated with the River Terrace Deposits west of Binsted (Avisford Park Golf Club), and along the Binsted and Tortington Rife valleys in alluvium. Ponds at Priory Farm north-east of Tortington are associated with the margins of raised beach and raised marine deposits overlying London Clay.

Groundwater chemistry

13.5.76 Chalk groundwater in the area is dominated by calcium carbonate. The groundwater contains higher sodium concentrations than the groundwater found in inland Chalk areas, indicating the influence of the nearby sea.

13.5.77 Aerobic conditions help to maintain very low concentrations of dissolved iron in the unconfined aquifer, while nitrate concentrations are elevated due to agricultural land uses. In the confined Chalk (beneath the Scheme alignment), reducing conditions exist in the Chalk aquifer leading to higher iron concentrations and no nitrate. The main trace elements found in groundwater are strontium and manganese, with manganese increasing in the confined aquifer under reducing conditions (Ref 13-25).

13.5.78 There is no published information on groundwater quality in the Lambeth Group or superficial deposits in the area. If groundwater is encountered during the GI, samples will be collected and analysed.

13.5.79 Water quality in the rifes can be an indicator of the chemistry of the aquifer providing baseflow. Sampling was undertaken in Binsted Rife at a location approximately 400 m south of Binsted on 1 July 2021 and recorded concentrations of bicarbonate below the range of values in South Downs Chalk groundwater in the study area (208 mg/l compared to 294-345 mg/l in groundwater), while in Tortington Rife (sample taken approximately 400 m north of confluence with Binsted Rife) bicarbonate concentrations were approximately half that of Binsted Rife. Whereas Tortington Rife recorded higher concentrations of manganese than Binsted Rife, manganese concentrations in both rifes are lower than those recorded in Chalk groundwater by an order of magnitude.

13.5.80 These results indicate no significant Chalk influence on surface water chemistry in the rifes.

Abstractions

13.5.81 There are 26 active Environment Agency licensed, and 17 unlicenced (Ref 13-
26) groundwater abstractions located within the study area (1 km from centre line, and 5 k

Ref 13-25 Jones, H K, and Robins, N S (editors). 1999. The Chalk aquifer of the South Downs. Hydrogeological Report Series of the British Geological Survey
Ref 13-26 Arun Environmental Health online services

Seven are licensed for drinking water supply, 18 licensed for agricultural purposes and one for environmental use. Unlicensed abstractions are for volumes below the licensing thresholds and generally used for domestic supply and registered with Arun DC.

13.5.82 The Chalk is the major aquifer in the region in terms of catchment area, storage capacity and yield. The South Downs Chalk Aquifer spans the water supply areas of three water companies. The eastern blocks of the Eastbourne and Seaford Chalk lie within Southern Water's supply area; Portsmouth Water supplies the area surrounding Portsmouth and Chichester; and Southern Water covers the Brighton and Worthing Chalk blocks, the eastern end of the Chichester block, and part of the Seaford block.

13.5.83 Industrial and private water supplies in the area are very small in comparison with public water supply abstractions, with public water supply accounting for between 89% and 97% of total abstractions (Ref 13-27).

13.5.84 Source Protection Zones (SPZ) are designated by the Environment Agency in order to protect significant potable water groundwater abstractions. The zones identify areas which may be at risk of pollution, resulting in contamination of a groundwater source. They are classified into three zones depending on travel time of pollutants and therefore potential risk to the source: the inner zone (or zone 1), the outer zone (or zone 2) and the total catchment (or zone 3). The zones have been determined to represent respectively a 50-day travel time, a 400-day travel time, and the whole groundwater catchment for public water supply and other sensitive groundwater sources.

13.5.85 SPZ1, 2 and 3 intersect the study area to the north and west of the Scheme, around Fontwell (Figure 9-3). The majority of the Scheme alignment does not intersect these zones, with only a small overlap between the outer zone 2 and the western end of the tie-in where the SPZs are confined.

Groundwater – WFD classification

13.5.86 The Chalk aquifer in the study area is designated as a groundwater body under the WFD; 'Chichester Chalk' (GB40701G505200). It is currently in poor status owing to the 'quantitative dependent surface water body status', 'chemical drinking water protected area' and 'general chemical test' tests.

13.5.87 The reasons for the Chichester Chalk not achieving good status and reason for deterioration are associated with agriculture and rural land management (poor nutrient management) and the water industry (pressures from groundwater abstraction). The water body has an objective status of 'good' by 2027.

Ref 13-27 Jones, H.K., and Robins, N.S. (1999). The Chalk aquifer of the South Downs. Hydrogeological Report Series of the British Geological Survey.

13.5.88 The Lambeth Group Formation is also designated as a groundwater body under the WFD; 'Sussex Lambeth Group' (BG40701G505100). It is currently at good status.

Flood risk

13.5.89 In support of the ES and the DCO application, a detailed FRA will be carried out in accordance with the NPSNN, the NPPF and associated PPG. The detailed FRA will provide more detail on how the Scheme will affect flood flows and depths and mitigation requirements. The FRA will be supported by further hydraulic modelling using models approved with the Environment Agency.

13.5.90 A preliminary assessment of baseline flood risk sources and associated flood risk effects related to the Scheme has been undertaken for this stage of the Scheme design.

Surface water flood risk

13.5.91 The Environment Agency surface water flood risk map shows the main overland pluvial flow paths (following saturation) that flow south past the existing A27 and across the Scheme alignment. These flow paths follow the topography within the valleys that make up the headwaters of the western stream watercourses, with some ponding in low lying areas.

13.5.92 The Environment Agency surface water flooding is classified into four flood risk categories:

a. Very Low which has an Annual Exceedance Probability (AEP) of less than 0.1%.

b. Low which has an AEP between 0.1% and 1%.

c. Medium which has an AEP of between 1% and 3.3%.

d. High which has an AEP of greater than 3.3%.

13.5.93 There is surface water flood risk associated with the 1% and 0.1% AEP events in the River Arun floodplain, particularly to the north of the Scheme, on the western side of the river.

13.5.94 The majority of the surface water flood risk in the study area is typically located in the valley bottoms of the Western Streams WFD water body. Here the surface water flow paths are impeded by artificial structures such as road embankments. The majority of the surface water flood risk in these areas is Low, with lesser spatial extents of Medium and High overlapping in these valley regions.

13.5.95 A tributary of the Lidsey Rife (LID_AQ101) is crossed by the existing A27 with the watercourse passing under the road in a culvert. The surface water flood risk data shows an area flooding in the 3.3%, 1% and 0.1% AEP events upstream of the A27 within woodland areas.

Groundwater flood risk

13.5.96 This type of flood risk occurs when receptors are affected by water emerging from the ground rather than by direct rainfall. Persistent groundwater flooding is generally a feature of Chalk upland areas following extreme and prolonged weather events. A very small component of the Western Streams baseflow is derived from the Chalk aquifer and is not anticipated to lead to groundwater flooding in the study area. The River Arun is tidal in the study area. The ADC Level 1 and Level 2 Strategic Flood Risk Assessment (SFRA) (Ref 13-28) does not describe local issues with groundwater flooding in the area.

Fluvial flood risk

13.5.97 The River Arun, Binsted and Tortington Rifes are designated by the Environment Agency as Main Rivers where they are crossed by the Scheme. The Environment Agency's 'Flooding from Rivers' online mapping classifies parts of the study area as Flood Zone 2 or 3 (Ref 13-29) associated with flooding from these river systems, indicating that there are areas at medium or high probability of flooding. Areas in Flood Zone 2 have an indicative AEP of flooding between 0.1% and 1%, and those in Flood Zone 3 an AEP greater than 1%. Where the Scheme would cross the River Arun floodplain, there is an extensive area of Flood Zone 3 which is also tidally influenced (Figure 13-1).

13.5.98 Hydraulic models of the watercourses used to derive Flood Zones have been updated to include more detailed river, structure and land representation and these models continue to be developed as surveys of the study area continue. Updates to the models have been used to provide design support for the Scheme and to inform preliminary assessments of flood risk from fluvial sources, including allowances for climate change (Ref 13-30). Baseline model runs demonstrate that the Flood Zone outlines represent a good estimation of the extent of flooding from these river systems.

13.5.99 The model outputs confirm that, whilst peak flood levels in the River Arun floodplain are dominated by tidal influences, there is also an extensive fluvial floodplain for the River Arun (approximately 1.5 km wide) in the study area. The floodplain for the Tortington Rife at the Scheme crossing point is also relatively wide in comparison to the watercourse catchment. For Binsted Rife, the valley is more incised and the floodplain much narrower as a result.

13.5.100 The River Arun has raised earth embankment defences which provide a variable standard of protection (2% AEP flood event) with a mixture of defence structures providing protection to Arundel to the north of the

Ref 13-28 2016 s3756 - Arun District Council Level 1 and Level 2 SFRA - Final Report (v5 November 2016)
Ref 13-29 Flood map for planning https://environment.data.gov.uk/
Ref 13-30 Flood risk assessments: climate change allowances

Scheme. No formal defences are present along the Binsted or Tortington Rifes.

Tidal Flood Risk

13.5.101 The River Arun is a significantly tidally influenced river, with this influence stretching 20 km upstream of the study area to Pulborough.

13.5.102 The Environment Agency's Flood Map for Planning indicates that there is tidal flood risk associated with the River Arun, Tortington Rife and Binsted Rife.

13.5.103 Tidal influences on fluvial flood levels have been considered in preliminary hydraulic modelling for the River Arun as well as the Binsted and Tortington Rifes (which become tide locked and cannot freely discharge to the River Arun during high tides). Events which are dominated by high tides have also been simulated to understand the depth and extent of tidal flood events in the floodplain. Tidal surge events propagating upstream, wind and wave action could also cause flooding in the study area.

13.5.104 Tidal flood risk has been assessed in the hydraulic model using two events, the 1% AEP fluvial event with a spring/neap tide, and 0.5% AEP tidal with a 50% AEP fluvial event. Both of these events would overtop the existing River Arun flood defences.

Flooding from other sources

13.5.105 Flooding from foul or surface water sewers is possible when rainfall exceeds sewer capacity and/or when sewers are unable to discharge into watercourses due to high water levels. The Scheme is generally remote from areas of significant sewer systems and hence the risk is generally low.

13.5.106 The Environment Agency Risk of Flooding from Reservoir's maximum flood extent mapping indicates that the Scheme is not in an area of reservoir flood risk and risks from this source have been scoped out of the assessment as detailed in the *EIA Scoping Opinion* (Appendix 1-B).

Historic flooding events

13.5.107 From available information, there have been several historic flood events in or near to the study area with surface water and fluvial flooding being the two primary causes.

13.5.108 Previous (2008) and current (2016) SFRAs (combined in Ref 13-31) conclude that previous recorded flood incidents were due to heavy rainfall, saturated ground, high river flows and high tides (but not necessarily in combination) within the study area. These were to the south of Arundel and in the vicinity of Ford Road roundabout in the centre of Arundel.

Ref 13-31 2016s3756 - Arun District Council Level 1 and Level 2 SFRA - Final Report (v5 November 2016)

13.5.109 The source of flooding in the centre of Arundel is identified as fluvial and from sewers following on from high intensity rainfall events in 1974, 2000 and 2012.

13.5.110 Email correspondence received on 17 May 2018 from the Environment Agency confirms that there have been no major recorded fluvial events within the study area in recent years due to the current defences being in place. The Environment Agency stated that the last recorded tidally influenced flood event within the study area was recorded to have taken place in 2014. The 2014 event affected most of the River Arun and Rother catchments (Ref 13-32).

13.5.111 A fluvial flood in September 1968 in Barnham caused several properties to flood and a road to close. The recorded flood level for this event was 5.63 m AOD (Ref 13-23).

13.5.112 As detailed above, significant events of fluvial flooding occurred in 1974/ 1975 and 2000. In the 1975 flood event more than 10 properties in Arundel were flooded. Water levels in the downstream reaches of the River Arun channel were heavily influenced by tide levels (Ref 13-23).

13.5.113 Reported surface water flooding in the Lidsey Catchment occurred in 1993/ 1994, 2009, 2010 and 2012, and have been attributed to a range of sources. These surface water flooding events were a result of a combination of heavy rainfall, high tide and high river levels preventing surface water outfalls from discharging within the Lidsey catchment (Ref 13-23).

13.6 Potential impacts

13.6.1 Prior to implementation of the mitigation, a summary of the potential impacts (both positive and negative) associated with the construction and operation of the Scheme is outlined in the following section. Mitigation measures being incorporated in the design and construction of the Scheme are set out in *Section 13.7*.

Construction – temporary impacts

13.6.2 Prior to mitigation, there are several potential temporary impacts on the water environment and risk of flooding arising from the construction of the Scheme. These are summarised as follows:

a. Risks to the quality of the water environment and related abstractions and discharges due to:

   i. Excavation, and the subsequent deposition of soils, sediment, or other construction materials causing pollution in runoff and infiltration.

   ii. Spillage of fuels or other contaminating liquids causing pollution.

Ref 13-32 Environmental Assessment Report Chapter 13 - Road Drainage and the Water Environment A27 Arundel Bypass – PCF Stage 2

iii. Temporary physical modifications (such as temporary watercourse crossings for haul roads) interrupting the natural passage of surface and sub-surface flow and reducing dilution.

iv. Mobilisation of contaminants following disturbance of contaminated ground or groundwater, or through uncontrolled site runoff.

b. Risks to groundwater (and related abstractions) associated with cuttings and piling construction including:

i. Contamination risk to underlying aquifers.

ii. Temporary dewatering, if required, for diverting water away from cutting working areas, leading to reduced groundwater level.

c. An increase in flood risk arising from activities such as:

i. Construction work temporarily impacting on the function of the floodplain and existing hydraulic processes, particularly during viaduct construction in the River Arun floodplain, and construction works in both the Binsted and Tortington Rife valleys.

ii. Temporary and/or permanent deposition of excavated material impacting on existing flood flow paths or flood storage areas.

iii. During the construction process, operations within the floodplain could result in an increase in flood risk elsewhere due to temporary loss of floodplain storage.

iv. Construction work temporarily and/or permanently impacting the standard of protection provided by existing flood defences (e.g., embankments) in the River Arun floodplain.

Construction – permanent impacts

13.6.3 Prior to mitigation, there are potential permanent impacts arising from the construction (and permanent placement) of elements of the Scheme specific to identified water environment and flood risk receptors across the Study area.

Surface water features

13.6.4 Crossing structures are required over the main rivers of Binsted Rife, Tortington Rife, and River Arun. These structures would be designed as underbridges; however, new structures over watercourses have the potential to impact river flow, river morphology, and the interaction and connectivity of the watercourses with their floodplains which, in turn, can impact on WFD status and objectives and linked water dependent habitats (further assessment of ecological aspects is considered in *Chapter 8: Biodiversity*).

13.6.5 Smaller ordinary watercourses will also be crossed by the scheme where underbridge structures are not possible with the potential to impact river flow, morphology, and biology. These include:

a. unnamed watercourse TORT_AQ054 which would be culverted

b. unnamed watercourse WAL_AQ100 which would be replaced with a new drainage ditch parallel to the proposed alignment

c. unnamed watercourse TORT_AQ052 which would be realigned and culverted through the proposed alignment to maintain downstream continuity

13.6.6 The viaduct over the River Arun valley and its floodplain would pass over several of the floodplain's ditches including the larger Station Ditch and Tortington Upper Ditch. The floodplain ditches have the potential to be impacted by the placement of pier footings or maintenance access track requirements. This may require realignment or culverting of sections of the watercourses with the potential to impact on flow, morphology and biological condition.

13.6.7 The Binsted Wood Complex LWS is located within the study area north of the Scheme alignment and the LWS is hydraulically connected to the Binsted Rife and Tortington Rife. If flow in either watercourse is affected by the Scheme, there is potential to impact on connected habitats within the LWS designation.

13.6.8 Of the identified non-linear surface water features in the study area, three have been identified as hydraulically linked to watercourses or aquifers intercepted by the scheme, and one directly impacted:

a. Avisford Golf Club pond – which would be lost to the Scheme alignment and would need to be replaced.

b. Walberton Allotment Gardens ponds – may be in hydraulic connectivity with the underlying River Terrace Deposits which are intercepted by the Scheme via proposed cutting near Avisford Park, and which could alter groundwater inputs to the ponds.

c. Wicks Farm (Marsh Farm) ponds – connected to the Binsted Rife catchment which has the potential for flow impacts from crossing structures in the rife valley, and which could reduce water supply to the ponds.

d. Manor Farm Reservoirs – which are connected to the Tortington Rife catchment and unnamed watercourse TORT_AQ052 which are crossed by the Scheme and may result in flow impacts, and which could reduce water supply to the reservoirs.

Groundwater and aquifers

13.6.9 Cuttings are required in several locations across the scheme alignment. No cuttings have been identified as likely to reach aquifers associated with bedrock formations (Lambeth Group Secondary A, or Chalk Principal aquifers).

13.6.10 The majority of cutting sections are shallow and would likely be above groundwater levels; however, a deeper section of cutting is required at Avisford Park with the potential to intercept groundwater within the secondary A superficial aquifers associated with the Head and Brickearth

deposits, River Terrace Deposits and Raised Beach Deposits. The cutting has the potential to interrupt groundwater flow where groundwater levels are above the cutting, potentially reducing groundwater levels within the aquifer and interrupting flow paths to surface water bodies.

13.6.11 Piling would be required for the viaduct pier foundations where the Scheme would cross the Arun valley and its floodplain and would extend into the secondary A superficial aquifer associated with the estuarine alluvium as well as the Secondary A aquifer associated with the Lambeth Group bedrock.

13.6.12 Piles have the potential to interrupt groundwater flow, raising water levels upstream of the groundwater flow direction and lowering levels downstream with the potential to alter base flow to the river Arun and the floodplain ditches. They also have the potential create preferential pollution pathways, resulting in water quality impacts on aquifers.

Abstractions and discharges

13.6.13 Of the identified abstractions in the study area, seven abstract from aquifers or watercourses which hydraulic connectivity to elements of the scheme. If surface water or groundwater flow in these systems is affected, there is potential for the abstraction yield or quality of water of these abstractions to be impacted.

13.6.14 Of the identified discharges in the study area, three discharge to watercourses, which are hydraulically connected to elements of the Scheme. If flow in these watercourses is reduced, it could prevent the conditions of the permit for these discharges under the Environmental Permitting Regulations.

Flood Risk

13.6.15 The crossing of the River Arun and its floodplain has the potential to increase flood risk to vulnerable receptors both upstream and downstream of the viaduct. The requirement for piers to be located in the floodplain would reduce floodplain storage, potentially increasing the risk of flooding upstream of the viaduct when defences are overtopped, and also has the potential to affect conveyance of tidal flood flows moving upstream during tidal flooding events which overtop the defences. The proposed crossing structure also has the potential to alter both fluvial and tidal flood conveyance of the river.

13.6.16 The crossings of the Tortington Rife and Binsted Rife would include sections of embankment leading to the underbridge structures located within the floodplains of the watercourses which could reduce floodplain storage, potentially increasing the risk of flooding to upstream vulnerable receptors.

13.6.17 Crossings of other, smaller ordinary watercourses also have the potential to increase flood risk upstream, if proposed structures or realignments reduce the conveyance capacity of the watercourses during times of flood.

13.6.18 The baseline risk of surface water flooding is generally low, with overland surface water flow routes mostly associated with the identified watercourses and their valleys. However, there is potential for some Scheme elements, including realigned roads and landscaping features, to affect overland flow routes associated with surface water flooding, and surface water flooding poses a direct risk to sections of the Scheme that would be in cutting. There is the potential for surface water flood flows to be rerouted or redirected, leading to increases in flood risk elsewhere.

Scheme operation impacts

13.6.19 Potential impacts on the water environment during the Scheme operational phase are focused on impacts from road drainage arising from new discharges in terms of flood risk and the discharge of pollutants, e.g., routine runoff or spillage risk.

13.6.20 The drainage design has been developed to collect (and where required, attenuate) surface water flows from the Scheme following rainfall and requires new discharges to several watercourses including:

a. Unnamed watercourse LID_AQ101 (a tributary to the Lidsey Rife).

b. Binsted Rife.

c. Tortington Rife and tributaries.

d. The River Arun.

e. Unnamed watercourse EAST_AQ015 for the eastern tie-in section of the Scheme.

13.6.21 There is the potential for operational drainage discharges to alter the flow regime of receiving watercourses and to impact upon water quality as a result of pollutants in routine runoff and via spillage risk. This has the potential to impact on linked abstractions, discharges, water dependent habitats and overall WFD compliance of watercourses.

13.7 Design, mitigation and enhancement measures

13.7.1 Water environment, drainage and flood risk constraints have been taken into account during the development of the Scheme design, taking opportunities to avoid and reduce potential impacts where these have been identified for specific receptors as set out in *Section 13.6*.

13.7.2 Opportunities have been taken, where possible, to avoid identified hydrological, hydrogeological, hydromorphological and flood risk constraints. The extent of the draft Order Limits allows for refinement of the Scheme to take place, once further design is completed, and when additional survey data has been collected. This will provide flexibility to reduce possible adverse impacts as part of the design development process.

13.7.3 Mitigation of potentially significant adverse environmental effects is an iterative part of the Scheme's design development following the hierarchy

as outlined in *Chapter 4: Environmental Assessment Methodology*: avoidance; reduction; compensation/remediation and enhancement.

13.7.4 The following opportunities to avoid or mitigate impacts by influencing the Scheme's design have been realised to date:

a. The Scheme will cross the River Arun floodplain on a viaduct spanning the simulated extent of the 1 % AEP fluvial event with an allowance for climate change, minimising the loss of floodplain storage compared to embankment options considered in previous stages and minimising impacts on floodplain flow conveyance, thereby reducing flood risks to third party land and property.

b. Designing the River Arun floodplain crossing as a viaduct prevents the need for long culverts for the ordinary watercourses in the River Arun floodplain, including Station Ditch and Tortington Upper Ditch, minimising impacts on surface water flows, hydromorphology and biological quality of the watercourses.

c. Given the nature of the expansive floodplain superficial alluvial deposits, designing the River Arun floodplain crossing as a viaduct reduces the number of piles required compared to an embankment structure, thus reducing the risk of potential impacts on groundwater flow in the underlying superficial aquifers.

d. The River Arun crossing has been designed as a clear span structure with no built structures in the river. This minimises impacts on river flow, quality, hydromorphology and navigation. In addition, a viaduct structure prevents an impact pathway in relation to the risk of changes in the fluvial/tidal interface at the upstream River Arun SAC as identified in the *EIA Scoping Opinion* (Appendix 1-B).

e. The Binsted Rife and Tortington Rife will be crossed by clear span underbridge structures, avoiding the need for culverts and reducing impacts on flow, water quality and hydromorphology. The underbridge structures have been designed with adequate horizontal clearance for maintenance and to maintain a riparian zone along the watercourses.

f. Preliminary hydraulic modelling using precautionary parameters has been used to develop appropriate flood risk mitigation for structures in the floodplain, including floodplain storage compensation for viaduct piers in the River Arun floodplain, and floodplain storage compensation and flood relief culverts for structures in the Tortington Rife floodplain.

g. The length of Binsted Rife crossed by the Scheme has been minimised through the proposed realignment of the rife through a skewed underbridge structure with retaining walls, which also allows ecology, landscape and visual mitigation to be realised.

h. The drainage design has been developed to ensure that runoff from the Scheme will be attenuated to existing greenfield runoff rates via Sustainable Drainage Systems (SuDS), using the hierarchy of preferred SuDS as set out by the LLFA. As such, there will be no increase in

runoff rates compared to the baseline and there will be no increase in surface water or fluvial flood risk.

i. The management of surface water runoff from the road will be based on good practice embodied in the DMRB and will include provision of appropriate measures for treatment to mitigate pollution risks. Preliminary assessment of water quality impacts has been undertaken using HEWRAT for the current Scheme design and used to inform the size and location of treatment and attenuation ponds proposed for the drainage design. This will minimise any impacts on the quality of surface water and groundwater. In addition, there is likely to be a reduction in pollution risk from the drainage of the existing A27 alignment through reduced traffic flowing on the existing road.

j. Transfer of drainage flow between natural hydrological catchments has been minimised through development of a drainage design which reflects current hydrological catchments.

k. Smaller ordinary watercourses intercepted by the Scheme will maintain their hydraulic connectivity downstream through minor realignment where required and the use of culverts where necessary.

l. Land drainage ditches will be provided along cuttings and embankments to intercept substantial overland flow paths transferring water to the nearest watercourse within the overall catchment, reducing the risk of surface flood risk to the Scheme and elsewhere.

m. Watercourses and ponds lost to the Scheme alignment will be replaced (see *Chapter 8: Biodiversity* for details on replacement ponds).

n. Any groundwater intercepted by the cutting near Avisford Park within the superficial aquifer would be collected in the cutting drainage and attenuated before discharging to the Binsted Rife.

13.7.5 The first iteration EMP will be included as part of the ES submitted with the DCO application. The first iteration EMP will confirm the mitigation measures needed to protect the water environment during construction activities. The first iteration EMP and associated measures will be secured through the DCO through a requirement for approval from the relevant risk management authority prior to construction of certain works. Standard control measures within the first iteration EMP, which would mitigate and avoid, as far as practicable, temporary construction phase effects will include:

a. Works will be undertaken in accordance with Government planning practice, water-land management guidance, the principles of the non-statutory technical standards for SuDS and the DMRB.

b. Bunding of areas which may generate contaminated water.

c. If dewatering is required for cutting construction, the extent will be minimised where practicable.

d. Water used in construction processes will be treated to relevant required standards at the time prior to discharge to any watercourse.

e. Controlling and appropriately managing polluted surface water runoff from construction and compound areas and ensuring no direct discharges of polluted surface water to groundwater during construction.

f. Tests will be undertaken to ensure contaminated material is identified, isolated and reworked or removed to appropriate landfill or treated to avoid any leachate problems.

g. Floodplain working areas will be minimised as far as practicable, including using the sequential approach to the selection and use of construction compounds and providing temporary flood compensation where required.

13.7.6 Routine maintenance measures to mitigate potential operational phase impacts would include:

a. Pollution treatment measures such as settlement via attenuation storage incorporated into the drainage design where a risk of pollution has been identified.

b. Maintenance of drainage features to be undertaken in line with an operational management plan that will include training of personnel, frequency of inspections, maintenance and replacement of drainage systems.

c. Drains will be designed in such a way to ensure no loss of habitat or flood conveyance, and where practicable to enhance biodiversity, geomorphology and flood storage.

d. Any discharge of drained groundwater from cuttings will be balanced alongside drainage from the road and attenuated before discharge to surface water.

13.8 Assessment of effects

13.8.1 Potential water environment effects have been assessed following consideration of the potential impacts outlined in *Section 13.6* and the mitigation options detailed in *Section 13.7*, reflecting the development of the Scheme design to date.

13.8.2 Through the effective implementation of the measures detailed in the first iteration EMP, which would be secured through the DCO, no likely adverse temporary significant effects upon the water environment are anticipated during the construction phase.

13.8.3 Outcomes of the preliminary assessment for permanent construction effects and operational effects are detailed in Table 13-2 and a summary of the main effects provided in the subsequent section.

Summary of effects

13.8.4 The selection of a viaduct structure over the River Arun floodplain, coupled with provision of floodplain storage compensation for the piers, will manage both floodplain storage and flood conveyance, ensuring that changes in flood level as a result of the Scheme are negligible, and resulting in no likely adverse significant flooding effects on vulnerable flood risk receptors.

13.8.5 Floodplain storage compensation and provision of flood relief culverts for the Tortington Rife crossing structure will ensure that changes in flood level are localised and will not affect sensitive receptors, resulting in no likely adverse significant flood effects.

13.8.6 Providing wide spans of the crossings for Binsted Rife and Tortington Rife, as well as the realignment of the Binsted Rife and provision of floodplain connectivity and habitat in both valleys will ensure impacts on these receptors are negligible, with no likely adverse significant effect. There is some potential for a slight beneficial effect, subject to further design review and assessment.

13.8.7 The drainage design incorporates storage of surface water runoff through SuDS for both attenuation purposes (to reduce runoff rates and flood risk) and a degree of treatment via settlement. This will ensure that there is no increase in flood risk and that water quality effects from operational road runoff are not significant.

13.8.8 The cuttings assessments indicate that groundwater levels in the Lambeth Group deposits and superficial deposits that are directly underlying the rifes are likely to be below the cutting depth in most cases and hence groundwater is unlikely to be intercepted, with negligible impacts on groundwater flow, principal aquifers, associated abstraction and hydraulically connected surface water features. Groundwater is anticipated to be intercepted in superficial deposits at higher elevations which may contribute water resources via leakage to deeper deposits supporting rife flows. These contributions are not anticipated to be significant and are considered a minor adverse impact. Therefore, no likely significant adverse groundwater effects are predicted.

13.8.9 With the incorporation of mitigation measures identified, the WFD Scoping and Screening assessment (Appendix 13-A) completed to support this assessment has not identified any WFD compliance risk for the current stage of project design. Further assessment will be completed as the further survey information is collated and design develops and will be reported in the ES.

13.8.10 In summary, with the implementation of the first iteration EMP during the construction phase, and the integration of the embedded mitigation outlined within this chapter and *Chapter 2: The Scheme*, no likely significant adverse effects associated with the water environment, flood risk and road drainage are anticipated.

Further mitigation development

13.8.11 The following measures are relevant to further mitigate potential permanent impacts arising from the construction of the Scheme and will be considered as the design develops, and reported within the ES:

a. The orientation of the Arun Valley Viaduct piers will be placed to minimise hydromorphological impacts on the floodplain ordinary watercourses and ditches.

b. Opportunities to provide watercourse and floodplain connectivity enhancement will be sought for the Binsted Rife and Tortington Rife crossings and the Tortington Rife floodplain storage compensation area.

c. The Binsted Rife realignment will seek to introduce hydraulic variability to the channel and improve floodplain connectivity to create opportunities for instream and riparian habitat creation and enhancement.

d. Risk assessments will be undertaken to assess and develop mitigation for potential impacts from construction of the viaduct piers and cuttings and will be reported in the ES.

13.9 Scheme options

13.9.1 As described in *Chapter 2: The Scheme*, options are still being considered for the potential reprovision of Avisford Park Golf Club. In addition, a potential alternative option from the current proposed alignment where the Scheme passes between Avisford Park, the new housing development at Avisford Grange and the existing Yapton Lane is being considered. This would raise the vertical alignment of the Scheme, with an offline Yapton Lane overbridge. The sections below discuss these in turn and outline whether adopting either of these would change anything stated in the preceding baseline conditions, potential impacts and assessment of effects sections and consider the potential for different effects of the options.

Options for Avisford Park Golf Club reprovision

Option 1: 9 hole golf course with driving range or practice facilities

13.9.2 The reprovision of an amended golf course is unlikely to result in any changes to the information already provided in the baseline conditions, potential impacts and assessment of effects sections of this chapter. It does not represent a material change in land use. The first iteration EMP will also confirm the mitigation measures needed to protect the water environment during construction activities and the amended golf course would be designed such that no likely significant adverse effects associated with the water environment, flood risk and drainage are anticipated. Therefore, the preliminary conclusions in terms of the potential for likely significant effects remains the same.

Option 2: Replacement 18 hole golf course

13.9.3 Full reprovision of the existing golf course would not result in any changes to the information already provided in the baseline conditions, potential impacts and assessment of effects sections of this chapter. It does represent an increased level of development and a change in land use from agricultural fields to a golf course. However, the golf course and associated drainage would be designed and profiled such that there would be no material change in surface water runoff rates or volumes compared to current land use and hence no likely significant adverse effects associated with the water environment, flood risk and drainage are anticipated. As with Option 1, the first iteration EMP will also confirm the mitigation measures needed to protect the water environment during construction activities. Therefore, the preliminary conclusions in terms of the potential for likely significant effects remains the same and there is no discernible difference in terms of effects between Option 1 and Option 2 at this stage.

Option for raised vertical alignment with offline Yapton Lane overbridge

13.9.4 Raising the vertical alignment of the Scheme through Avisford Park has the potential to reduce the extent to which groundwater may be intercepted in the Secondary A Aquifer associated with the River Terrace Deposits compared to the current proposed alignment of the Scheme assessed and reported above. This would reduce the impact magnitude on groundwater levels and rife flow contribution to negligible, resulting in a slight adverse effect which is not significant. Therefore, the offline option is likely to be the better option.

Table 13-2 Preliminary assessment of potential effects (construction Permanent and Operation)

Receptor (Importance)	Scheme element	Potential significant effects	Design/mitigation measures (Impact magnitude after mitigation)	Effect
Construction - Permanent				
River Arun (Very High)	Crossing structure	Reduced river flow conveyance. Impact on tidal/fluvial interface. Channel morphology changes. Reduced connectivity with floodplain. Impact on navigation through structure.	Clear span underbridge structure with no construction in the channel and no impact on tidal/fluvial interface. Current channel connectivity to the floodplain is restricted by flood defence earth embankments; the proposed structure would not change this baseline position. Vertical distance between Mean High Water Springs (MHWS) level and soffit of underbridge would provide minimum clearance required for navigation. (No change)	Neutral (not significant)
	Piles for Viaduct Pier foundation	The Viaduct crossing of the River Arun floodplain would require piles for the foundation of the viaduct piers. Potential for the piers to impact on groundwater flows and levels in the Secondary A superficial aquifer connected to the River Arun.	Pier numbers minimised where practicable – viaduct selected over embankment which would require more frequent shallower piling due to floodplain deposit stability. Lateral and vertical extent of the superficial aquifer is very large in contrast to piles. Any change will be very localised and would be unlikely to affect regional flow toward the river.	Slight adverse (not significant)

Receptor (Importance)	Scheme element	Potential significant effects	Design/mitigation measures (Impact magnitude after mitigation)	Effect
			(Negligible)	
Binsted Rife (Medium)	Crossing structure	Reduced river flow conveyance, channel morphology changes, reduced connectivity with floodplain.	Clear span underbridge structure with no construction in the channel. Clearance either site of the watercourse through the structure to provide maintenance access and riparian connectivity. Watercourse realigned through the structure to minimise length of watercourse covered by underbridge and provide morphological diversity. (Negligible)	Neutral (not significant)
Binsted Rife (Medium)	Watercourse realignment	Reduced river flow conveyance, channel morphology changes, reduced connectivity with floodplain.	Watercourse realignment designed to minimise increase in length and provide some sinuosity with potential for two stage channel to increase bed substrate and habitat diversity. (Minor beneficial)	Slight beneficial (not significant)
Tortington Rife (Medium)	Crossing Structure	Reduced river flow conveyance, channel morphology changes, reduced connectivity with floodplain.	Clear span underbridge structure with no construction in the channel. Clearance either site of the watercourse through the structure to provide maintenance access and riparian connectivity. (Negligible)	Neutral (not significant)

Receptor (Importance)	Scheme element	Potential significant effects	Design/mitigation measures (Impact magnitude after mitigation)	Effect
Unnamed watercourse: WAL_AQ100 (Low)	Cutting	The cutting would remove the feature.	The ditch is not connected to a river network and has been created for land drainage purposes and incorporated into the site drainage. A replacement drainage channel would be provided along the edge of the cutting to provide the same drainage function as the lost feature with the potential for the provision of swales. (Moderate Adverse)	Slight adverse (not significant)
Unnamed watercourse: TORT_AQ054 (Low)	Tortington Embankment	Reduced river flow conveyance, channel morphology changes, reduced connectivity with floodplain.	Watercourse is an artificial drainage feature with no associated floodplain. Watercourse alignment and downstream connectivity will be maintained through the embankment via a culvert. Culvert will be designed with lower invert level to encourage natural bed substrate. Culvert designed to convey flood flows so no change in usual flow range conveyance. (Moderate Adverse)	Slight adverse (not significant)
Unnamed watercourse: TORT_AQ052	Cutting near Tortington Lane	Reduced river flow conveyance, channel morphology changes, reduced connectivity with floodplain.	Watercourse would be realigned around the diverted Tortington Lane overbridge, culverted under the Scheme alignment and reconnected south of the Scheme near Tortington Lane to	Slight adverse (not significant)

Receptor (Importance)	Scheme element	Potential significant effects	Design/mitigation measures (Impact magnitude after mitigation)	Effect
(Low)			maintain continuity. A small section of the catchment between Tortington Lane realignment and the Scheme alignment would be diverted into cutting drainage and lost to the watercourse. Watercourse length would be increased. Culvert will be designed with lower invert level to encourage natural bed substrate. Culvert designed to convey flood flows so no change in usual flow range conveyance. (Moderate Adverse)	
Floodplain ditches (Low)	Viaduct Pier placement and Potential maintenance access road	Reduced river flow conveyance, channel morphology changes.	Pier placement will seek to avoid watercourses where practicable. Minor realignments would be constructed for affected watercourses. Permanent culverts required over watercourses for access track designed to convey flood flows so no change in usual flow range conveyance. (Minor Adverse)	Slight adverse (not significant)
Binsted Wood Complex LWS	Binsted and Tortington Rife crossing structures	The LWS is in hydraulic connectivity with the Binsted Rife, Tortington Rife and tributaries of the Tortington Rife. Changes in the	The LWS is located upstream of the crossing structure. The proposed underbridge structures over the rifes will not affect flow conveyance and flood	Neutral (not significant)

Receptor (Importance)	Scheme element	Potential significant effects	Design/mitigation measures (Impact magnitude after mitigation)	Effect
(Moderate)		flow regime due to crossing structures could impact on connected habitat.	mitigation would limit upstream effects during infrequent flood scenarios. No hydraulic pathway to LWS has been identified with current design solution and mitigation. (No change)	
Avisford Golf Club Pond (Low)	Cutting	The cutting would remove the feature.	The ponds would be replaced in proximity to the proposed cutting. (Moderate Adverse)	Slight adverse (not significant)
Walberton Allotment Gardens ponds (Low)	Cutting	Feature may be in hydraulic connectivity with the underlying River Terrace Deposits which are intercepted by the Scheme via cutting at Avisford Park and which could alter groundwater inputs to the ponds.	The ponds are fed by surface water flow and unlikely to receive significant groundwater input. Cutting unlikely to intercept large volumes of groundwater in superficial aquifer (Moderate Adverse)	Slight adverse (not significant)
Wicks Farm (Marsh Farm) ponds (Medium)	Binsted Rife crossing	Feature connected to the Binsted Rife catchment and could be affected by flow changes	Clear span underbridge structure with no constriction in the channel and no alteration in flow regime. (No change)	Neutral (not significant)

Receptor (Importance)	Scheme element	Potential significant effects	Design/mitigation measures (Impact magnitude after mitigation)	Effect
Manor Farm Reservoirs (Medium)	Tortington Rife and TORT_AQ052 crossing	Feature connected to watercourses and could be affected by flow changes	Clear span underbridge structure over Tortington Rife and downstream connectivity of TORT_AQ052. Small potential for reduction in flow in TORT_AQ05 (Minor Adverse)	Slight adverse (not significant)
Secondary A aquifers: superficial deposits (Medium)	Cutting	The initial cuttings assessments indicate that groundwater levels in the Lambeth Group deposits and superficial deposits that are directly underlying the rifes are likely to be below cutting depths in most cases and hence groundwater is unlikely to be intercepted, with negligible impacts on groundwater flow. Groundwater is anticipated to be intercepted in superficial deposits for the deeper cutting near Avisford Park affecting groundwater levels in the aquifer and connected systems.	Any intercepted groundwater may contribute water resources via leakage to deeper deposits supporting rife flows. These contributions are not anticipated to be significant and impact on the contributions is considered a minor adverse impact. (Minor Adverse)	Slight adverse (not significant)
Secondary A aquifer: superficial deposits –	Viaduct Piers	Piling would be required for the viaduct pier foundations where the Scheme would cross the Arun valley and its floodplain and would	Number of piers minimised where practicable – viaduct selected over embankment which would	Neutral (not significant)

Receptor (Importance)	Scheme element	Potential significant effects	Design/mitigation measures (Impact magnitude after mitigation)	Effect
Estuarine Alluvuim (Medium)		extend into the secondary A superficial aquifer associated with the Estuarine Alluvium. This could impact groundwater levels and create preferential pathways for pollution.	require more frequent shallower piling due to floodplain deposit stability. Lateral and vertical extent of the aquifers is very large in contrast to piles. Any change in groundwater level would likely be very localised and would be unlikely to affect groundwater levels beyond the pile structure. Piling methods would be selected to minimise creation of pollution pathways and will be subject to detailed risk assessment as part of the ES. (Negligible)	
Secondary A aquifer: Lambeth Group bedrock (Medium)	Viaduct Piers			
Abstractions and discharges (Low to Moderate)	Cuttings and river crossings	Changes in watercourse flow regimes or regional groundwater flow affecting abstraction yield or quality for watercourses connecting the scheme and abstractions/discharges.	No material changes to watercourse or groundwater flow regimes have been identified for watercourses with abstractions or discharges identified in the study area. (No change)	Neutral (not significant)
Essential Infrastructure (rail line) and Highly Vulnerable development	Fluvial and tidal flood risk from Arun river crossing and viaduct in the floodplain	The crossing of the River Arun and its floodplain has the potential to increase flood risk to vulnerable receptors both upstream and downstream of the viaduct. The requirement for piers to be located	Selection of viaduct over embankment through the Arun Valley floodplain. Clear span structure over the river not impacting on channel flow conveyance.	Slight adverse (not significant)

Receptor (Importance)	Scheme element	Potential significant effects	Design/mitigation measures (Impact magnitude after mitigation)	Effect
(Very High)		in the floodplain would reduce floodplain storage, potentially increasing the risk of flooding upstream of the viaduct when defences are overtopped, and also has the potential to affect conveyance of tidal flood flows moving upstream during tidal flooding events which overtop the defences. The proposed crossing structure also has the potential to alter both fluvial and tidal flood conveyance of the river.	No changes to flood defence standard of protection. Road level set above maximum design flood event (fluvial and tidal) flood level (with an allowance for climate change). Floodplain compensation storage provided for floodplain volume lost due to piers within the fluvial design event extent (with an allowance for climate change). With mitigation, preliminary hydraulic modelling shows no material change in water level for design fluvial flood event (Negligible)	
Less Vulnerable development: farmland (Medium)	Fluvial flood risk from Tortington Rife crossing	The crossings of the Tortington Rife would include sections of embankment leading to the underbridge structure. This crossing would be located within the floodplain of the watercourse which could reduce floodplain storage, potentially increasing the risk of flooding to upstream vulnerable receptors.	Clear span structure over the rife not impacting on channel flow conveyance. Floodplain compensation storage provided for floodplain volume lost due to embankment within the fluvial design event extent (with an allowance for climate change). Flood relief culverts provided through Tortington Rife embankment. With mitigation, preliminary hydraulic modelling shows small increase in the floodplain upstream of crossing used for agriculture. No change in	Slight adverse (not significant)

Receptor (Importance)	Scheme element	Potential significant effects	Design/mitigation measures (Impact magnitude after mitigation)	Effect
			the extent of floodplain and no material change in flood depth for other receptors has been identified (Minor Adverse)	
Less Vulnerable development: farmland and golf course (Medium)	Fluvial flood risk from Binsted Rife crossing	The crossings of the Binsted Rife would include sections of embankment leading to the underbridge structure This crossing would be located in close proximity to the floodplain of the watercourses which could affect flood flow conveyance.	Clear span structure over the rife not impacting on channel flow conveyance and limiting impact on existing flood extent Realigned watercourse to increase connectivity with floodplain. With mitigation, preliminary hydraulic modelling shows no material change in flood depth for receptors. (Negligible)	Slight adverse (not significant)
More Vulnerable development: dwellings (High)	Surface water flood risk from Scheme elements affecting overland flow routes	The baseline risk of surface water flooding is generally low, with overland surface water flow routes mostly associated with the identified watercourses and their valleys. However, there is potential for some Scheme elements, including realigned roads and landscaping features, to affect overland flow routes associated with surface water	All embankments and cuttings with overland flow paths will have drainage ditches and or swales to intercept overland flow paths and direct water to the nearest watercourse within the hydrological catchment. No material areas of simulated surface water ponding or overland flow paths are impacted by scheme elements. No changes in surface water flood risk are anticipated.	Slight adverse (not significant)

Receptor (Importance)	Scheme element	Potential significant effects	Design/mitigation measures (Impact magnitude after mitigation)	Effect
		flooding. There is the potential for surface water flood flows to be rerouted or redirected leading to increases in flood risk elsewhere.	(Negligible)	
	Fluvial or surface water flood risk from crossing of ordinary watercourses	Crossings over smaller ordinary watercourses (TORT_AQ54 and TORT_AQ52) have the potential increase flood risk upstream if proposed structures or realignments reduce the conveyance capacity of the watercourses during times of flood	Culverts will be designed to convey the fluvial design event flood flow with an allowance for climate change. (Negligible)	Slight adverse (not significant)
Operational Effects				
Unnamed watercourse: LID_AQ101 Binsted Rife Tortington Rife (Medium)	Drainage Discharge	Increase in rate of discharge, volume of flow (catchment transfer) and pollution risk (routine runoff and spillage risk)	All road runoff from the Scheme (including realigned roads) discharging to fluvial watercourse will be attenuated to greenfield runoff rates via SuDS, including a mixture of swales and attenuation ponds, providing runoff rate reduction and treatment via settlement. No material changes in catchment flows/transfers.	Slight adverse (not significant)
Unnamed watercourse			Preliminary HEWRAT assessment has demonstrated no likely failures of water quality	Neutral

Receptor (Importance)	Scheme element	Potential significant effects	Design/mitigation measures (Impact magnitude after mitigation)	Effect
EAST_AQ015 (Low)			standards for proposed discharge locations and catchments. (Negligible)	(not significant)
River Arun (Very High)	Drainage Discharge (Viaduct)	Increase in rate of discharge, volume of flow (catchment transfer) and pollution risk (routine runoff and spillage risk)	Rainfall falling on the viaduct and drained from the structure would be discharged to a treatment pond with direct discharge to the tidal River Arun. Attenuation is not required for discharge to a tidal water body and the pond is provided for treatment purposes. No catchment transfer as viaduct captures rainfall that would otherwise fall directly onto the Arun floodplain. Preliminary HEWRAT assessment has demonstrated no failures of water quality standards for proposed discharge with mitigation in place.(Negligible)	Slight adverse (not significant)

14. Climate

14.1 Introduction

14.1.1 This chapter of the PEI Report introduces the potential impacts on climate as a result of the Scheme and the impacts of future climate change on the resilience of the Scheme.

14.1.2 There may be interrelationships between the outputs of this climate chapter and other disciplines. Reference should also be made in particular to the following chapters:

a. Chapter 5: Air Quality

b. Chapter 10: Material Assets and Waste

c. Chapter 13: Road Drainage and the Water Environment

14.1.3 A review of all relevant legislation, policy and guidance has been completed and is presented in the *EIA Scoping Report* (Appendix 1-A); it is also included below for reference.

a. *Climate Change Act 2008* (Ref 14-1)

b. The Climate *Change Act 2008 (2050 Target Amendment) Order 2019* (Ref 14-2)

c. *NPSNN* (Ref 1-7)

d. *The Waste Framework Directive* (Ref 14-3)

e. *Carbon Budget Orders (2009-2022)* (Ref 14-4)

f. *England Biodiversity Strategy (2011)* (Ref 14-5)

g. *NPPF* (Ref 1-8) and associated *PPG* (Ref 1-9)

h. *West Sussex Transport Plan 2011-2026* (Ref 1-11)

i. *Arun District Local Plan 2011-2031* (Ref 1-12)

j. *South Downs Local Plan 2014-2022 adopted 2 July 2019* (Ref 1-13)

k. SDNP Authority Position Statement on A27 route corridor (2017) (Ref 14-6)

l. West Sussex Plan 2017- 2022 (Ref 1-10).

Ref 14-1 UK Climate Change Act (2008), Chapter 27 Targeting and Budgeting
Ref 14-2 H.M. Government, (2008); Climate Change Act 2008 (2050 Target Amendment) Order 2019
Ref 14-3 HM Treasury, The Infrastructure Planning (Environmental Impact Assessment) Regulations (2017)
Ref 14-4 Climate Change (2009) The Carbon Budgets Order No.1259
Ref 14-5 DEFRA, Biodiversity 2020: A strategy for England's wildlife and ecosystem
Ref 14-6 South Downs National Park Authority, 2019. South Downs National Park Authority Position Statement on A27 corridor.

14.1.4 To align with the requirements of the *EIA Regulations* and *DMRB LA 114 Climate* (Ref 14-7), consideration of climate impacts is divided into two aspects:

a. Impact of the Scheme on climate (greenhouse gas (GHG) emissions), which considers the impact on the climate of GHG emissions arising from the Scheme during its lifetime, including how it would affect the ability of Government to meet its carbon reduction targets.

b. Vulnerability of the Scheme to climate change, which considers the resilience of the Scheme to climate change impacts, including how the Scheme design will take account of the projected impacts of climate change.

14.1.5 As set out in the EIA Scoping Report, GHG emissions from the end of life and decommissioning stage of the Scheme have been scoped out of the assessment as it is anticipated that the Scheme will be in use beyond the design life of the road infrastructure. Any future decommissioning would require a separate planning submission. Decommissioning has therefore been scoped out.

14.1.6 In terms of climate parameters, wind has been scoped out of the vulnerability assessment as the impacts of wind on receptors in the surrounding environment are likely to be no worse as a result of the Scheme relative to baseline conditions.

14.1.7 This chapter addresses each of these climate topic assessments separately: GHG impact assessment in *Section 14.3* and vulnerability to climate change in *Section 14.4*. Cumulative effects, including the impact of a changing climate and the Scheme on the surrounding environment, are considered in *Chapter 15: Cumulative, In-Combination and Project-wide Effects* of this PEI Report.

14.1.8 As stated in the Intergovernmental Panel on Climate Change (IPCC) sixth Assessment Report (AR6) (Ref 14-8), mitigation (i.e., reducing GHG emissions) and adaptation (i.e., responding to climate change impacts) are complementary approaches to reducing risks of climate change impacts over different timescales. Mitigation, in the short-term and medium-term, can substantially reduce climate change impacts in the latter decades of the 21st century. Benefits from adaptation can be realised now to address current risks and can be realised in the future to address emerging risks. Innovation and investments in environmentally sound infrastructure and technologies can both reduce lifecycle GHG emissions and enhance resilience to climate change.

14.2 Stakeholder engagement

14.2.1 Consultation has taken place on the climate aspect of the *EIA Scoping Opinion* (Appendix 1-B). Five organisations (Planning Inspectorate, ADC,

Ref 14-7 Standards for Highways, DMRB LA 114
Ref 14-8 Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (AR6) -

WSCC, Natural England and the Environment Agency) provided comments, which have influenced this PEI Report chapter and will be taken forward to the ES.

14.2.2 With regard to resilience of the Scheme to a changing climate, a number of statutory stakeholders, including ADC, WSCC and the Environment Agency, have been consulted. Further details on the consultation, specifically in relation to future flood risk and water flows and levels in periods of water scarcity can be found in *Chapter 13: Road Drainage and the Water Environment* of this PEI Report.

14.3 GHG impact assessment

Assessment methodology

14.3.1 In line with the World Business Council for Sustainable Development *(WBCSD)/World Resources Institute (WRI) Greenhouse Gas Protocol* (Ref 14-9) guidelines, the GHG emissions assessment will be reported as tonnes of carbon dioxide equivalent (tCO_2e) and consider the seven *Kyoto Protocol* (Ref 14-10) gases:

a. Carbon dioxide (CO_2)
b. Methane (CH_4)
c. Nitrous oxide (N_2O)
d. Sulphur hexafluoride (SF_6)
e. Hydrofluorocarbons (HFCs)
f. Perfluorocarbons (PFCs)
g. Nitrogen trifluoride (NF_3)

14.3.2 GHG emissions will be assessed using a calculation-based methodology as per the below equation:

Activity data x GHG emissions factor = GHG emissions value

14.3.3 Whilst the scope of the assessment will cover the lifecycle stages identified in Table 14-3, it is proposed that the GHG assessment will comprise two parts reflecting both the level of certainty of future activity and GHG emissions and the extent that the predicted GHG emissions will be additional to the existing GHG inventory. Construction emissions will be estimated using the National Highways *Carbon Tool* (Ref 14-11), while road user emissions will be taken from the *WebTAG* (Ref 14-12) assessment which uses emissions factors from the *Defra Emissions Factor Toolkit Version 10*.

Ref 14-9 World Business Council for Sustainable Development (WBCSD)/World Resources Institute (WRI) Greenhouse Gas Protocol
Ref 14-10 United Nations (1998) Kyoto protocol to the united nations framework convention on climate change
Ref 14-11 Carbon emissions calculation tool: Highways England - GOV.UK (www.gov.uk)
Ref 14-12 https://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.html

14.3.4 The first part of the GHG assessment will include the construction of the Scheme itself. The majority of these emissions will be additional to the existing National GHG inventory.

14.3.5 The second part of the GHG assessment will address Scheme operation (road lighting and any other powered processes), maintenance and 'use' of the Scheme, specifically those emissions resulting from vehicles travelling on the road. The assessment will consider the impact of GHG emissions on the whole traffic network (consistent with the traffic model for the Scheme) to account for any variation in GHG impacts as a result of the Scheme.

14.3.6 Two types of data will be collected for the GHG assessment: activity data and GHG emissions factors. Data quality principles will be applied so that the results from the GHG assessment are as accurate and representative as possible:

a. Age – the GHG assessment will be based on activity data and GHG emissions factors applicable to the study period.

b. Geography – activity data will reflect the design of the Scheme. GHG emissions factors will be representative of the UK construction industry and UK transport sector.

c. Technology – the default solution will be to apply data which is representative of the UK construction industry and transport sector. However, technology specific data may be used for the purpose of developing scenarios of the future.

d. Methodology – activity data will be gathered directly from the engineering and design teams to enable consistency and completeness of data collection.

e. Competency – activity data will be generated by the engineering and design teams in-line with applicable industry standards.

14.3.7 The National Highways *Carbon Tool* (Ref 14-13) will be used to calculate construction phase emissions. The carbon tool uses GHG emission factors from a range of sources, including, but not limited to the Bath ICE Database and BEIS Emissions Factors. Where the data provided is not in the format that is aligned to the carbon tool, the tool will not be used to calculate GHG emissions. Instead, assumptions from either peer reviewed publications (papers published in recognised journals) or industry specific literature (UK construction trade associations) which adhere to the BS EN 15804 standard (Ref 14-14) will be used to find emissions factors and calculate GHG emissions.

14.3.8 To put the magnitude of GHG emissions into context, *DMRB LA 114* requires that the assessment of the Scheme related emissions will be compared to relevant UK carbon budgets. In line with the *NPSNN*, significance of effects will be assessed by comparing estimated GHG

Ref 14-13 https://www.gov.uk/government/publications/carbon-tool
Ref 14-14 BS EN 15804 Sustainability of construction works (British Standards Institution, 2012)

emissions arising from the Scheme with UK carbon budgets, and the associated reduction targets. Consideration will be given to the Scheme's GHG impact in the context of the UK's net zero 2050 target. In addition, National Highways has recently released their *Net Zero Highways Plan* (Ref 14-15) in line with the Department for Transport's *Decarbonisation Plan* (Ref 14-16*),* which will also be considered during the GHG emissions assessment.

14.3.9 Table 14-1 shows the current and future UK carbon budgets, which at present have only been calculated up to 2037 (Ref 14-17).

Table 14-1 UK carbon budget

Carbon budget	Total budget ($MtCO_2e$)
3rd (2018-2022)	2,544
4th (2023-2027)	1,950
5th (2028-2032)	1,725
6th (2033-2037)	965

Assessment assumptions and limitations

14.3.10 The assumptions and limitations that will apply to this assessment are outlined in Table 14-2. For each assumption or limitation, an explanation of the possible result of the assumption has been provided, as well as a description of any corrective actions that will be taken to adjust for any limitations.

Table 14-2 Assessment assumptions and limitations for GHG impact assessment

Assumption or Limitation	Result of Assumption or Limitation	Correction for Assumption or Limitation
The assessment is expected to take place before the detailed design is prepared and construction has begun. There will be some uncertainty	The construction emissions estimate may not reflect the final detailed design, as the design will develop post DCO submission, and some items may not be included within the	Some items may not be included within the assessment if these materials and their volumes have not been quantified at this stage of the design process.

Ref 14-15 Net zero highways: our 2030/ 2040/2050 plan, Highways England, 2021
Ref 14-16 Department for Transport, 2021. Decarbonisation Plan Decarbonising Transport – A Better, Greener Britain
Ref 14-17 Committee on Climate Change, 2017

Assumption or Limitation	Result of Assumption or Limitation	Correction for Assumption or Limitation
regarding the types and quantities of materials to be used in construction, which will require assumptions to be agreed.	most up to date bill of quantities, which will be used for the assessment presented in the ES.	However, professional judgement and a conservative and precautionary approach to emissions quantification will be used.
The assessment of end user emissions will use modelled traffic data, which includes assumptions and limitations (for example, assumptions about fleet characteristics).	The assumptions and limitations inherent in the traffic model may result in the emissions estimate not wholly accurately reflecting the effects of the Scheme.	The professional judgement, and guidance followed by the traffic modelling team will maximise the accuracy of the traffic data. Validation will be undertaken of the traffic model. Any uncertainties associated with the traffic model will be detailed in the ES. A realistic worst-case scenario based on central traffic forecasts will be used.
The assessment of end user emissions relies on government predictions regarding vehicle types, efficiency and electricity grid decarbonisation	The emissions estimate may mean that the ultimate effects of the Scheme are different.	The data selected will be the most appropriate for the quantification of end user emissions. The emission rates utilised within these calculations are based on those nationally available at the time of assessment from Defra. The NNNPS for air quality states the following in 5.8: "*Defra publishes future national projections of air quality based on evidence of future emissions, traffic and vehicle fleet.*

Assumption or Limitation	Result of Assumption or Limitation	Correction for Assumption or Limitation
		Projections are updated as the evidence base changes. Applicant's assessment should be consistent with this but may include more detailed modelling to demonstrate local impacts". Therefore, the use of Defra emission rates for the calculation of GHG emissions aligns with the guidance provided for Air Quality emissions.
There is currently no specific guidance or carbon emissions threshold, which if exceeded, is considered significant.	Assessment of significance of emissions cannot be judged objectively.	The assessment will be aligned to the methodology in DMRB, which is consistent with guidance from the Institute of Environmental Management & Assessment (IEMA) (Ref 14-18). The GHG emissions will also be put into context using professional judgement the national carbon budgets, and local authority emissions.

Study area

14.3.11 The study area for the lifecycle GHG impact assessment includes GHG emissions arising from within the Scheme boundary during the construction phase of the Scheme. It includes the Scheme's related activities and embodied carbon in materials used for construction as a result of raw

Ref 14-18 IEMA EIA Guidance (IEMA, 2017); Environmental Impact Assessment Guide to: Assessing Greenhouse Gas Emissions and Evaluating their Significance.

material extraction, processing and manufacture or the recycling and use of existing construction materials, as well as their associated transport.

14.3.12 The study area for operational GHG emissions (specifically from road users) includes all road links within the traffic model rather than a subset of affected links. This approach is based on the study area text presented in Paragraph 3.9 of the *DMRB LA114* (*"For operational road user GHG emissions, the study area shall be consistent with the affected road network defined in a project's traffic model")* and our discussions with the air quality team at SES which have confirmed our approach is appropriate. This also aligns with the approach taken within the appraisal process for WebTAG and the approach taken historically when traffic teams calculated GHG emissions using the Transport Users Benefit Appraisal (TUBA) transport model (Ref 14-19), which is also a whole network approach. By including all links in the traffic network for the GHG calculations, links with smaller changes in traffic which would still impact on GHG emissions/contribute to total GHGs are included.

Baseline conditions

14.3.13 The current and future baseline for the GHG impact assessment is a "business as usual" scenario whereby the Scheme is not constructed, and the existing road remains (Do Minimum (DM) scenario). Under this scenario, GHG emissions associated with the future use and maintenance of the existing A27 are included in the baseline. The detailed baseline is being developed using traffic models based on the current road Scheme layout and its predicted use, accounting for any increase in traffic and associated congestion, through to 2042 (the design year for the Scheme considered in the traffic model). This model will establish a baseline against which the Scheme can be compared to identify any variation in GHG emissions over time.

14.3.14 To allow for an assessment of the GHG emissions impact due to a change in maintenance emissions, the existing and future (DM) maintenance emissions will be incorporated into the current and future baseline. Maintenance emissions will be estimated in the Do Something (DS) scenario, where the difference between the DS and DM scenarios will provide the change in maintenance GHG emissions.

14.3.15 To allow for an assessment of the GHG emissions impact due to land use change, the baseline also includes GHG emissions sequestered by the existing vegetation and habitats which will be subject to land acquisition when the Scheme is constructed. This land, including the soils and vegetation, is currently acting as a carbon sink which will be lost once the Scheme is built, unless compensatory habitat is created.

Ref 14-19 https://www.gov.uk/government/publications/tuba-downloads-and-user-manuals

Potential impacts

14.3.16 Mitigation measures being incorporated in the Scheme design and to be implemented during Scheme construction are identified below. Prior to implementation of mitigation, the Scheme has the potential to generate a range of impacts, including those key impacts identified in Table 14-3.

14.3.17 As the effects of GHGs are not geographically constrained, *"any GHG emissions have the potential to be considered significant"* (Ref 14-20) due to their combined environmental effect in the atmosphere. In order to assess the magnitude of impact of GHG emissions from proposed development, UK Carbon Budgets have been used as a proxy for the climate.

14.3.18 To assess the GHG emissions arising from the construction, operation and maintenance of the Scheme, a lifecycle assessment approach will be undertaken using design, construction and transportation data. This approach is consistent with the principles set out in *DMRB LA 114* (Ref 14-1), *BS EN 15804* (Ref 14-21), *PAS 2080* (Ref 14-22) and the *IEMA guidance* (Ref 14-6).

14.3.19 The final outputs from the GHG assessment will be presented in the ES. The key GHG emission sources that are being considered in the GHG assessment are set out in Table 14-3. The *EIA Scoping Report* details activities/lifecycle stages that have been scoped out of the assessment and hence are not presented in Table 14-3.They are also referred to in *Section 14.1* of this report.

Table 14-3 Key anticipated GHG emission sources

Lifecycle Stage	Activity	Primary Emission Sources
Pre-construction stage	Enabling works to prepare the site for construction.	GHG emissions from fuel use for works equipment and vehicles. GHG emissions from fuel use for worker commuting.
	Disposal of any waste generated during the enabling works.	GHG emissions from disposal of waste. GHG emissions from fuel consumption for transportation of waste.

Ref 14-20 Institute of Environmental Management and Assessment (IEMA), (2017); Environmental Impact Assessment Guide to: Assessing Greenhouse Gas Emissions and Evaluating their Significance
Ref 14-21 BS EN 15804 Sustainability of construction works (British Standards Institution, 2012)
Ref 14-22 PAS 2080 Carbon management in infrastructure (British Standards Institution, 2016)

Lifecycle Stage	Activity	Primary Emission Sources
	Land clearance, for example, removal of any vegetation or habitats for replacement with other land use.	Losses of carbon sink (removal of a natural environment that has the ability to absorb GHG emissions).
Product stage	Raw material extraction and manufacturing of products required to build the Scheme.	Embodied GHG emissions within the construction materials (emissions resulting from the extraction of raw materials into secondary/final products for use and the GHG emissions associated with the transportation of those materials).
Construction process stage	Use of construction vehicles and plant. Transport of materials to the construction site. Transportation of construction workers to site. Disposal of any waste or other materials generated by the construction processes. Proposed planting of new vegetation, including green bridges and flood compensation areas. Potable water consumption and quantity of wastewater requiring treatment.	GHG emissions from energy (electricity and fuel) consumption for plant and vehicles, as well as generators on site. Fuel consumption from transport of materials to site. GHG emissions from energy consumption (electricity and fuel) for worker commuting. GHG emissions from disposal of waste. GHG emissions from fuel consumption for transportation of waste. Sequestration of GHG emissions by new vegetation acting as a carbon sink. GHG emissions from potable water consumption and wastewater treatment.
Operation stage	Operation of the associated road, including lighting and signalling.	GHG emissions from electricity use.

Lifecycle Stage	Activity	Primary Emission Sources
	Maintenance activities, including re-surfacing. Maintenance of landscaped areas included subject to data availability. Waste generation (volume, method of disposal, destination for disposal). Potable water consumption and quantity of wastewater requiring treatment. Transportation/vehicle use by maintenance workers.	Embodied emissions associated with additional materials used as part of maintenance activities, such as re-surfacing materials. Fuel use for maintenance activities. Ongoing sequestration of GHG emissions by vegetation acting as a carbon sink. GHG emissions from disposal of waste. GHG emissions from potable water consumption and wastewater treatment. GHG emissions from energy consumption (electricity and fuel) for maintenance activities and road users.
Use stage	Vehicle journeys both on the road and within the vicinity of the road.	GHG emissions per vehicle km.

14.3.20 At this stage of the Scheme, insufficient data is available to undertake a preliminary GHG impact assessment. Instead, construction emissions from a range of other National Highways schemes are presented in Table 14-4. The emissions presented in Table 14-4 are typical of road schemes and have been normalised by road length. The range of emissions presented in Table 14-4 give an indication of the impact expected from the Scheme.

Table 14-4 Construction emissions benchmarking for other National Highways Schemes

National Highways Schemes	Construction GHG emissions (tCO_2e/km)
A428 (Black Cat to Caxton Gibbet Improvements)	11,600
M54 – M6 Toll Link Road	23,400
A46 Coventry Junctions	19,084

National Highways Schemes	Construction GHG emissions (tCO_2e/km)
A38 Derby Junctions	24,896
A303 Amesbury to Berwick Down	35,900

14.3.21 The construction emissions benchmarking shown in Table 14-4 demonstrates that there is a range of 11,600 tCO_2e to 35,900 tCO_2e per km of road.

14.3.22 Operational emissions have not been included in this benchmarking as maintenance activities, and in particular vehicle use, depend heavily on the location of the Scheme.

Design, mitigation and enhancement measures

14.3.23 In accordance with the *NPSNN* requirements (paragraph 5.19), *"*evidence *of appropriate mitigation measures (incorporating engineering plans on configuration and layout, and use of materials) in both design and construction should be presented"*. As the GHG assessment progresses, measures will be identified to reduce emissions across the lifecycle of the Scheme. Mitigating measures currently being considered where practicable include but are not limited to:

a. An Environmental Management Plan (EMP) will be prepared that will include a range of best practice construction measures outlining an environmental management framework, operational control procedures (for example, development of a site waste management plan), as well as a pollution control contingency plan. Some of the measures relating to GHG emissions may include:

   i. the specification of energy efficient construction lighting and durable construction materials to reduce energy consumption

   ii. implementing measures to manage material resource use during construction, including using materials and plant with lower embedded GHG emissions and water consumption

   iii. the sustainable reuse of soil and aggregate materials won from excavation and demolition activities, where feasible, to minimise GHG emissions associated with the importation of materials to site and embodied carbon associated with additional materials

b. Specification of alternative materials with lower embodied GHG emissions, such as locally sourced products and materials with a higher recycled content. Opportunities to re-use material resources are being sought where practicable, such as the re-use of excavated materials and the recycling of demolition materials within the Scheme. Additional mitigation measures that may reduce the GHG emissions associated

with materials are detailed in *Chapter 10: Material Assets and Waste* of this PEI Report.

c. Low carbon design specifications such as energy-efficient lighting and durable construction materials to reduce maintenance and replacement cycles.

d. Retention of current infrastructure wherever practicable to reduce the number of assets required for the Scheme and therefore the volume of construction materials required.

e. Recovery and re-use/recycling of arisings from site, ideally for reuse/ redeployment on the same site to reduce waste generation (and transportation emissions associated with waste) and GHG emissions associated with importing materials.

f. Consideration of alternative modes of transportation used to move materials on and off-site, as well as construction workers. Further details of sustainable transport should be identified in the Construction Worker Travel Plan that is developed for the Scheme.

g. Sustainable construction through the use of efficient plant, including hybrid and electric machinery and equipment as appropriate. Remove diesel generators from site and connect to the mains power supply and/or use battery storage where possible.

h. Inclusion of green bridges in the design that will act as carbon sinks.

i. Minimise replacement emissions by specifying assets with long operational lives.

j. The design of the Scheme to be focussed upon reduction of emissions from traffic and vehicle movements of end-users, such as the provision of electric charging infrastructure along the route to encourage a modal shift to less carbon intensive journeys.

14.3.24 The most appropriate mitigation measures will be confirmed within the GHG impact assessment in the ES. National Highways has recently released their *Net zero highways* plan (Ref 14-23), in line with the Department for Transport's *Decarbonisation Plan* (Ref 14-24), which will also be taken into account in the ES.

Assessment of effects

14.3.25 The NPSNN states that *"it is very unlikely that the impact of a road project will, in isolation, affect the ability of Government to meet its carbon reduction plan targets"*. The carbon reduction plan targets referred to in the NPSNN are the UK's legally binding framework to cut GHG by at least 80% by 2050. The NPSNN also states that *"for road projects applicants should*

Ref 14-23 Net zero highways: our 2030/ 2040/2050 plan, Highways England, 2021
Ref 14-24 Department for Transport, 2021. Decarbonisation Plan Decarbonising Transport – A Better, Greener Britain

provide evidence of the carbon impact of the project and an assessment against the Government's carbon budgets".

14.3.26 The national carbon reduction strategy (provided in the *Carbon Plan 2011* (Ref 14-25) provides a plan for the UK to meet its carbon reduction targets. While the Government is legally bound to meet the commitments set out in this plan, any increase in GHG emissions as a result of the Scheme would not necessarily result in the Scheme being refused consent unless the increase causes a materially significant negative effect in the UK's ability to achieve its statutory target.

14.3.27 While the *NPSNN* does not specify significance criteria for GHG emissions, it does highlight the document *Investing in Britain's Future* (Ref 14-26), which states that the programme of investment planned for the UK Strategic Road Network (SRN) would equate to below 0.1% of average annual carbon emissions allowed in the fourth carbon budget. This needs to be considered in the context of other policy around an increase in the use of electric vehicles and the decarbonisation of the national electricity grid.

14.3.28 The GHG impacts of the Scheme should also be put into the wider context of the UK SRN. The length of the Scheme represents less than 0.1% of the 4,400 mile UK SRN (DfT 2017) (Ref 14-27). Therefore, although it is important that the relative GHG impacts are considered so that mitigation measures can be integrated into the Scheme design, the overall GHG increase is expected to be minimal when considered in the national context.

14.3.29 Of all the lifecycle stages within the GHG impact assessment (illustrated in Table 14-3 above), the embodied carbon associated with materials use is likely to be the biggest contributor to the carbon footprint of the Scheme. Materials such as steel, concrete and bitumen can have high embodied carbon contents depending on the specifications used. The assessment in the ES will identify the materials used and calculate (using the National Highways Carbon emissions calculation tool) the associated carbon emissions from their production as well as transport to site.

14.3.30 During the construction stage, activities associated with the construction of the viaduct (approximately 1.5 km long and 11.6 – 16.2 m above ground level at the western and eastern ends of the viaduct respectively) across the River Arun floodplain (such as piling), will likely contribute to construction GHG emissions. It is worth noting that there are other Scheme construction activities, including the potential for piling required for other structures, which will also contribute to construction GHG emissions.

14.3.31 The ES will provide a comparison of the total emissions from the construction and maintenance of the Scheme with national level carbon budgets and the associated six five-year reduction targets.

Ref 14-25 The Carbon Plan: Delivering our low carbon future
Ref 14-26 Investing in Britain's Future, HM Treasury, 2013
Ref 14-27 Road Lengths in Great Britain, DfT, 2016

14.3.32 To put the impact of the Scheme into context, total GHG emissions will also be compared against other new road proposed schemes within the SRN to benchmark GHG performance. It is expected that the construction emissions associated with this Scheme will fall within range of construction emissions associated with other National Highways schemes as detailed in Table 14-4. None of these schemes detailed in Table 14-4 resulted in construction emissions that were deemed to be significant.

14.3.33 The GHG emissions assessment is inherently cumulative. National carbon budgets are used as a proxy for the global climate and the emissions from this individual Scheme will be estimated and compared against those carbon budgets.

14.3.34 The six five-year carbon budgets and associated carbon reduction targets will already take account of projected carbon emissions resulting from the existing road network. The purpose of the GHG assessment is therefore to understand what additional emissions may arise as a result of the Scheme in addition to those already projected. GHG impacts from 'additional' road use will therefore be assessed by comparing a business as usual baseline (i.e., Do Minimum (DM), where the Scheme is not built) against road use for the Scheme, Do Something (DS).

Summary of preliminary assessment

14.3.35 Whilst there are no specified significance criteria currently published in relation to National Highways projects, likely GHG impacts include embodied carbon associated with raw material use and excavation works. Mitigation options are being considered to reduce the impact of these factors on the national carbon budgets. Based on the information available, the expected design, mitigation and enhancement measures set out above and using professional judgement, it is anticipated that the GHG emissions for this Scheme will fall within the range of other National Highways schemes. Therefore, it is expected that the full GHG impact assessment undertaken as part of the ES will show that the Scheme would be unlikely to affect the UK's ability to meet its overarching binding GHG reduction targets.

14.4 Vulnerability to climate change

Assessment methodology

14.4.1 This assessment will address the resilience of the Scheme to climate change impacts. The assessment will include all infrastructure and assets associated with the Scheme. It will assess resilience against both gradual climate change, and the risks associated with an increased frequency and intensity of extreme weather events.

14.4.2 The assessment will consider the measures that are integrated into the Scheme design to make it resilient to impacts arising from current and future weather events and climatic conditions, and designed in accordance with current planning, design and engineering practice and codes. The assessment will identify and take into account the existing resilience and

adaptation measures for each risk either already in place or in development for infrastructure and assets.

14.4.3 The degree to which the probability and frequency of these potential hazards may change as a result of climate change will be identified using the UKCP18 (Ref 14-28) climate change projections.

14.4.4 The vulnerability assessment will follow the method detailed in *DMRB LA 114* (Ref 14-1). This will be completed in liaison with the project design team and the other EIA technical disciplines by considering the UKCP18 projections for the geographical location and timeframe of the Scheme (from construction through to operation).

14.4.5 During the construction phase, impacts will be assessed qualitatively, which is consistent with *DMRB LA 114*.

14.4.6 *DMRB LA 114* details how to assess the relevance of potential impacts during operation; evaluation of significance; and when further design and mitigation measures are required. Once climate hazards have been identified, the likelihood and consequences will be assessed according to Table 14-5 and Table 14-6.

14.4.7 During enabling and construction works, receptors such as the construction work force, construction plant, vehicles and materials may be vulnerable to a range of climate risks. Operational phase receptors may include assets and infrastructure (including, but not limited to lighting and signage) users and any plant/machine workers required for maintenance.

Table 14-5 Likelihood categories

Likelihood	Description (probability and frequency of occurrence)
Very high	The event occurs multiple times during the lifetime of the Scheme (60 years). For example, approximately annually, typically 60 events.
High	The event occurs several times during the lifetime of the Scheme (60 years). For example, approximately once every five years, typically 12 events.
Medium	The event occurs limited times during the lifetime of the Scheme (60 years). For example, approximately once every 15 years, typically 4 events.
Low	The event occurs during the lifetime of the Scheme (60 years). For example, once in 60 years.
Very low	The event can occur once during the lifetime of the Scheme (60 years).

Ref 14-28 Met Office, (2020); UK Climate Projections User Interface (online)

Table 14-6 Description of consequences

Consequence of impact	Description
Very large adverse	Operation - national level (or greater) disruption to strategic route(s) lasting more than one week.
Large adverse	Operation - national level disruption to strategic route(s) lasting more than one day but less than one week or regional level disruption to strategic route(s) lasting more than one week.
Moderate adverse	Operation - regional level disruption to strategic route(s) lasting more than one day but less than one week.
Minor adverse	Operation - regional level disruption to strategic route(s) lasting less than one day.
Negligible	Operation - disruption to an isolated section of a strategic route lasting less than one day.

14.4.8 The significance of each effect will then be evaluated through a matrix as detailed in Table 14-7. This will be based on and incorporate confirmed design and mitigation measures, as required by *DMRB LA 114* (Ref 14-1). Ongoing Scheme design will aim to incorporate mitigation measures to increase resilience to climate change as far as practicable.

Table 14-7 Significance of effect matrix ('S' significant, 'NS' not significant)

		Likelihood				
		Very Low	Low	Medium	High	Very High
Measure of consequence	Very large	NS	S	S	S	S
	Large	NS	NS	S	S	S
	Moderate	NS	NS	S	S	S
	Minor	NS	NS	NS	NS	NS
	Negligible	NS	NS	NS	NS	NS

14.4.9 The climate chapter of the ES will describe how the Scheme will be designed and monitored to improve its resilience to future climatic conditions.

14.4.10 Section 3.3 of *DMRB LA114* (Ref 14-1) states that '*assessments shall use the H++ climate scenarios to test the sensitivity of vulnerable safety critical features, to ensure that such features will not be affected by more radical changes to the climate beyond that projected in the latest set of UK climate projections'*. In practice, this refers to 'high-end' climate change scenarios, referred to as H++ scenarios, which are typically extreme climate change scenarios on the margins or outside of the 10th to 90th percentile range.

Assessment assumptions and limitations

14.4.11 The assumptions and limitations which apply to this assessment are outlined in Table 14-8. For each assumption or limitation, an explanation of the possible result of the assumption has been provided as well as a description of any corrective actions that have been taken to adjust for any limitations.

Table 14-8 Assessment assumptions and limitations for vulnerability to climate change assessment

Assumption or Limitation	Result of Assumption or Limitation	Correction for Assumption or Limitation
The assessment of resilience will be carried out based on projected climate change using UKCP18 climate projections.	There are inherent uncertainties associated with climate projections and they are not predictions of the future. It is possible that future climate will differ from the baseline climate against which the resilience of the Scheme has been assessed depending on global emissions over the next century.	A 'high' emissions scenario (RCP8.5) will be used to develop the baseline against which resilience will be assessed. This is consistent with the precautionary principle (i.e., 'worst-case' scenario).

Study area

14.4.12 The study area for the climate change vulnerability review will be the draft Order Limits, which captures all assets, infrastructure and users associated with the Scheme as described in *Chapter 2: The Scheme*, including all temporary works. The assessment will consider climate projections over a 60-year period from the Scheme opening year, in accordance with *DMRB LA114*.

Baseline conditions

14.4.13 The current baseline for the vulnerability assessment is based on historic climate data obtained from the *Met Office (2020)* (Ref 14-29) recorded at the closest meteorological station to the Scheme (Shoreham, approximately 20 km to the east) for the period 1981-2010. This data is detailed in Table 14-9. The latest data will be reviewed prior to production of the ES.

Table 14-9 Historic climate data

Climatic Variable	Month	Value
Average annual maximum daily temperature (°C)	-	14
Warmest month on average (°C)	August	20.8
Coldest month on average (°C)	February	1.9
Mean annual rainfall levels (mm)	-	722.7
Wettest month on average (mm)	October	87.8
Driest month on average (mm)	May	44.3

14.4.14 The Met Office historic 10-year averages for the 'England South East and Central South' region identify gradual warming between 1969 and 2018, with increased rainfall also. Information on mean maximum annual temperatures (°C) and mean annual rainfall (mm) is summarised in Table 14-10.

Table 14-10 Historic 10-year averages for temperature and rainfall for the 'England South East and Central South' region

Climate Period	Mean maximum annual temperatures (°C)	Mean annual rainfall (mm)
1969-1978	13.7	731.9
1979-1988	13.5	777.3
1989-1998	14.4	746.0
1999-2008	14.8	830.1
2009-2018	14.8	799.3

Ref 14-29 https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-climate-averages/gcpc1q7m5

14.4.15 The future baseline for the vulnerability assessment is based on *UKCP18* (Ref 14-30) data detailed in Table 14-11 and Table 14-12.

14.4.16 The review of vulnerability to climate change has considered the *UKCP18* (Ref 14-17) high emissions scenario that reflects a high level of GHG emissions at the 50% probability levels to assess the impact of climate change over the lifecycle of the Scheme. A 50% probability results indicates that 50% of model results were above and below this figure.

14.4.17 For the purposes of the assessment, *UKCP18* (Ref 14-17) probabilistic projections for pre-defined 20-year periods for the following average climate variables have been obtained and will be further analysed in the EIA:

a. Mean annual temperature
b. Mean summer temperature
c. Mean winter temperature
d. Maximum summer temperature
e. Minimum winter temperature
f. Mean annual precipitation
g. Mean summer precipitation
h. Mean winter precipitation
i. Sea Level Rise (SLR)

14.4.18 Projected temperature and precipitation variables are presented in Table 14-11 and Table 14-12 respectively. *UKCP18* (Ref 14-17) projections have been analysed for the 25 km grid square in which the Scheme is located. These figures are expressed as temperature/precipitation anomalies in relation to the 1981-2000 baseline.

14.4.19 *UKCP18* (Ref 14-17) uses a range of possible scenarios, classified as Representative Concentration Pathways (RCPs), to inform differing future emission trends. These RCPs "*specify the concentrations of greenhouse gases that will result in total radiative forcing increasing by a target amount by 2100, relative to preindustrial levels*". RCP8.5 has been used for the purposes of this assessment as a worst-case scenario. The Scheme has varying design life elements, with the pavement surface at 15 years, the pavement at 40 years and the structures at 120 years. In accordance with *DMRB LA 114*, the assessment of a Scheme's vulnerability to climate change takes the life span of the Scheme to be 60 years. Table 14-11 and Table 14-12 present the projected climate variables that may occur during the Scheme's life span. The time periods presented in Table 14-11 and Table 14-12 refer to the time frames used in the *UKCP18* data base.

Ref 14-30 UKCP18 https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/index

14.4.20 The future baseline used in the assessment of the Scheme's vulnerability to climate change during the construction phase will be based on the *UKCP18* probabilistic projections for the 2020-2039 time period.

14.4.21 The future baseline used in the assessment of the Scheme's vulnerability to climate change during the operational phase will be based on the *UKCP18* probabilistic projections for the 2050-2069 and 2080-2099 time periods.

14.4.22 Section 3.3 of *DMRB LA114* (Ref 14-1) states '*Assessments shall use the H++ climate scenarios to test the sensitivity of vulnerable safety critical features, to ensure that such features will not be affected by more radical changes to the climate beyond that projected in the latest set of UK climate projections'*. However, the H++ climate scenarios have not been updated in *UKCP18* (Ref 14-17) as '*the H++ scenario of UKCP09 can still be considered a useful plausible but unlikely high-end sea level pathway for decision-making.*'

Table 14-11 Projected changes in temperature variables (°C), 50% probability (10% and 90% probability in brackets)

Climate Variable	2020-2039	2050-2069	2080-2099
Mean annual air temperature anomaly at 1.5 m (°C)	+1.0 (+0.3 to +1.8)	+2.4 (+1.1 to +3.7)	+4.3 (+2.3 to +6.5)
Mean summer air temperature anomaly at 1.5 m (°C)	+1.4 (+0.4 to +2.4)	+3.2 (+1.2 to +5.3)	+5.8 (+2.7 to +9.2)
Mean winter air temperature anomaly at 1.5 m (°C)	+1.0 (0 to +2.0)	+2.1 (+0.6 to +3.7)	+3.6 (+1.4 to +5.9)
Maximum summer air temperature anomaly at 1.5 m (°C)	+1.5 (+0.3 to +2.9)	+3.6 (+1.1 to +6.3)	+6.5 (+2.5 to +10.9)
Minimum winter air temperature anomaly at 1.5 m (°C)	+0.9 (0 to +2.0)	+2.2 (+0.5 to +3.9)	+3.6 (+1.2 to +6.4)

Table 14-12 Projected changes in precipitation (%), 50% probability (10% and 90% probability in brackets)

Climate Variable	2020-2039	2050-2069	2080-2099
Annual precipitation rate anomaly (%)	+1.0 (-3.3 to +5.6)	+1.4 (-6.6 to +9.7)	+3.5 (-5.0 to +12.1)
Summer precipitation rate anomaly (%)	-9.6 (-34.7 to +16.4)	-26.2 (-57.54 to +6.7)	-42.3 (-75.6 to -2.5)
Winter precipitation rate anomaly (%)	+9.2 (-6.5 to + 26.3)	+17.5 (-7.1 to +44.6)	+30.7 (+0.2 to +66.5)

14.4.23 In general, greater SLR is projected for the south of the UK, where values are similar to the global mean projections (UKCP18, 2018). Using a RCP8.5 scenario demonstrates that SLR globally (and in the south of the UK) could be 0.56-1.12 m higher in 2100 compared to the 1981-2000 baseline (Ref 14-31).

14.4.24 The frequency of severe weather events is also projected to increase due to climate change. Summers that experience days above 40°C somewhere in the UK have a return time of 100-300 years at present. This is projected to decrease to 3.5 years by 2100 with the RCP8.5 concentration pathway, consistent with 4°C of warming (Ref 14-32) (CCRA 2021). As noted by the *Climate Change Risk Assessment* (CCRA 2021), England is already impacted by extreme weather events. The report also identifies key risks and implications from a changing climate, which include:

a. Changes in extreme weather conditions, which will impact on infrastructure, in particular through storm damage, flooding and high temperatures.

b. Flooding of transport, including roads and rail is likely to increase, affecting both urban and rural access routes.

14.4.25 In relation to key infrastructure such as roads, the *CCRA* report (Ref 14-33) notes that England has a number of roads and railways at significant likelihood of river and tidal flooding. Flooding of transport infrastructure and the associated disruption is projected to increase, affecting both urban and rural access routes.

Ref 14-31 ukcp18-marine-report-updated.pdf (metoffice.gov.uk)
Ref 14-32 CCRA3-Chapter-1-FINAL.pdf (ukclimaterisk.org)
Ref 14-33 CCRA-Evidence-Report-England-Summary-Final.pdf (ukclimaterisk.org)

Potential impacts

14.4.26 The potential impacts for the vulnerability assessment are determined based on the *UKCP18* (Ref 14-17) projections.

14.4.27 The Scheme area may be vulnerable to a range of climate risks, including an increased frequency and severity of prolonged and/or heavy precipitation events, prolonged droughts and heatwaves, a greater frequency of very hot days, and an increased risk of storms. Warmer temperatures may also mean that the risks associated with ice and snow will decrease over time, but retaining the ability to respond to these events will remain important.

14.4.28 The Scheme itself is identified as having the potential to be vulnerable to a range of climate impacts during its use. These include, but are not limited to:

a. Material deterioration due to high temperatures leading to deterioration of structures and pavements such as softening, deformation and cracking.

b. Overheating of electrical equipment, such as information and communication systems.

c. Health and safety risks to road users and employees as a result of changing temperatures.

d. Increased frequency of fog episodes which may reduce visibility and access.

e. Changes in travel patterns of network users due to climate hazards impacting different transport networks.

f. Longer vegetation growing seasons leading to a reduction in soil moisture and/or increased tree leaf coverage with an increased magnitude and frequency of storm events which could result in tree fall and increased maintenance and management requirements.

g. Damage to roads from periods of heavy rainfall.

h. Flood risk on the network and damage to drainage systems with the potential for increased runoff from adjacent land contributing to surface water flooding.

i. Flood risk on this Scheme is primarily associated with crossing the River Arun floodplain, which is both fluvial and tidal, resulting in further potential impacts from SLR. It is noted that the viaduct being proposed would have no effect on in-channel flows. Modelling undertaken to date has shown that a viaduct would have insignificant effects on any flood plain flows during either extreme tidal or fluvial events, even when allowing for climate change. Further details are presented in *Chapter 13: Road Drainage and the Water Environment* of this PEI Report.

j. Health and safety risks to road users and employees as a result of reduced visibility and standing water originating from prolonged and/or heavy precipitation and storms.

k. Increased slope instability as a result of prolonged/heavy precipitation leading to subsidence.

l. Pollution as a result of surface runoff.

m. Storm damage to structures and other assets.

n. Inaccessible network during extreme weather events.

o. Reduced pavement and asset deterioration (over time) from less exposure to freezing, snow and ice, along with a reduced need for winter maintenance and a reduction in health and safety risks.

Design, mitigation and enhancement measures

14.4.29 A number of mitigation and adaptation measures will be considered to address potential climate change risks, many of which will have been identified by other technical assessments and included in the Scheme design. The assessment will identify and take into account the existing resilience measures for each climate risk either already in place or in development for infrastructure and assets.

14.4.30 The Scheme will be designed to be resilient to impacts arising from current and future weather events and climatic conditions and designed in accordance with current planning, design and engineering practice and codes. The vulnerability to climate change review identifies and considers existing resilience measures for each climate variable and associated risks either already in place or in development for infrastructure and assets.

14.4.31 Mitigation measures that could be considered include, but are not limited to:

a. Alternative pavement materials

b. Sustainable Drainage Systems (SuDS)

c. Flood compensation measures

d. Green bridges

e. Landscaping and habitat creation and improvements, as shown on Figure 2-1: Preliminary Landscape and Environmental Masterplan

14.4.32 To mitigate against any increases in peak flow that may exacerbate flooding as a result of climate change, hydraulic models of both the fluvial and tidal systems are being created. These models represent the baseline scenario (i.e., the current state) and a scenario in the 2080s taking into account climate change (64% allowance for climate change due to the flood zone area). This allows for an upper end (95 percentile) climate change scenario against which to assess the Scheme design and to identify measures to mitigate against these effects. Outputs from these models will be detailed in the ES. Infrastructure associated with the Scheme is being designed for a 1 in 100-year fluvial event with 64% allowance for climate

change, in line with the current guidance. As the River Arun is tidal, infrastructure suitability will also be assessed in line with the UK Government guidance issued in July 2021. Mitigation being considered includes flood compensatory storage, implementing appropriate attenuation areas, and/or localised re-profiling of land.

14.4.33 Adaptation measures could also include appropriate emergency systems being put in place.

14.4.34 Further assessment on the resilience of the Scheme to future climate impacts will continue as the design evolves and as further assessment is undertaken for other applicable EIA topic areas. The most appropriate mitigation measures (relevant to the identified risks) will be identified in the climate resilience assessment in the ES and will be embedded within the Scheme design.

Assessment of effects

14.4.35 The Scheme itself has been identified as being vulnerable to a range of climate risks during its use. Its resilience to these impacts will be assessed on an ongoing basis as the Scheme design develops and further data becomes available. The ES will provide the outputs of the ongoing climate resilience assessment, identifying the key impacts on the Scheme and appropriate measures that will be implemented to mitigate them.

14.4.36 The Scheme will be inherently designed to minimise the impacts of climate change on future use as far as is reasonably feasible. The design of the Scheme, the selection of materials used for its construction, and operational procedures will minimise the impacts of the following:

a. Potential impacts as a result of more extreme temperature fluctuations
b. An increase in the frequency of storms
c. The increased risk of flooding from higher levels of precipitation and SLR

14.4.37 For example, Scheme drainage will be designed to be resilient to the increase in predicted levels of precipitation, while materials specification will consider the ability of the product to withstand a wide range of temperature scenarios.

14.4.38 It is noted that the Scheme is required by *DMRB LA 144* paragraph 2.4 to have due regard for climate change resilience, and this will be considered inherently within the Scheme design.

Summary of preliminary assessment

14.4.39 In summary, based on the information available and professional judgement, the expected Scheme design, mitigation and enhancement measures set out above and the preliminary assessment undertaken to date, no likely significant effects around the resilience of the Scheme to climate change are anticipated.

14.5 Scheme options

14.5.1 As described in *Chapter 2: The Scheme*, options are still being considered for the potential reprovision of Avisford Park Golf Club. In addition, a potential alternative option from the current proposed alignment where the Scheme passes between Avisford Park, the new housing development at Avisford Grange and the existing Yapton Lane is being considered. This would raise the vertical alignment of the Scheme, with an offline Yapton Lane overbridge. The sections below discuss these in turn and outline whether adopting either of these would change anything stated in the preceding baseline conditions, potential impacts and assessment of effects sections and consider the potential for different effects of the options.

Options for Avisford Park Golf Club reprovision

Option 1: 9 hole golf course with driving range or practice facilities

14.5.2 The reprovision of an amended golf course is unlikely to result in any changes to the information already provided in the baseline conditions, potential impacts and assessment of effects sections of this chapter. The potential option does not represent a change in land use and the golf course would be designed and profiled such that no likely significant adverse effects associated with flood risk and drainage are anticipated. Therefore, this option is unlikely to result in any tangible impacts on the vulnerability of the Scheme to climate change. In the context of the overall Scheme, this option would not result in any tangible increase or reduction in materials used to construct it. Given there is an existing golf course in this location, this option would also not result in any tangible change in operational traffic numbers and associated vehicle emissions.

Option 2: Replacement 18 hole golf course

14.5.3 Full reprovision of the existing golf course would not result in any changes to the information already provided in the baseline conditions, potential impacts and assessment of effects sections of this chapter. Whilst this option does represent a change in land use from agricultural fields to a golf course, it will be designed and profiled such that no likely significant adverse effects associated with flood risk and drainage are anticipated. Therefore, the potential option is unlikely to result in any tangible impacts on the vulnerability of the Scheme to climate change. In the context of the overall Scheme, this option would not result in any tangible increase or reduction in materials used to construct it. Given there is an existing golf course in this location, as for Option 1, this option would also not result in any tangible change in operational traffic numbers and associated vehicle emissions.

14.5.4 Inherently, the construction of an 18 hole golf course is likely to have a greater carbon footprint than the construction of a 9 hole golf course. However, given that the difference between these two options is restricted to the landscaping and development of the course itself, the additional

GHG emissions associated with the construction of the 18 hole option is not expected to be material.

Option for raised vertical alignment with offline Yapton Lane overbridge

14.5.5 This option is considered to be a minimal change in respect of climate compared to the current proposed alignment. It would not result in any changes to the baseline conditions, potential impacts and assessment of effects set out in this chapter. The potential option is unlikely to result in any tangible impacts on the vulnerability of the Scheme to climate change, although it is noted that there will be less likelihood of an interaction with groundwater by adopting this option compared to the current proposed alignment. In the context of the overall Scheme, this option would not result in any tangible increase or reduction in materials used to construct it and there is little to discern between this option and the current proposed alignment at this stage. It would also not result in any change in traffic numbers and vehicle emissions associated with the operational Scheme. Therefore, the preliminary conclusions in terms of the potential for likely significant environmental effects remain the same.

15. Cumulative, In-combination and Project-wide Effects

15.1 Introduction

15.1.1 This chapter sets out the approach to the cumulative effects assessment including initial findings and proposed actions to be completed as part of the on-going Environmental Impact Assessment.

15.1.2 This chapter considers the following:

a. Cumulative effects (also known as inter-project effects): the effects of other developments in the vicinity of the Scheme which are proposed, under construction or have been consented, which when combined with the effects of the Scheme may have an incremental significant effect.

b. In-combination effects (also known as inter-related) the combined effects from the Scheme on a single receptor from a number of different environmental impacts, for example noise, dust and traffic.

15.1.3 Other developments identified as part of the cumulative effects assessment expected to be completed before construction of the Scheme will be considered within the ES as part of the future baseline within the environmental topic construction and operational assessments.

15.1.4 The following sub-sections consider each of these types of effect in turn and summarise the approach that is being used for their assessment. Given that the assessments for these types of effect are undertaken towards the end of the EIA process, when other topic assessments have been well progressed and data relating to other developments in the vicinity is confirmed, it is not possible to identify likely significant effects with certainty at this stage. However, some initial findings have been gathered which determine the other developments which have the potential to have significant cumulative effects. The final assessment will be included within the ES submitted with the DCO application taking account of other developments agreed with relevant stakeholders during statutory consultation.

15.1.5 The following legislation, policy framework and standards have been used to inform the scope and content of this chapter and will be further referred to within the ES:

a. Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (Ref 15-1)

b. *NPSNN* (Ref 1-7)

c. *DMRB LA 104 Environmental Assessment and Monitoring* (Ref 4-1)

Ref 15-1 The Stationary Office, The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017

d. The Planning Inspectorate (2019) Advice Note Seventeen: Cumulative Effects Assessment (Ref 15-2)

e. The Planning Inspectorate (2019) Advice Note Seven: Environmental Impact Assessment: Process, Preliminary Environmental Information and Environmental Statements (Ref 15-3)

f. The Planning Inspectorate (2019) Advice Note Nine: Rochdale Envelope (Ref 15-4)

15.2 Cumulative effects

Methodology

15.2.2 The Planning Inspectorate's Advice Note Seventeen (Ref 15-2) on the assessment of cumulative effects identifies a four stage approach, as follows:

a. Stage 1 – establish the project's zone of influence (ZoI) and identify a long list of 'other development' (the 'development schedule').

b. Stage 2 – identify a shortlist of 'other development' for the cumulative impact assessment which have the potential to give rise to significant cumulative effects by virtue of overlaps in scope, scale, nature, the receiving environment and any other relevant factors.

c. Stage 3 – information gathering and undertaking a desktop review of available environmental information for identified cumulative developments.

d. Stage 4 – assessment of each individual 'other development' to identify whether there is potential for significant cumulative effects and whether any mitigation measures are identified.

15.2.3 This approach has been adopted for the assessment, alongside consideration of the requirements as set out within *DMRB LA 104 Environmental assessment and monitoring* (Ref 4-1) which sets out a high-level methodology for assessing cumulative effects on highway projects as well as consideration of the Planning Inspectorate's Advice Note Seven: Environmental Impact Assessment: Process, Preliminary Environmental Information (Ref 15-3) and Environmental Statements and Advice Note Nine: Rochdale Envelope (Ref 15-4).

15.2.4 The assessment of cumulative effects arising from the Scheme in combination with other Schemes (inter-project effects) is based upon a review of current planning applications as well as a study of planning and policy documents.

15.2.5 The cumulative assessment for the Scheme is currently at Stage 1 and is focussed on the identification of relevant developments and land allocations

Ref 15-2 The Planning Inspectorate (2019) Advice Note Seventeen: Cumulative Effects Assessment.
Ref 15-3 The Planning Inspectorate (2019) Advice Note Advice Note Seven: Environmental Impact Assessment: Process, Preliminary Environmental Information and Environmental Statements.
Ref 15-4 The Planning Inspectorate (2019) Advice Note Nine: Rochdale Envelope.

within the Scheme's ZoI (see Figure 15-1) which have the potential to give rise to significant cumulative effects. Details of developments are currently being collated and placed on an initial long-list which identifies the size, type and location of each development. These long-list developments are being reviewed to assess their potential temporal and spatial interactions with the Scheme in order to identify whether they should be scoped into the cumulative assessment (e.g. whether they should progress to Stage 2). The consideration of developments within the long-list is a continuous process that ensures developments that get added to the local authority planning portals after the initial list is drawn together are still considered within the assessment - these updates will take place up until a cut-off point just prior to DCO submission.

Stage 1 - Establishing the Scheme's ZOI and identifying a longlist of 'other developments'

15.2.6 The cumulative ZoI for each environmental topic as shown on Figure 15-1 is indicative and will be subject to review as the assessment progresses. Table 15-1 explains the current rationale for the extent of each ZoI. It should be noted that the cumulative ZoIs presented below are reflective of the study areas identified by each technical discipline. Further detail on the study areas identified for each environmental discipline can be found in chapters 5-14 of this PEI Report. Depending on the discipline, the point at which the study areas are measured from varies. These include:

a. From the draft Order Limits (in some chapters this includes the existing A27 to be de-trunked and in others it excludes this aspect).

b. From the Scheme (this includes the outer extent of the proposed physical carriageway and includes side roads and access roads).

c. Scheme centreline.

d. Based on the Zone of Theoretical Visibility (ZTV).

Table 15-1 ZoI for environmental topic areas considered in the cumulative effects assessment

Environmental topic	Scheme study area	Cumulative ZoI
Air Quality	Construction dust: The study area will be 200 m from construction activities for construction dust. Construction traffic: The 'affected road network' within the construction phase traffic model defines the study area. As the construction phase traffic data includes traffic associated with other developments, the	Construction dust: Up to 400 m from the draft Order Limits. Construction traffic: The affected road network.

Environmental topic	Scheme study area	Cumulative ZoI
	construction phase traffic air quality impact assessment to be included within the ES will inherently be a cumulative impact assessment.	
	Operation: The 'affected road network' within the traffic model defines the study area.	The affected road network. As the operational phase traffic data includes traffic associated with other developments, the air quality impact assessment to be included in the ES will inherently be a cumulative impact assessment and therefore a separate cumulative assessment will not take place.
Cultural Heritage	Construction and Operation: Designated heritage assets and their setting: 1km High-value assets (designated assets of Grade I and II* and Scheduled Monuments): beyond the 1 km study area, which may be impacted by the Scheme through changes to their setting, taking into consideration the increased significance of these assets and the increased potential for their setting to be influenced by change, over larger distances.	Up to 2 km from the Scheme (high value assets included within the ZTV based on professional judgement).
Landscape and Visual	Construction and Operation: Subject to localised variations based on the ZTV and on-site verification of up to 15 km. Beyond	Up to 15 km from the centreline of the Scheme,

Environmental topic	Scheme study area	Cumulative ZoI
	this, the Scheme would be unlikely to give rise to any significant effects on landscape or visual receptors due to the scale and massing of the proposed built elements and associated operational elements (i.e. the traffic moving along the road); and the intervening landform and vegetation. The final ZoI will be informed by a range of computer generated Zones of Theoretical Visibility which will be prepared in accordance with Guidelines for Landscape and Visual Impact Assessment, and verified by site visits in both winter and summer.	informed by the ZTV.
Biodiversity	Construction and Operation: 2 km from the draft Order Limits based on proximity to statutory designated sites. The study area for assessment purposes varies according to specific biodiversity receptors, is informed by SSSI risk zones and for species by Natural England and best practice guidance from the Chartered Institute of Ecology and Environmental Management and other sources. International and/or European designated sites within 2km (or 30 km for bat sites) of the draft Order Limits.	Up to 4 km from the draft Order Limits with varying ZoI depending on the receptor. Committed developments within local plans within 12km of the International and/or European designated sites identified for bats based on the wider conservation area identified in the Sussex Bat Protocol, and relevant development not included within local plans based on stakeholder engagement and

Environmental topic	Scheme study area	Cumulative ZoI
		professional judgement.
Noise and Vibration	Construction: The construction noise and vibration study area is defined by proximity of closest identified receptors to the Scheme construction works, following which an appropriate buffer will be established around receptors. The specific location of construction work areas is still to be confirmed. Once the construction area is confirmed it is anticipated that the vibration study area will be a maximum of 100 m from the construction works and that the noise study area will extend a maximum of 300 m from the draft Order Limits.	Up to 600 m beyond the draft Order Limits.
	Operation: 600 m from the Scheme and the bypassed section of the existing A27 and extends to cover all areas subject to potentially significant effects from operational road traffic noise within the affected road network of the traffic model. cumulative impact assessment.	The affected road network. Cumulative effects will be inherently included within the noise assessment as the operational phase traffic data includes traffic associated with other developments, therefore, a separate cumulative assessment will not take place.
Geology and Soils	Construction and Operation: The land contamination assessment will include the draft Order Limits and an additional	Up to 500 m for geology, soils and land contamination and extended up to 2 km for

Environmental topic	Scheme study area	Cumulative ZoI
	radial zone of 250 m excluding the existing A27 to be de-trunked. The groundwater, surface water and potable water abstraction will consider a radial zone of 1 km from the draft Order Limits excluding the existing A27 to be de-trunked. For the remainder of the topic and other receptors e.g., soil resources and geological sites, the study area comprises the draft Order Limits only excluding the existing A27 to be de-trunked.	groundwater, surface water and potable water abstractions from the draft Order Limits excluding the existing A27 to be de-trunked.
Road Drainage and the Water Environment	Construction and Operation: In general, the study area is 1 km beyond the Scheme centreline for features of the water environment and 2 km upstream and downstream of the River Arun.	2 km beyond the Scheme centreline for features of the water environment, extended up to 4 km up and downstream of the River Arun.
Material assets and Waste	Construction: The study area for the following is defined by the draft Order Limits: a. Consideration of the sterilisation of mineral safeguarding sites and peat resources and for the use of material assets b. Waste arising from the Scheme The study area for the following is the south east England region (comprising Berkshire, Buckinghamshire, East Sussex, Hampshire, Isle of Wight, Kent,	Not applicable. As part of their planning function, Waste Planning Authorities (WPAs) are required to ensure that enough land is available to accommodate facilities for the treatment of all waste arising in the area, either within the WPA area, or through export to suitable facilities in other

Environmental topic	Scheme study area	Cumulative ZoI
	Oxfordshire, Surrey and West Sussex): a. Alternative materials (secondary and recycled aggregates) b. Waste management comprises the wider region within which waste management infrastructure (specifically landfill capacity) is located For hazardous waste management, the study area is defined as the whole of England. Operation: Operational phase waste management issues are scoped out of the assessment.	areas. Minerals Planning Authorities (MPAs) are similarly required to ensure an adequate supply of minerals, sufficient to meet the needs of national and regional supply policies, and local development needs. In preparing minerals and waste local plans, the WPAs and MPAs take account of waste generation and demand for minerals at the regional and sub-regional scale. It is therefore not necessary or feasible for each development within the region to, in effect, duplicate the function of the WPA and MPA as part of the EIA process. Therefore, as there are no likely significant effects on Material Assets and Waste, cumulative effects are scoped out of the assessment.

Environmental topic	Scheme study area	Cumulative ZoI
Population and Human Health	Construction and Operation: The study area for the assessment of impacts on land use and accessibility includes residential properties, community land and assets, businesses, development land, walking, cycling and horse riding (WCH) facilities (Public Rights of Way (PRoW), cycle routes and footways) and agricultural holdings within and up to 500 m from the draft Order Limits. Where specific impacts on receptors that are located beyond the 500 m study area could result in significant effects, these have been included within the assessment. The health assessment will draw on information and conclusions contained within the air quality, landscape and visual, noise and vibration, and climate assessments. Therefore, the cumulative ZoI will be as per these topics.	Up to 1 km for land use and access (receptors included beyond the study area will be included based on professional judgement). Health ZoI will be as per the topics which contribute to the health assessment i.e., construction dust, landscape and visual, noise and vibration, and road drainage and the water environment.
Climate	The study area for GHG assessment is the area within the draft Order Limits and the affected road network. It includes the Scheme's related activities and embodied carbon in materials used for construction and maintenance. The study area for climate resilience and in-combination climate effects is land within the Scheme draft Order Limits and the surrounding environment as informed by other environmental	Not applicable. The assessment uses the construction and operational phase traffic data which includes traffic associated with other developments. As a result the assessment to be reported within the ES will be

Environmental topic	Scheme study area	Cumulative ZoI
	topic assessments study areas. Therefore, no additional cumulative ZoI is identified beyond the other topic ZoI within this table.	inherently cumulative.

15.2.7 The following assessments, as noted in Table 15-1, will rely wholly, or in part, on the forecasts derived from the traffic model for the Do-Minimum scenario and the Do-Something scenario:

a. Chapter 5: Air Quality
b. Chapter 9: Biodiversity (as part of the air quality assessment on ecological protected sites)
c. Chapter 11: Noise and Vibration
d. Chapter 12: Population and Human Health (as part of the air quality and noise assessment on human health)
e. Chapter 13: Road Drainage and the Water Environment (as part of the calculations for road runoff and accidental spillages)
f. Chapter 14: Climate

15.2.8 As the influence of other development projects already forms an inherent part of the traffic forecasts on which the assessments of the Scheme's effects within these topics have been based or part based, by default cumulative effects are included and reported within their assessments that utilise the traffic model. Thus, where this is the case the assessments are effectively cumulative impact assessments in that they take account of all potential traffic generated by future development proposals. This also applies to the conclusions drawn where other topics have relied on the results of these assessments.

Initial list of developments

15.2.9 An initial long-list of other developments has been developed through a review of local planning documents and planning application portals from the surrounding local authorities. The search looked at major applications lodged on the local planning portals in the past 5 years within all parishes from ADC, the SDNP authority, Adur and Worthing District Council and Chichester District Council. The following local plans were used to inform the long-list of other developments:

a. Adur Local Plan 2017 (adopted on 14th December 2017) (Ref 1-14)
b. Worthing Core Strategy 2011(adopted 12th April 2011) (Ref 1-17)
c. Site Allocation Development Plan Document (adopted 22nd January 2019)
d. Chichester Local Plan 2014/2029 (adopted 14th July 2015) (Ref 1-15)

e. Adopted Arun Local Plan 2011-2031 (adopted 18th July 2018) (Ref 1-12)

f. Adopted South Downs Local Plan 2014-33 (adopted 02nd July 2019) (Ref 1-13)

g. Draft Worthing Local Plan 2016-2033 (emerging) (Ref 1-17)

h. Draft Horsham District Local Plan 2019-2036 (emerging) (Ref 1-16)

15.2.10 The traffic model developed for the Scheme assessment includes other developments in order to forecast future traffic flows, both with and without the Scheme, during both construction and operational phases. The other developments identified within the traffic model used the initial list generated using the above criteria. From this, an assessment was made of the likelihood of developments proceeding based on their planning status. Those developments likely to proceed were then included in the traffic model, using information from the planning portal on their number of houses or floor-space of development to calculate generated trips.

15.2.11 The developments included within the traffic model have been reviewed and selected in conjunction with the developments identified as part of the initial long-list of other developments.

15.2.12 Full details of the other development projects included within the traffic model (and the factors applied during the modelling process) will be presented in the transport assessment as part of the DCO submission.

15.2.13 The initial long-list of developments can be found in Appendix 1-A as a separate appendix to the *EIA Scoping Report*. The initial long-list is largely the same as presented at scoping stage with the addition of the Rampion 2 Offshore Windfarm which is discussed further below.

15.2.14 The initial long-list will continue to be developed through further reviews of local planning documents, planning applications, NSIPs (under construction, projects on the Inspectorate's programme of projects where a Scoping Report has or has not been submitted) and Transport and Works Act Orders to identify 'other developments' within the combined cumulative ZoI that should be considered within the cumulative effects assessment.

15.2.15 As the initial long-list is further developed, the other developments will be assigned a level of certainty based on the following criteria set out in guidance by the Planning Inspectorate:

Tier 1

a. development currently under construction.

b. permitted applications which have not yet been implemented.

c. submitted applications not yet determined.

Tier 2

d. projects on the Planning Inspectorate's Programme of Projects where a scoping report has been submitted.

Tier 3

e. projects on the Planning Inspectorate's Programme of Projects where a scoping report has not been submitted.

f. development identified in the relevant Development Plan (and emerging Development Plans).

g. development identified in other plans and programmes which set the framework for future development consents/approvals, where such development is reasonably likely to come forward.

Initial Findings

15.2.16 Based on a review of the initial long-list of developments and allocations, a number of developments are currently considered to have potential to generate significant cumulative effects with the Scheme based on their temporal scope, location and/or scale and nature, including but not limited to:

a. Rampion 2 Offshore Wind Farm – Offshore Wind Farm with a generating capacity of up to 1200MW together with associated electrical infrastructure. The windfarm is to be located adjacent to the existing Rampion Wind Farm, approximately 13 km off the Sussex Coast, the Red line boundary of the developed is currently proposed to cross the Scheme's draft Order Limits. The application is expected to be submitted to the Planning Inspectorate Q1 2022.

b. Land at Barnham, Eastergate and Westergate - Environmental scoping opinion for up 1,500 dwellings, community facilities, local centre (shops and services), a primary school and associated playing fields and early years provision (nursery). The development is located approximately 1.3 km south west of the Scheme. The planning reference is BN/112/20/EIS, and the status is undecided.

c. Land at Ford Airfield - Outline planning application (with all matters reserved except for access) for the development of up to 1,500 dwellings (Use Class C3), 60-bed care home (Use Class C2), up to 9,000 sqm of employment floorspace (Use Classes B1), local centre of up to 2,350 sqm including up to 900 m^2 retail/commercial (Use Classes A1-A5) and 1,450 m^2 community/leisure floorspace (Use Classes D1-D2), land for a two-form entry primary school (Use Class D1), public open space, allotments, new sports pitches and associated facilities, drainage, parking and associated access, infrastructure, landscape, ancillary and site preparation works, including demolition of existing buildings and part removal of existing runway hardstanding. The development is located approximately 1.1 km south of the Scheme. The planning reference is F/4/20/OUT, and the status is undecided

15.2.17 It should be noted that the long-list is subject to ongoing review and update, and thus further developments may be scoped into the assessment.

15.2.18 Consideration is also being given to the inclusion of other National Highway schemes as part of the cumulative effects assessment. It should be noted that schemes which will have a preferred route announcement before the DCO application has been submitted for the Scheme, and whose scheduled year of opening is before that for the Scheme, will be included as part of the baseline (i.e., it is assumed that they will be operational before the Scheme), and therefore will not be included in the cumulative effects assessment for the operational phase. The assessment will, however, take account of potential cumulative impacts which may occur during the construction phase, based on the anticipated construction timescales for these developments.

15.2.19 A review of sites allocated for waste disposal and mineral extraction is currently underway, and these will be considered at Stage 2 as applicable.

Next Steps

15.2.20 The initial long-list of developments will be further refined (aided by consultation with the relevant local planning authorities) to ensure that all developments with the potential to result in potentially significant cumulative effects when considered together with the Scheme are taken into account by each of the environmental topic specialists.

Stage 2 - Establishing a shortlist of 'other existing development

15.2.21 At Stage 2, developments on the long-list will be reviewed and those identified as not having the potential to result in likely significant cumulative effects will be excluded. This will include consideration of the nature and scale of the development, and potential temporal and/or spatial interactions with receptors affected by the Scheme in the relevant ZoIs. For some developments, particularly site allocations, it is likely that there will be limited information available regarding the delivery programme to understand temporal interactions. Where this is the case, a worst-case assumption of overlapping construction programmes (with the Scheme) and the development being fully operational by opening year will be applied. The short list will be developed through discussions with the local planning authorities and consideration by the environmental topic specialists.

Stage 3 - Information Gathering

15.2.22 Stage 3 will involve the collation of information relating to the short-listed schemes as per the Planning Inspectorates advice note 17, including the design and location, programme for construction, operation and demolition, and any environmental assessments carried out that set out baseline data and effects arising from the 'other existing development and/or approved development'.

Stage 4 - Assessment

15.2.23 Stage 4 will involve the assessment and identification of potentially significant cumulative effects in combination with the Scheme.

15.2.24 The ES will report the results of the assessment with particular consideration given to any significant cumulative effects that are identified, and the need for mitigation.

15.2.25 The criteria for determining the significance of residual cumulative effects will be based on the below:

a. the duration of effect, i.e., will it be temporary or permanent
b. the extent of effect, e.g., the geographical area of an effect
c. the type of effect, e.g., whether additive or synergistic
d. the frequency of the effect
e. the 'value' and resilience of the receptor affected
f. the likely success of mitigation.

15.2.26 Professional judgement will also be applied in order to determine the significance of residual effects.

15.2.27 These effects will be reported within the cumulative and in-combination effects ES chapter with full details of stages 1 to 4, including details of long-list and short-list of developments. Prior to the ES being completed, the long list will be updated with any new proposed developments identified.

15.3 In-combination effects

15.3.1 The combined effects of different environmental impacts from the Scheme on a single receptor will be determined when the environmental assessments for the separate environmental topics have been completed. As this data is not available at this stage, definitive in-combination effects cannot be determined.

15.3.2 There is potential for both adverse and beneficial in-combination effects associated with the Scheme. At this stage it can be determined that there is potential for in-combination effects on residential and other sensitive receptors (including community facilities, places of worship and schools) that are located adjacent or close to the Scheme. As the assessments of environmental effects progresses, identification of environmental resources and receptors where there is potential for more than one impact to be experienced, and therefore potential for interactions between these to occur, will be identified and assessed within the ES. *DMRB LA 104* alongside professional judgement.

15.3.3 It should be noted that some of the environmental assessments will consider the assessment of combined effects relating to receptors experiencing overlapping effects inherently within their own chapter and will therefore not be repeated in the cumulative and in-combination ES chapter. Examples of this include, but are not limited to:

a. The cultural heritage will consider the potential interaction of effects relating to visual intrusion, lighting and dark skies, noise and vibration, air quality, severance and access on receptors.

b. The biodiversity assessment will consider the effects of noise and vibration, lighting, air quality (including construction dust and nitrogen deposition) and how impacts to the water environment could affect ecological receptors.

c. The population and human health assessment will consider the combined residual effects from other assessment topics (noise, air quality and landscape and visual) which could affect people's enjoyment of a PRoW, community facility or public open space, and associated health indicators.

d. The road drainage and the water environment assessment will consider the effects of traffic in combination with changes that would be made to the water environment as well as the combined effects of road run-off on biodiversity, specifically on aquatic biodiversity and habitats.

15.3.4 As mentioned above, it is difficult to provide definitive details on the in-combination effects arising as a result of the Scheme, but an early prediction based on professional judgement of the likely in-combination effects is provided below.

15.3.5 It is currently predicted that during the Scheme construction phase there could be potential adverse in-combination effects on the following receptors:

a. Residential properties in Walberton, Binsted and Tortington in close proximity with the Scheme.

b. Education facilities close to the Scheme, including, for example Walberton and Binsted C of E Primary School and Walberton Pre-School.

c. Community facilities, including places of worship, village halls and medical facilities that are positioned close to the Scheme.

15.3.6 It is likely that such receptors may experience combined impacts during the construction phase. This is due to a decrease in air quality (albeit not significant) resulting from the increased construction traffic operating within the draft Order Limits and in the local area, increased dust emissions arising from the construction earth works, noise, vibration and visual effects resulting from the construction activity and also potentially severance if receptors are impacted by the closure or diversions of roads and PRoWs during the construction phase. The closer the receptors are to the Scheme, the higher the cumulative effect classification is likely to be. Properties between Tye Lane and Yapton Lane close to the section of the Scheme in cutting as well as properties close to the overbridges at Tye Lane, Yapton Lane, Binsted Lane and Tortington Lane are most at risk of a higher classification of in-combination effects particularly in regard to noise and vibration. The receptors listed above are also likely to experience adverse in-combination effects associated with air quality, noise and visual effects during the operational phase of the Scheme due to the introduction of the

new dual carriageway in an area previously occupied with smaller local roads.

15.3.7 During the operational phase of the Scheme, it is also predicted that there is likely to be beneficial in-combination effects associated with a reduction in road traffic on the existing A27. Residential receptors at Havenwood Park and parts of Arundel including Canada Road and the north end of Jarvis Road are likely to experience beneficial in-combination effects resulting from air quality, noise and visual improvements.

15.3.8 The likelihood of in-combination significant effects will be reported in the ES, following completion of the individual environmental topic assessments.

15.4 Summary of effects

15.4.1 This chapter has set out the assessment methodology for the cumulative and in-combination effects assessment. A full cumulative effects assessment and in-combination effects assessment will be undertaken as part of the EIA and reported in the ES.

16. Summary of effects

16.1.1 Chapters 5 -15 present a preliminary assessment of the potential significant environmental effects as associated with Scheme construction and operation. Table 16-1 provides a high level summary of these likely significant environmental effects.

16.1.2 These effects are those that arise after the implementation of embedded mitigation mentioned in *Section 2.4*, but before the implementation of further mitigation that is identified as part of the ongoing EIA and reported within the ES. As a result, the summary of effects presented below are determined to be a worst-case scenario. Ongoing work is being undertaken with regard to further mitigation measures, which aims to reduce these effects. Ongoing consultation and focus groups with stakeholders will continue to take place.

16.1.3 The potential significant environmental effects as reported in Table 16-1 will be subject to further investigation and confirmed or otherwise in the ES.

Table 16-1 Summary of preliminary assessment of potential significant environmental effects

Topic	Preliminary assessment of potential significant environmental effects	
	Construction stage	**Operational stage**
Air quality	Temporary **adverse** effects could arise from construction phase traffic management and construction HGV movements.	No potential significant effects anticipated.
Cultural heritage	Permanent **adverse** effects on the setting of listed buildings and scheduled monuments along the Scheme corridor including: a. Tortington Priory (scheduled monument) b. Arundel Castle (scheduled monument; NHLE 1012500), (Grade I listed building; NHLE 1027926) (Grade II* Registered Park and Garden (NHLE 1000170) c. Church of St Andrew, Ford (Grade I listed building; NHLE 1233989) d. Avisford Park Hotel (Grade II listed building; NHLE 1222534) e. Swiss Cottage (Grade II listed building; NHLE 1222535) f. Beam Ends (Grade II listed building; NHLE 1222465) g. The Glebe House, Binsted (Grade II listed building; NHLE 1221993)	Permanent **beneficial** effects to the setting of heritage assets within Arundel as a result of the de-trunking of the existing A27, these include: a. Goblestubbs Copse earthworks (Scheduled Monument NHLE 1005895) a. Arundel Castle (scheduled monument; NHLE 1012500), (GI listed building; NHLE 1027926) (Grade II* Registered Park and Garden (NHLE 1000170) b. Park Farm (Grade II listed buildings NHLE1353713, 1027936 and 1247969) Permanent **adverse** effects to Church of St Mary's, Binsted (Grade II* listed building; NHLE 1274877) due to the proximity to the Scheme.

Topic	Preliminary assessment of potential significant environmental effects	
	Construction stage	**Operational stage**
	h. Church of St Mary's, Binsted (Grade II* listed building; NHLE 1274877) i. Meadow Lodge (Grade II listed building; NHLE 1274878) j. Morleys Croft (Grade II listed building; NHLE 1222201) k. The Thatched Cottage (Grade II listed building, NHLE 1274880) l. Tortington Priory Barn, to the north of Priory Farm (Grade II* listed building; NHLE 1221996) m. Windmill, Fitzalan Road (Grade II listed building NHLE 1353714) n. The Camillia Hotel (Grade II listed building; NHLE 1027602) Permanent **adverse** effects on non-designated archaeological assets due to the loss or truncation of archaeological remains, including: a. Non-designated Mesolithic site at Avisford Park (A20) b. Non-designated Iron Age earthworks (A32) c. Non-designated Roman Villa at Blacksmith's Corner, Walberton (A52)	

Topic	Preliminary assessment of potential significant environmental effects	
	Construction stage	**Operational stage**
	d. Non-designated Chichester to Arundel Roman Road (A71) e. Non-designated medieval pits (A98) f. Non-designated kilns (A145) g. Non-designated medieval park at Tortington (A90) h. Non-designated medieval ridge and furrow identified in aerial photographs and LiDAR data (A100, A249, A252) i. Non-designated medieval moated site (A93) j. Non-designated deserted medieval village (A99) k. Non-designated industrial activities (A143) l. Non-designated post-medieval field boundaries identified in aerial photographs and LiDAR data (A247) m. Non-designated undated earthworks identified in aerial photographs and LiDAR data (A192, A193, A242, A243, A244, A245, A246) n. Non-designated ditch and embankment (A217) o. Non-designated flood defences identified in aerial photographs and LiDAR data (A250)	

Topic	Preliminary assessment of potential significant environmental effects	
	Construction stage	**Operational stage**
	p. Non-designated drainage features identified in aerial photographs and LiDAR data (A248) q. Non-designated post-medieval house platforms identified in aerial photographs and LiDAR data (A251) r. Non-designated lynchets (A96, A134) Permanent **adverse** effects on non-designated historical landscapes due to the severance during construction of the Scheme and presence of the Scheme within the historic landscape: a. Non-designated Avisford Park (A137) b. Non-designated dispersed historic landscape of Binsted c. Non-designated Tortington medieval landscape d. Non-designated Arundel medieval landscape Permanent **adverse** effects on previously unrecorded paleoenvironmental and archaeological remains dating to all the prehistoric periods as well as to the Roman, medieval and post-medieval periods.	
Landscape and visual	Temporary **adverse** landscape effects to the following Local Landscape Character Areas (LLCAs): a. LLCA 2: Walberton Settled Woodland	Permanent **adverse** landscape effects as a result of the introduction of new highway infrastructure within the open landscape to the following LLCAs:

Topic	Preliminary assessment of potential significant environmental effects	
	Construction stage	**Operational stage**
	b. LLCA 3: Hooe Farm c. LLCA 4: Avisford Park d. LLCA 5: Walberton e. LLCA 6: Binsted Farmland f. LLCA 7: Binsted Rife g. LLCA 8: Binsted h. LLCA 9: Tortington Rife i. LLCA 10: Tortington Valley Sides j. LLCA 11: Lower Arun Valley Floodplain k. LLCA 12: Lyminster Arun Valley Sides Temporary **adverse** visual effects due to views of construction activity: a. for visitors to the South Downs National Park (SDNP) and Arundel, such as views from Arundel Castle, of construction activity within the River Arun floodplain associated with the construction of the viaduct. b. for residents of Arundel with views across the River Arun floodplain to the south. c. for residents of Tortington, Binsted, and Walberton.	a. LLCA 3 Hooe Farm b. LLCA 4 Avisford Park c. LLCA 7 Binsted Rife d. LLCA 8 Binsted e. LLCA 9 Tortington Rife f. LLCA 10 Tortington Valley Sides g. LLCA 11 Lower Arun Valley Floodplain Permanent **adverse** visual effects due to the introduction of the Scheme into views: a. for visitors to the SDNP and Arundel Castle as a result of views of the viaduct across the River Arun floodplain. b. for residents of Arundel with views across the River Arun floodplain to the south. c. for residents of Tortington, Binsted, and Walberton. d. for residents at Ford with views north across the River Arun floodplain. e. for users of PRoW crossed by the Scheme and in the vicinity of Scheme f. for road users and rail passengers.

Topic	Preliminary assessment of potential significant environmental effects	
	Construction stage	**Operational stage**
	d. for residents at Ford with views north across the River Arun floodplain. e. for recreational users of Public Rights of Way (PRoW) crossed by or in close proximity to the Scheme, including those adjacent to the Church of St Mary's, Binsted and Tortington Manor. f. for road and rail users.	Permanent **beneficial** effects within the SDNP and at Arundel through the removal of signage, introduction of planting, and reduction in visible traffic on the existing A27.
Biodiversity	Permanent **adverse** effects to potential veteran and ancient trees. Temporary **adverse** effects to bats. Temporary **adverse** effects to hazel dormice. Temporary **adverse** effects to fish. Temporary **adverse** effects to water vole. Temporary **adverse** effects to fungi, lichens, barn owls and invertebrates (terrestrial).	Temporary **adverse** effects to bats due to severance and road traffic. Permanent **adverse** effects to barn owls due to increased risk of collision with vehicles. Permanent **beneficial** effects to fungi, lichens and invertebrates (terrestrial).
Geology and soils	Temporary and permanent **adverse** effect due to the loss of agricultural land. Permanent **adverse** effects to standard geological site SU90/86 due to potential for damage to, or loss of this asset.	No potential significant effects anticipated.

Topic	Preliminary assessment of potential significant environmental effects	
	Construction stage	**Operational stage**
	Permanent **beneficial** effects should any existing land contamination require remediation or removal. Detailed assessment, which will be undertaken as part of the ES, will confirm if the beneficial effects are likely to be significant.	
Material assets and waste	No potential significant effects anticipated.	No potential significant effects anticipated (scoped out of the assessment).
Noise and vibration	Temporary **adverse** noise and vibration effects for Noise Sensitive Receptors (NSRs) in close proximity to the works in Walberton, Binsted and Tortington. Those most at risk will include properties adjacent to the sections of the Scheme in cutting and the overbridges.	Permanent **adverse** noise effects at NSRs in Walberton, Binsted and Tortington. Permanent **adverse** noise effects for NSRs south of Walberton and in parts of south west Arundel and south and east of Crossbush junction. Permanent **beneficial** noise effects for residents of Havenwood Park and parts of Arundel close to the existing A27 (such as properties on Canada Road and the north end of Jarvis Road).
Population and human health	Temporary and permanent **adverse** effects on community assets due to the temporary closure of Avisford Park Golf Club and permanent land take from the golf club.	Permanent **beneficial** effects for walkers, cyclists and horse riders as a result of a new PRoW on Tye Lane, new overbridge by Tye Lane, and a new PRoW that connects to the existing PRoW 350 footpath to Binsted Lane.

Topic	Preliminary assessment of potential significant environmental effects	
	Construction stage	**Operational stage**
	Temporary and permanent **adverse** effects on the business, including the temporary closure and permanent land take, at the Avisford Park Golf Club. Permanent **adverse** effects on the business due the permanent land take from the Billycan Camping. Temporary and permanent **adverse** effects on agricultural land holdings. Temporary **adverse** effects for walkers, cyclists and horse riders.	
Road drainage and water environment	No potential significant effects anticipated.	No potential significant effects anticipated.
Climate	No potential significant effects anticipated.	No potential significant effects anticipated.
Cumulative and in-combination effects	It is not possible to determine whether there are any potential significant effects at this stage of the project.	It is not possible to determine whether there are any potential significant effects at this stage of the project.
Major accidents and disasters	No potential significant effects anticipated.	No potential significant effects anticipated.

Topic	Preliminary assessment of potential significant environmental effects	
	Construction stage	Operational stage
Habitat Regulation Assessment (HRA)	HRA Screening identified a potential **adverse** effect in relation to the bat populations of Singleton & Cocking Tunnels SAC.	

17. Glossary

Annual Average Daily Traffic	AADT is a measure used in transportation engineering and is the number of vehicles that will use a new or improved road on an average day
Air Quality Management Area (AQMA)	Places where air quality objectives are not likely to be achieved. Where an AQMA is declared, the local authority is obliged to produce an Action Plan in pursuit of the achievement of the air quality objectives.
Conservation Area	An area of special environmental or historic interest or importance, of which the character or appearance is protected (Section 69 of the Planning (Listed Buildings and Conservation Areas) Act 1990).
Cumulative Effects	Effects upon the environment that result from the incremental impact of an action when added to other past, present or reasonably foreseeable actions. Each impact by itself may not be significant but can become a significant effect when combined with other impacts.
Department for Transport	Government department responsible for the transport network in England, and for aspects of the transport network in the devolved administrations.
Design Manual for Roads and Bridges	A series of 15 volumes that provide standards, advice notes and other published documents relating to the design, assessment and operation of trunk roads, including motorways in the United Kingdom, and, with some amendments, the Republic of Ireland.
Development Consent Order	The means of applying for consent to undertake a Nationally Significant Infrastructure Project (NSIP). NSIPs include, for example, major energy and transport projects.
Draft Order Limits	Land anticipated to be required temporarily and/or permanently for the construction, operation and maintenance of the Scheme.
Environmental Impact Assessment	A process by which information about environmental effects of a proposed development is collected, assessed and used to inform decision making. For certain projects, EIA is a statutory requirement.

Environmental effect	The consequence of an action (impact) upon the environment such as the decline of a breeding bird population as a result of the removal of hedgerows and trees.
Environmental impact	The change in the environment from a development such as the removal of a hedgerow
Environmental Management Plan	A site specific plan developed to ensure that appropriate environmental management practices are followed during the construction phase of a project.
Environmental Statement	A document produced in accordance with the EIA Directive as transposed into UK law by the EIA Regulations to report the results of an EIA
Flood Zone Three	This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%), or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.
Flood Zone Two	This zone comprises land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% – 0.1%), or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.5% – 0.1%) in any year.
Grade Separated Junction	A junction where the conflicting traffic flows are kept apart, usually by means of a bridge or tunnel.
Green Bridge	Artificial structure over road or rail infrastructure which is either vegetated or provides wildlife function.
Mitigation	Measures including any process, activity, or design to avoid, reduce, remedy or compensate for negative environmental impacts or effects of a development
Nationally Significant Infrastructure Projects (NSIP)	NSIP are large scale developments such as certain new harbours, power generating stations (including wind farms), highways developments and electricity transmission lines, which require a type of consent known as 'development consent' under procedures governed by the Planning Act 2008 (and amended by the Localism Act 2011).
Preliminary Environmental Information	PEI is defined in the EIA Regulations as: 'information referred to in Part 1 of Schedule 4 (information for inclusion in environmental statements) which: (a) has been compiled by the applicant; and

	(b) is reasonably required to assess the environmental effects of the development (and of any associated development).'
Principal Aquifer	These are layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, principal aquifers are aquifers previously designated as major aquifer.
Receptor	A component of the natural or man-made environment that is affected by an impact, including people.
Scheduled Monument	A 'nationally important' archaeological site or historic building, given protection against unauthorised change and included in the Schedule of Monuments kept by the Secretary of State for Culture, Media and Sport. The protection given to scheduled monuments is given under the Ancient Monuments and Archaeological Areas Act 1979
Secondary A aquifer	These 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. These are generally aquifers formerly classified as minor aquifers.
Secondary B aquifer	These are predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering. These are generally the water-bearing parts of the former non-aquifers.
Setting	The surroundings within which a heritage asset is experienced and any element which contributes to the understanding of its significance.
Source Protection Zone	Source Protection Zones ("SPZ") show the risk of contamination from any activities that might cause pollution to groundwater sources such as wells, boreholes and springs used for public water supplies. The closer the activity, the greater the risk. SPZs can comprise of up to three main zones (inner, outer and total catchment). A fourth zone of special interest can also occasionally be applied to a groundwater source.
Water Framework Directive	The Water Framework Directive ("WFD") introduced a new system for monitoring and classifying the quality of surface and ground waters. The Directive requires that Environmental

	Objectives be set for all surface waters and groundwater to enable them to achieve Good Ecological Potential/Status by a defined date.

18. Key Abbreviations

AADT	Annual Average Daily Traffic
ADC	Arun District Council
ALC	Agricultural Land Classification
AOD	Above Ordinance Datum
APIS	Air Pollution Information System
AQMA	Air Quality Management Area
AQS	Air Quality Strategy
BGS	British Geological Survey
BS	British Standard
CCRA	Climate Change Risk Assessment
CCTV	Close Circuit Television
COPA	Control of Pollution Act
CRTN	Calculation of Road Traffic Noise
DCO	Development Consent Order
DfT	Department for Transport
DMRB	Design Manual for Roads and Bridges
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
END	Environmental Noise Directive
EPS	European Protected Species
ES	Environmental Statement
EU	European Union
GHG	Greenhouse Gases
HGV	Heavy Goods Vehicle
HRA	Habitats Regulations Assessment
IAQM	Institute of Air Quality Management
IPCC	Intergovernmental Panel on Climate Change
LCA	Landscape Character Area
LGS	Local Geological Sites
LNR	Local Nature Reserve
LSOA	Lower Super Output Areas
LVIA	Landscape and Visual Impact Assessment

MCA	Mineral Consultation Areas
MSA	Mineral Safeguarding Areas
NCA	National Character Areas
NCN	National Cycle Network
NH	National Highways
NHLE	National Heritage List for England
NMU	Non-Motorised Users
NNR	National Nature Reserve
NO_x	Nitrogen Oxide
NPPF	National Planning Policy Framework
NPS	National Policy Statement
NPSE	Noise Policy Statement for England
NPSNN	National Policy Statement for National Networks
NRMM	Non-Road Mobile Machinery
NSIP	Nationally Significant Infrastructure Report
OS	Ordnance Survey
PA 2008	Planning Act 2008
PCM	Pollution Climate Mapping
PEI	Preliminary Environmental Information
PPE	Personal Protective Equipment
PRoW	Public Right of Way
PWS	Private Water Supplies
RBMP	River Basin Management Plan
RHPG	Registered Historic Park and Garden
SAC	Special Area of Conservation
SLA	Special Landscape Area
SPA	Special Protection Area
SPZ	Source Protection Zones
SRN	Strategic Road Network
SSSI	Sites of Special Scientific Interest
SuDS	Sustainable Drainage Strategy
TPO	Tree Preservation Order
VMS	Variable Messaging Systems

VP	Viewpoints
WAC	Waste Acceptance Criteria
WFD	Water Framework Directive
WSCC	West Sussex County Council
ZTV	Zone of Theoretical Visibility
ZVI	Zone of Visual Influence