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9 Geology and Soils

9.1 Introduction

9.1.1 This chapter presents the Preliminary Environmental Information (PEI) in relation to the geology and soils assessment. It provides information on bedrock and superficial deposits, including geological designations and sensitive or valuable non-designated features, soil resources and potential land contamination.

9.1.2 There may be interrelationships related to the potential effects on geology and soils and other disciplines. Therefore, please also refer to the following chapters:

- Chapter 6: Biodiversity
- Chapter 7: Climate
- Chapter 10: Landscape and Visual Effects
- Chapter 11: Material Assets and Waste
- Chapter 13: Population and Health
- Chapter 14: Road Drainage and the Water Environment.

9.1.3 The methodology used will follow the requirements of the *Design Manual for Roads and Bridges* (DMRB) *LA 109 Geology and Soils* (Highways England, 2019)[1] and the Environment Agency's Land Contamination: Risk Management (LCRM) guidance (Environment Agency, 2020)[2].

9.1.4 In accordance with DMRB LA 109, geotechnical hazards such as ground instability are outside the scope of this chapter and are instead addressed as part of the geotechnical design in line with DMRB CD 622 Managing Geotechnical Risk (Highways England, March 2020)3. Information on land instability is included in the PSSR, Section 4.64.

9.2 Legislative and Policy Framework

Legislation

9.2.1 The following key legislation is relevant to this assessment:

- Wildlife and Countryside Act 1981 (as amended)
- National Parks and Access to the Countryside Act 1949 (as amended)
- Part IIA of the Environmental Protection Act (EPA) 1990 (the "contaminated land" regime) (as amended)
- Water Resources Act 1991 (WRA 1991) (as amended)
- Town and Country Planning Act 1990 (as amended)
- Building Act 1984 and the Building Regulations 2010 (as amended)

[1] Highways England (2019) Design Manual for Roads and Bridges LA 109 Geology and Soils, available at: https://www.standardsforhighways.co.uk/prod/attachments/adca4c7d-4037-4907-b633-76eaed30b9c0?inline=true [accessed 31 August 2021]
[2] Environment Agency (2020) Land Contamination: Risk Management, available from https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm [accessed 31 August 2021]
[3] Highways England (2020) Design Manual for Roads and Bridges CD 622 Managing Geotechnical Risk, available at: https://www.standardsforhighways.co.uk/prod/attachments/ff5ed991-71ed-4ff2-9800-094e18cd1c4c?inline=true [accessed 31 August 2021]
[4] Highways England (2019) A66 Northern Trans-Pennine Project Preliminary Sources Study Report. Ref. HE565627-ARC-HGT-A66-RP-CE-2005. HA GDMS Report Reference 31259, 17th September 2019

- Water Act 2003 (as amended)
- Environmental Permitting (England and Wales) (Amendment) Regulations 2016
- Highways Act 1980 Section 105A
- Groundwater (England and Wales) Regulations 2009 SI 2902
- Water Framework Directive (2000/60/EC) (as amended)
- The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017
- The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017

National policy statement for national networks

9.2.2 The primary policy basis for deciding whether or not to grant a Development Consent Order (DCO) is the *National Policy Statement for National Networks (NPSNN)* (Department for Transport, 2014)[5], which sets out policies to guide how DCO applications will be decided and how the effects of national networks infrastructure should be considered by the relevant decision maker. The policies for geological conservation are detailed within the Biodiversity and Ecological Conservation Chapter and include statements that:

"Geological conservation relates to the sites that are designated for their geology and/or their geomorphological importance…As a general principle, and subject to the specific policies below, development should avoid significant harm to biodiversity and geological conservation interests, including through mitigation and consideration of reasonable alternatives." (NPSNN paragraphs 5.20 and 5.25)

9.2.3 The *NPSNN* also advises:

"In taking decisions, the Secretary of State should ensure that appropriate weight is attached to designated sites of international, national and local importance, protected species, habitats and other species of principal importance for the conservation of biodiversity, and to biodiversity and geological interests within the wider environment." (NPSNN paragraph 5.26)

9.2.4 Table 9-1: Relevant NPSNN policies for the geology and soils assessment identifies identifies the *NPSNN* policies relevant to the cultural heritage assessment methodology.

Table 9-1: Relevant NPSNN policies for the geology and soils assessment

Relevant NPSNN paragraph reference	Requirement of the NPSNN (paraphrase)
5.168	Applicants should identify any effects and seek to minimise impacts on soil quality, taking into account mitigation measures proposed.
5.168	Where possible, developments should be on previously developed brownfield sites, ensuring that consideration is given to the risk posed by land contamination and how it will be addressed.
5.168	The economic and other benefits of the best and most versatile agricultural land (BMV) should be taken into account. Where significant development on agricultural land is necessary, the project

[5] Department for Transport (2014) National Policy Statement for National Networks, available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/387222/npsnn-print.pdf accessed 06/09/21

Relevant NPSNN paragraph reference	Requirement of the NPSNN (paraphrase)
	should seek to use areas of poorer quality land in preference to that of a higher quality. The project should also identify any effects, and seek to minimise impacts, on soil quality, taking into account any mitigation measures proposed.
5.169	Mineral resources on the proposed site should be safeguarded as far as possible.
5.176	The economic and other benefits of the best and most versatile agricultural land (BMV) should be taken into account. Little weight should be given to the loss of agricultural land in grades 3b, 4 and 5, except in areas (such as uplands) where particular agricultural practices may themselves contribute to the quality and character of the environment or the local economy.
5.22	The environmental statement should clearly set out any likely significant effects on internationally, nationally and locally designated sites of geological conservation importance.
5.23	It should be demonstrated how the project has taken advantage of opportunities to conserve and enhance geological conservation interest.

National planning policy framework

9.2.5 The NPPF originally published in March 2012 and most recently updated in July 2021, sets out the government's planning policies for England and provides a framework within which locally prepared plans can be produced. The NPPF is "an important and relevant matter to be considered in decision making for NSIP".

Local planning policies

9.2.6 The following regional and local plan policies are relevant to the assessment:

- Eden *Core Strategy Development Plan*, March 2010 (Eden District Council, 2010)[6], Policy CS16
- County *Durham Development Plan* (adopted 2020) (Durham County Council, 2020)[7], Policy 42 and Policy 15
- Richmondshire *Local Plan 2012-2028 Core* Strategy (Richmondshire District Council, 2014)[8] Policy CP12

[6] Eden District Council (2010) Core Strategy Development Plan Document. Available at: https://www.eden.gov.uk/media/5551/core-strategy-dpd-final.pdf [Accessed 31 August 2021]
[7] Durham County Council (2020) County Durham Plan. Adopted 2020. Available at: https://www.durham.gov.uk/media/34069/County-Durham-Plan-adopted-2020-/pdf/CountyDurhamPlanAdopted2020vDec2020.pdf?m=637424969331400000 [Accessed 31 August 2021]
[8] Richmondshire District Council (2014) Richmondshire Local Plan 2012-2018 Core Strategy. Adopted 9 December 2014. Available at: https://www.richmondshire.gov.uk/media/9616/core-strategy-2012-28.pdf [Accessed 31 August 2021]

- North Pennines Area of Outstanding Natural Beauty (AONB) *Geodiversity Audit and Action Plan, 2018-2022* (North Pennines Area of Outstanding Natural Beauty and UNESCO Global Geopark, 2018)[9].
- County *Durham Geodiversity Audit 2004* (Durham County Council, 2004)[10]
- Cumbria Local Geodiversity Action Plan January 2009[11]
- North Yorkshire County Council North Yorkshire Minerals and Waste Plan (Minerals and Waste Development Scheme, Seventh Review 2017)[12]

Standards and guidance

9.2.7 In addition to compliance with the *NPSNN* and *NPPF*, this assessment has been compiled in accordance with professional standards and guidance. The standards and guidance which relate to the assessment are:

- The Ministry of Housing, Communities & Local Government, 2021[13] ("*Conserving and enhancing the natural environment*")

9.3 Assessment Methodology

9.3.1 The methodology for the assessment of geology and soils for the PEI Report follows the requirements of *DMRB LA 109* and considers potential impacts on:

- Geodiversity sites
- Soil resources
- Human health, surface water and groundwater arising from the project's interaction with contamination.

9.3.2 Baseline conditions have been established through a desk based review of information from a range of sources and through engagement with stakeholders.

9.3.3 The provisional receptor value or sensitivity has been determined with reference to Table 3.11 of *LA 109* (ranging from Very High to Negligible). Appendix 9.1 Potential Contamination Sources and Receptors details the key receptors identified at this stage of assessment and their location relative to the draft DCO boundary for each scheme or scheme alternative. The draft DCO boundaries are shown in Figure 9.1 – Study area. It also outlines their assigned provisional value determined with reference to Table 3.11 of *LA 109*.

[9] North Pennines Area of Outstanding Natural Beauty and UNESCO Global Geopark (2018) Geodiversity Action Plan 2018-2022. Available at: https://www.northpennines.org.uk/wp-content/uploads/2019/03/North-Pennines-Geodiversity-Action-Plan-2018-to-2022.pdf [Accessed 31 August 2021]
[10] Durham County Council (2004) Durham Geodiversity Audit. Available at: https://www.durham.gov.uk/media/3683/County-Durham-Geodiversity-Audit/pdf/CountyDurhamGeodiversityAudit.pdf?m=635901951858470000 [Accessed 31 August 2021]
[11] Cumbria RIGS Group (2009) A Local Geodiversity Action Plan for Cumbria. Prepared by Cumbria RIGS Group. Available at: https://cumbria.gov.uk/elibrary/Content/Internet/538/755/1929/17716/17717/4215011314.PDF [Accessed 31 August 2021]
[12] North Yorkshire County Council *North Yorkshire Minerals and Waste Plan* (*Minerals and Waste Development Scheme*, *Seventh Review 2017)* available at: https://www.northyorks.gov.uk/sites/default/files/fileroot/Planning%20and%20development/Minerals%20and%20waste%20planning/Minerals_and_waste_development_scheme_-_seventh_review_2017.pdf [Accessed 31 August 2021]
[13] Ministry of Housing, Communities & Local Government (2021) National Planning Policy Framework, available at: https://www.gov.uk/government/publications/national-planning-policy-framework--2 [Accessed 31 August 2021]

9.3.4 The potential magnitude of impact on the identified receptors has been determined with reference to Table 3.12 of *LA 109* (ranging from major to negligible). The assessment of impact significance is based on receptor value and magnitude of effect, as detailed in *DMRB LA 104 Environmental assessment and monitoring* (Highways England, 2020)[14] using the significance matrix in Table 3.8.1. Where Table 3.8.1 includes two signficance categories, evidence will be provided to support the reporting of a single significance category. Significant effects are those that have a moderate impact or above. More detailed assessment of the identified potential significant effects will be carried out as part of the Environmental Statement (ES).

9.3.5 Further details of the methodology for establishing baseline geology and ground conditions, and for the assessment of geodiversity, soil and contamination, are provided below.

[14] Highways England (2020) Design Manual for Raods and Bridges LA 104 Environmental Assessment and Risk, available at: https://standardsforhighways.co.uk/dmrb/search/0f6e0b6a-d08e-4673-8691-cab564d4a60a [Accessed 31 August 2021]

Geological context

9.3.6 The geology and ground conditions present across the study area (defined in Section 9.5: Study Area) are important in setting the context for the assessment, in terms of materials and resources present, and the potential pathways for contamination to migrate.

9.3.7 The nature and distribution of superficial deposits and bedrock across the study area has been determined through review of published geological information and historical ground investigation information. Project specific ground investigation was completed during the first quarter of 2021 but final reports were not available at the time of writing. Once available, the findings of this investigation will be used to inform the ES.

9.3.8 The information reviewed to determine the baseline geology and ground conditions is summarised in Table 9-2: Geological information sources.

Table 9-2: Geological information sources

Information Source	Description of information
Primary Sources Study Report (PSSR) (Highways England, 2019)	Information is provided on former and current land uses, geology, hydrogeology, statutory designations, mining, landfills and earthworks together with a geo-environmental preliminary conceptual site model
Desk Study – *Karst Risk Assessment* (Highways England)[15]	Provides information on karst and dissolution features across A66 schemes, and assesses risks based on underlying geology
British Geological Survey (BGS) Mapping (Britsih Geological Survey, 2021)[16]	Solid and drift mapping across the scheme to 1:50,000 scale including details of the type of bedrock present and superficial deposits including peat, alluvium and glacial till
BGS GeoIndex (British Geological Survey, 2021)[17]	Published historical borehole logs available online, provided by the BGS
Coal Authority Viewer (Coal Authority, 2021)[18]	Information is provided on past and current recorded coal mining activities, at surface (opencast) and depth (underground)
Technical Note HE565627-AMY-EGT-S00-RP-LG-000001 (Amey, 2021)[19]	This short technical note gives a very brief summary of geotechnical conditions across the western half of the project as encountered during the 2021 ground investigation.

[15] Highways England A66 NTP Integrated Project Team. (no date). Desk Study – Karst Risk Assessment. Ref. HE565627-AMY-EGT-S00-RP-LG-000005
[16] British Geological Survey (2021) Mapping, available at: https://www.bgs.ac.uk/technologies/web-map-services-wms/web-map-services-geology-50k/ [Accessed 31 August 2021]
[17] British Geological Survey (2021) GeoIndex, available at: https://www.bgs.ac.uk/map-viewers/geoindex-onshore/ [Accessed 31 August 2021]
[18] Coal Authority (2021) Interactive Map, available at: https://mapapps2.bgs.ac.uk/coalauthority/home.html [Accessed 31 August 2021]
[19] Amey (2021) *Technical Note HE565627-AMY-EGT-S00-RP-LG-000001*

9.3.9 The indicated bedrock and superficial geology are summarised in Figures 9.2 – Solid Geology and 9.3 – Drift Geology respectively.

Geodiversity assessment

9.3.10 Geodiversity impacts could occur as a result of direct loss of, or damage to, important sites through construction. Some geodiversity sites can also be impacted through changes to the local hydrogeology, as reported in Chapter 14: Road Drainage and the Water Environment.

9.3.11 The geodiversity assessment has considered the presence of geological designations and sensitive or valuable non-designated features. This has included the locations and reason for designation of geologically designated SSSI, Local Geology Sites (LGS) (formerly Regionally Important Geological Sites (RIGS), GCR sites and UNESCO Global Geoparks.

9.3.12 The geodiversity data sources, stakeholder engagement and a description of the information sought or obtained from each are summarised in Table 9-3: Geodiversity information sources.

Table 9-3: Geodiversity information sources

Information Source	Description of information
Data sources	
Defra Multi-Agency Geographic Information for the Countryside (*MAGIC) website* (Multi-Agency Geographic Information for the Countryside, 2020)[20]	Provides information on geological conservation areas such as SSSI and Geological Descriptions.
Cumbria geoconservation interactive mapping (Cumbria Biodiversity Data Centre, 2020)[21]	Provides information on LGSs in Cumbria.
Eden District Council (EDC) *interactive mapping* (Eden District Council, 2020)	Eden District Council's *interactive map* showing location of RIGS, now LGSs and SSSI.
North Pennines AONB website (North Pennines, 2020)[22]	Provides information on the UNESCO Global Geopark, located in the North Pennines AONB.
Stakeholder engagement	
North Pennines AONB, telecon February 2021	Consultation aimed to determine requirements in relation to the UNESCO Global Geopark designation.

[20] Multi-Agency Geographic Information for the Countryside (2020) Interactive Map, available at: https://magic.defra.gov.uk/magicmap.aspx [Accessed 31 August 2021]
[21] Cumbria Biodiversity Data Centre (2020) Cumbria GeoConservation - Geological Sites Map, available at: https://www.cbdc.org.uk/cumbria_geoconservation_home/cumbrialgs-publicmap/ [Accessed 31 August 2021]
[22] North Pennines (2020) North Pennines Area of Outstanding Natural Beauty, available at: https://www.northpennines.org.uk/unesco-global-geopark/ [Accessed 31 August 2021]

Information Source	Description of information
	It was confirmed that the AONB designation would take precedence over the Geopark designation. No further action at this time.
BGS, telecon December 2020	BGS confirmed that they do not hold the details of designated geoconservation sites.

9.3.13 The indicated geodiversity sites based upon the above are summarised in Figure 9.4 – Geodiversity Sites.

9.3.14 The potential impacts of the project on the identified geodiversity sites have been assessed taking into account the location of the site in relation to the draft Development Consent Order (DCO) boundary, the nature of the project in the vicinity of the site and the reason for the designation of the site.

9.3.15 The potential for significant effects has been considered in light of the sensitivity and value of receptors and magnitude of impacts, as set out in *DMRB LA 109*.

Soils assessment

9.3.16 Impacts on soil could occur as a result of the loss of agricultural land or as a result of degradation to or loss of soils through processes such as compaction, mixing or erosion. Such impacts may affect agriculture and sensitive habitats. The land was classified using the system outlined in the *Agricultural Land Classification of England and Wales - Revised guidelines and criteria for grading the quality of agricultural land* (Ministry of Agriculture, Fisheries and Food, now Department for Environment Food and Rural Affairs, 1988)[23]. Notwithstanding the age of this document, it remains the industry accepted publication.

9.3.17 The Agricultural Land Classification (ALC) system provides a framework for classifying land according to the extent to which its physical or chemical characteristics impose long-term limitations on agricultural use.

9.3.18 An initial desk study soils assessment for the purposes of this PEI Report has considered the presence and classification of agricultural soils and soils supporting ecologically valuable sites within the study area. The provisional agricultural land classification within the study area is shown in Figure 9.6 – Agricultural Land Classification. The findings of the soils assessment, following field survey, will be reported within the ES.

9.3.19 The soils data sources, stakeholder engagement and a description of the information sought or obtained from each are summarised in Table 9-4: Soils information sources.

9.3.20 Due to multiple changes in proposed boundaries for some schemes, the findings of the ALC assessments for some schemes may alter and the preliminary assessment as reported herein should be taken as indicative only for the purpose of the PEI Report. Whilst the finalised assessment will be reported in the ES, no additional significant effects are anticipated. This is because the only alternative option not captured in the current ALC assessment is the blue / western junction of the Cross Lanes to Rokeby scheme; the other options for that scheme are considered to exist entirely within the assessment buffer already. Overall, any changes in potential

[23] Ministry of Agriculture, Fisheries and Food (1988) Agricultural Land classification of England and Wales, available at: http://publications.naturalengland.org.uk/publication/6257050620264448 [Accessed 31 August 2021]

permanent and temporary land take posed by the completion of ALC assessment is considerd to be subtle and localised.

Table 9-4: Soils information sources

9.3.21

Information Source	Description of information
Data sources	
MAFF Provisional ALC Maps	The Provisional ALC maps (Ministry of Agriculture, Fisheries and Food, 1970s)[24]. The *Provisional Maps* give an indication of land quality at the strategic planning scale but should not be relied on for site specific assessment of land quality. In addition they do not classify land into Grade 3a and Grade 3b to differentiate between the 'best and most versatile' (BMV) i.e. better quality land (Grade 1 to Grade 3a) and lower quality land (Grade 3b to Grade 5).
Natural England Strategic ALC Maps (Natural England, 2021)[25]	ALC Strategic Map Information. The Strategic Map Information is based on Natural England predictions of the likelihood of BMV agricultural land (i.e. ALC Grades 1, 2 and 3a).
British Geological Survey Maps	The maps provide information of solid and superficial geology which have an effect on soil type and therefore on land quality.
Cranfield Soil Associations	Cranfield Soil and AgriFood Institute (CSAFI), (2017)[26]
Natural England Detailed ALC Surveys	The MAGIC website provides post-1988 subdivision survey digital data on detailed ALC surveys undertaken by Natural England. This information provides a definitive grade for the land and has been used as the primary source of information where available.
Soils of Northern England (NHBS, 2021)[27] 1:250,000 scale	Soils of Northern England 1:250,000 scale. This map provides information about soil associations i.e. soils which occur together in the landscape.
Stakeholder engagement	
Natural England, April 2021	The purpose of consultation was to agree an approach to the ALC methodology with Natural England as much as possible. Notable points NE wanted to consider were the identification of ALC for the draft DCO boundary, identifying the constraints and what is the best use of the soil i.e. reuse where applicable. It was noted by Natural England that: areas of peatland are adjacent to the route; and, a distinction should be

[24] Ministry of Agriculture, Fisheries and Food (1970) Provisional Agricultural Land Classification (ALC) Maps. Available at: https://data.gov.uk/dataset/952421ec-da63-4569-817d-4d6399df40a1/provisional-agricultural-land-classification-alc [Accessed 31 August 2021]
[25] Natural England (2021) Regional Agricultural Land Classification Maps, available at: http://publications.naturalengland.org.uk/category/5954148537204736 [Accessed 31 August 2021]
[26] Cranfield University Soilscapes: http://www.landis.org.uk/soilscapes/ [Accessed 31 August 2021]
[27] NHBS (2021) Soil Survey of England and Wales, Sheet 1: Northern England

Information Source	Description of information
	made between the temporary and permanent land take which would result in the loss of soil.

Contamination assessment

Potential sources

9.3.22 Contamination impacts could occur if contamination is disturbed or mobilised by the project, resulting in sensitive receptors being exposed to contamination. This could be as a result of existing pollutant linkages, or creation of new pollutant linkages.

9.3.23 The contamination assessment has considered the presence of potential sources of contamination associated with former and current land uses. Based on the desk study information, potential sources considered include:

- Current and historical landfill sites
- Current and historical mineral extraction sites
- Licensed waste management sites
- Current and historical industrial or commercial sites
- Discharges to surface and ground water
- Foot and mouth disease (FMD) burial sites
- Farmyards
- Operational and disused railway lines and railway land
- Sewage treatment works
- Cemeteries

9.3.24 Each potential contamination source identified has been given its own unique identifier (e.g. CL01-15, where 01 refers to the scheme reference number and 15 refers to a unique potential contaminant source) and has been classified in terms of its likely contamination potential, using guidance published by the Homes and Communities Agency (Homes and Communities Agency, 2013)[28]. This guidance assigns a “low, moderate or high” potential for contamination and catergorises sites according to their use. Professional judgement has been applied where a potential contamination source has had multiple uses, for example:

- a historical industrial building that had high potential for contamination but has since been converted into a residence and is therefore considered likely to now have a low contamination potential, or
- a former quarry which had low contamination potential was later used as a landfill site and is now likely to have a high contamination potential.

9.3.25 Potential land contamination sites have been identified using the data sources listed in Table 9-5: Contamination information sources, including historical and current ordnance survey mapping which has been used to identify site such as old quarries, tips and industrial or commercial sites.

9.3.26 The contamination data sources, stakeholder engagement and a description of the information sought or obtained from each are summarised in Table 9-5: Contamination information sources. Further stakeholder engagement will be carried out to inform the ES where it has not been possible to obtain information to date.

[28]Homes and Communities Agency (2013) Guidance on dereliction, demolition and remediation costs (3rd edition), available at: https://www.gov.uk/government/publications/guidance-on-dereliction-demolition-and-remediation-costs [Accessed 31 August 2021]

Table 9-5: Contamination information sources

Information Source	Description of information
Data sources	
PSSR	Information is provided on former and current land uses, geology, hydrogeology, statutory designations, mining, landfills and earthworks together with a geo-environmental preliminary conceptual site model.
Current and historical landfill sites	Information provided in spatial format based on Environment Agency and local authority records, provided by a third party data supplier.
Current and historical mineral extraction sites	Information provided online via the Coal Authority Interactive Map Viewer, which shows areas of previous and current coal mining. Historical Ordnance Survey mapping also used to identify former quarried areas.
Licensed waste management sites	Information provided in spatial format based on Environment Agency and local authority records
Current and historical industrial or commercial sites	Information taken from historical and current Ordnance Survey mapping at a variety of scales. Georeferenced mapping provided by a third party data supplier.
Discharges to surface water	Information provided in spatial format based on Environment Agency records, provided by a third party data supplier.
Foot and mouth disease (FMD) burial sites	Defra carried out a check of their records (previously held by APHA and Fera Science Ltd) of burials from the 2001 outbreak using maps of the study area. No records were held but Defra advised that burials may be present as their records are not complete. Defra noted that FMD burn sites are unlikely to have been located close to a major road such as the A66.
Farmyards	Information taken from historical and current Ordnance Survey mapping at a variety of scales. Georeferenced mapping provided by a third party data supplier.
Stakeholder engagement	
Cumbria County Council	Information on contaminated sites including FMD burials requested but not received at the time of writing
Eden District Council	Data on FMD burial/burn sites within the study area requested but not received at the time of writing
Richmondshire District Council	Richmondshire do not hold information on FMD burial/burn sites. Information on contaminated sites not requested as data obtained from third party supplier. Website states that there are no Part IIA sites within Richmondshire.
British Gypsum, Longriggs mine, January 2021	Information on the location and volumes of groundwater abstractions provided by operator
Environment Agency, December 2020	Comments received on initial scoping
Durham County Council, December 2020	Virtual meeting held with the Contaminated Land Officer. Proposal for assessment explained and potential contamination sources identified. No FMD burial/burn data held.
Defra, January 2021	Telephone conversation and request for information on FMD burials within study area made by email. Data provided but no burial records in study area

Information Source	Description of information
National Farmers Union (NFU), January 2021	Telephone conversation to determine whether NFU holds records of FMD burials/burn sites. They do not and advised Defra as the contact
Ministry of Defence, November 2020	Telephone conversation to request land quality information for the Warcop training ground and camp areas. Land quality report provided to the project team for information.

9.3.27 A two-stage screening process will be carried out for the identified potential contamination sources. The first stage, which is presented in this PEI Report, involves considering the potential for each source to feasibly be disturbed or mobilised by the project. This has taken into account:

- the location of the source in relation to the draft DCO boundary, with sources within the draft DCO boundary being most likely to be impacted.
- the nature of the project in the vicinity of the source, with sources outside the draft DCO boundary only likely to be impacted in areas where groundwater flow may be affected. This may include areas of deep cuttings or groundwater control during construction.
- the likely type and form of contaminants present, with less mobile contaminants being less likely to be impacted by any changes to groundwater flow as a result of the project.

9.3.28 The assessment has considered soil contamination, groundwater contamination and ground gas sources.

9.3.29 Contamination sources that have not been screened out in the first stage will move on to the second stage of the screening process, which has not been completed for this PEI Report but will be reported in the ES and will identify the potential impacts that disturbance or mobilisation of contamination could have. This will be based upon the source-pathway-receptor principle, as set out in the *Land Contamination: Risk Management (LCRM) guidance* (Environment Agency, 2020)[29]. The assessment will consider:

- the likely type, form and levels of contaminants present.
- the location, proximity and type of sensitive receptors in the vicinity of the contamination source.
- the potential pathways for exposure that could arise from, or be exacerbated by, the project.

9.3.30 The potential sources which have passed through the first stage of screening are summarised in Figure 9.5 – Potential Sources of Contamination and Appendix 9.1 – Contamination Sources and Receptors for each scheme or scheme alternative. It should be noted that a reasonable worst-case has been assumed for the screening assessment, in the absence of intrusive ground investigation information to verify desk-based sources.

Potential receptors

9.3.31 The assessment has identified receptors that could be exposed to any contamination, including the health of people living in, working in or otherwise using the study area ('human health') and the quality of groundwater and surface watercourses.

[29] Environment Agency (2020) Land Contamination: Risk Management, available from https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm [Accessed 31 August 2021]

9.3.32 The potential for significant effects to these receptors will be considered in the Environmental Statement in light of the sensitivity/value of receptors and magnitude of impacts, as described in paragraphs 9.3.1 to 9.3.4.

9.4 Assessment Assumptions and Limitations

9.4.1 The PEI Report assessment has been based upon desk top review of available data sources and engagement with stakeholders. Stakeholder engagement is ongoing and will continue when working towards the ES.

9.4.2 Development specific ground investigation was completed during the first quarter of 2021 but the results were not available at the time of writing. The available ground investigation was designed to provide adequate information for preliminary design and to inform the general understanding of baseline ground and contamination conditions in the environmental assessment. It did not target potential contaminative sources. An intrusive agricultural soils survey had not been completed at the time of writing. The baseline conditions and assessments will be reviewed and updated to take into account the findings of intrusive surveys as part of the ES.

9.4.3 There is the potential that further localised sources of contamination could be present over and above those identified as part of the assessment. These could, for example, be associated with localised fill materials, spillages or waste deposition. Whilst the assessment can not take into account such unknown sources, mitigations to manage the potential impacts of any such contamination are set out in Section 9.8: Design, Mitigation and Enhancement Measures. Mitigation will include targeted ground investigation. It is noted that the Environmental Impact Assessment (EIA) Scoping Opinion, dated 23 July 2021, requires the scope of any targeted ground investigation to be designed in consultation with the relevant local authority or Environment Agency.

9.4.4 Where screening for potential land contamination sites has identified potential for contamination to be disturbed or mobilised by the project, a more detailed assessment of potential impacts will be carried out in the ES, as described in paragraph 9.3.29. This second stage of the screening process will involve developing a conceptual model for each contamination source (source-pathway-receptor) at baseline, construction and post-construction.

9.4.5 The construction and operation assessments assume that appropriate mitigation has been undertaken and that the operation of the project is in accordance with environmental legislation.

9.4.6 Contaminant types included within the risk assessments presented in this chapter are based on the 'Industry Profiles' series of documents (Department for the Environment, 2021)[30] where available, and professional judgement.

9.5 Study Area

9.5.1 The study area for the geology and soils assessment is a 250m buffer to either side of the draft DCO boundary, as shown in Figure 9.1 – Study Area. Where sensitive surface water and groundwater receptors such as abstractions are present, these have been considered within a 1km buffer of the draft DCO boundary, in line with the

[30] Department for the Environment (2021) Industry Profiles, available from: https://www.claire.co.uk/index.php?option=com_content&view=article&id=198:doe-industry- [Accessed 31 August 2021]

approach adopted in Chapter 14: Road Drainage and the Water Environment, of this PEI Report.

9.5.2 The study area has been based upon professional judgement, and is considered to be in line with the requirements of Paragraph 3.5 of *LA 109* i.e. it is sufficient to ensure that any sources of contamination that could migrate and any sensitive receptors that could be affected by the project can be appropriately identified.The increased buffer of 1km for water receptors allows for the potential for greater travel distances of pollutants. A risk-based approach was taken to allow for extension of the study area beyond the 1km buffer to capture potential impacts on groundwater quality from significant contamination sources that lie close to the study area boundary, such as large historical landfill sites.

9.6 Baseline Conditions

9.6.1 This section provides a description of the geology and soils baseline for each scheme. The section relies on the borehole reviews undertaken within the A66 Northern Trans-Pennine Project *PSSR.* Note that some areas of the route, including Penrith M6 J40 were not included within the orginal PSSR. As such, the following geology section also relies on freely available information, including historical borehole logs, available on the *BGS GeoIndex*.

Route wide

Geological context

9.6.2 The route wide study area is expected to be underlain by Made Ground of varying thicknesses, overlying natural superficial deposits including Alluvium comprising mixtures of sand, silt and clay associated with watercourses, Glaciofluvial Geposits comprising sands and gravels, and Glacial Till, comprising clay with layers of sand, gravel and cobbles.

9.6.3 Peat is noted in some areas, generally in the uplands of the Pennines including M6 Junction 40 to Kemplay Bank, Penrith to Temple Sowerby, Temple Sowerby to Appleby, Appleby to Brough and Bowes Bypass.

9.6.4 Bedrock within the route wide study area comprises sandstone with shales and gypsum west of the Pennines between Penrith and Brough. Carboniferous sandstones, limestone and shales are present in the uplands of the Pennines between Brough and Scotch Corner.

9.6.5 Deep and surface coal resources are present in the west from M6 Junction 40 to Appleby. The majority of the project does not lie within a Coal Mining Reporting Area, except for a small area in Appleby to Brough (Warcop) scheme. There is a mineshaft recorded approximately 400m south-west of the draft DCO boundary in the Stephen Bank to Carkin Moor scheme, but no reported mineworkings within the draft DCO boundary itself.

9.6.6 Karstic features have been identified in the vicinity of Kirkby Thore. The Great Limestone Member, which is present in the Bowes Bypass and Cross Lanes to Rokeby schemes, was assessed to have moderate karst risk.

Geodiversity

9.6.7 The study areas for the Appleby to Brough (Warcop) and Bowes Bypass schemes include part of the North Pennines UNESCO Global Geopark. The Geopark area is the same as that of the North Pennines AONB.

Soils

9.6.8 The majority of soils in the routewide study area are Agricultural Land Classification (ALC) Grade 3a and 3b. There is some Grade 2 agricultural land, non agricultural land and urban land within the routewide study area.

Contamination sources

9.6.9 A number of potentially contaminative sites have been identified within the routewide study area, including railway land, disused quarries, landfill sites, industrial land uses and farms.

Contamination receptors

9.6.10 A number of potential contamination receptors have been identified within the route wide study area. Potential human receptors include residential properties, schools, allotments, public open spaces, industrial and commercial land uses. Water receptors include aquifers, groundwater abstractions and surface water bodies.

9.6.11 Designated ecological receptors are the River Eden SAC and the River Eden Tributaries SSSI.

M6 Junction 40 to Kemplay Bank

Geological context

9.6.12 The study area is indicated to be underlain by Made Ground overlying natural superficial deposits comprising Alluvium, River Terrace Deposits, Glacial Till, Glaciofluvial Deposits and Undifferentiated Glacial Deposits. The existing A66 alignment is situated on embankments, within cuttings and at-grade. Consequently, extensive engineered fill and/or reworked natural ground is anticipated in areas of the embankments. Thicknesses for the superficial deposits were highly variable in historical borehole logs, with Glaciofluvial Deposits proven by historical ground investigation to maximum depth of approximately 12m below ground level (BGL) and Alluvium proved to 1.1m BGL as stated within the *PSSR*. These thicknesses have only been observed for the eastern portion of the scheme (Kemplay Bank), as the west of the scheme (M6 Junction 40) was not reviewed within the original PSSR. The ground conditions information will be reviewed and updated in the ES to include the results of the ground investigation completed during 2021.

9.6.13 Historical borehole logs were therefore reviewed for the west of the scheme; glacial deposits were not always in the same stratigraphic order and therefore the only proven thickness via historical borehole logs is that of the Glacial Till, which varied between c.4m to 18m.

9.6.14 Peat was also encountered in one location in the west of the scheme, but Alluvium was not encountered in historical borehole records.

9.6.15 Across the scheme, anticipated bedrock comprises the Stainmore Formation and the Penrith Sandstone Formation. The Penrith Sandstone Formation was only encountered in one location (NY52NW199). The *PSSR* records bedrock has typically been encountered between depths of c.5 and 6m BGL comprising of Penrith Sandstone and Stainmore Formation.

The distribution of surface superficial deposits and bedrock at rockhead is shown in Figures 9.2: Solid Geology and 9.3: Drift Geology, with the ground conditions described in more detail in

9.6.16 Table 9-6: Summary of geology and ground conditions: M6 Junction 40 to Kemplay Bank.

Table 9-6: Summary of geology and ground conditions: M6 Junction 40 to Kemplay Bank

Strata	Description	Distribution
Superficial deposits		
Made Ground	Potentially variable materials described as an intermixture of granular and cohesive material, of a variable thickness between 0.5m to 1m where encountered.	The 1:50,000 scale *BGS viewer* did not identify the presence of any artificial ground along Penrith M6 J40 to Kemplay scheme. However, deposits are anticipated locally associated with previous development, including embankments and cuttings.
Alluvium	Very soft to soft mottled grey and brown laminated silty clay with pockets of very sandy clay between c. 0.3m to c.1.10m in thickness.	Anticipated to the south of the M6 Junction, to the east of the Kemplay Bank, and along the routes of the River Eamont, River Lowther and Thacka Beck.
Peat	*BGS viewer* does not indicate the presence of any peat deposits within the scheme boundary. However, a silty clay with bands of peat was recorded in a historical borehole log, with a thickness of approximately 0.8m.	The historical borehole (NY52NW81) is located within the existing M6 J40 Roundabout alignment, within the centre of the scheme.
Glaciofluvial Deposits	Sands and gravels with a thickness of between 0.15m and c.12m.	*BGS viewer* indicates deposits are the south of Kemplay Bank, and also parallel to Thacka Beck. A pocket is also evident to the north west, in the vicinity of the Nine Chimneys.
Glacial Till	Historical borehole logs describe the Till as broadly comprising clayey or silty sand with gravel, cobbles and boulders.	Anticipated to underlie the majority of the scheme area.
Undifferentiated Glacial Deposits	Classified based on review of historical borehole logs. The deposits broadly comprised laminated clay with sand partings and occasional cobbles and boulders.	Anticipated to underlie Glacial Till based on a review of historical borehole logs.
Bedrock		
Penrith Sandstone Formation	*BGS viewer* and historic borehole logs indicate the formation is present below the scheme, described as a coarse-grained	Anticipated to be encountered in the east of the scheme. A historic borehole log (NY52NW199)

Strata	Description	Distribution
	cross-bedded aeolian sandstone. The formation is up to 100m in thickness.	encountered the formation in the south east of the study area.
Stainmore Formation	*BGS viewer* logs indicate the formation is present below the scheme, described as a cyclical repetition of sandstones, siltstones mudstones and thin limestones with some coals. The formation is up 1km in thickness.	Anticipated to underlie the majority of the west of the scheme.
Alston Formation	Comprising '*bioclastic limestones, sandstones, mudstones and siltstones and rare coals typically in a regular cyclothymic sequence*'. The formation is up to 340m in thickness.	Anticipated to underlie the most westerly portion of the scheme.
Coal Mining and Mineral Extraction		
Deep Coal	The *BGS viewer* states; '*deep coal between 50m and 1200m*'.	The BGS 1:50,000 scale viewer indicates the scheme is located to the south-west of an area of deep coal seams. The BGS 1:50,000 mapping indicates that coal measures underlie the Penrith Sandstone Formation to the north west of the scheme. The BGS memoir for the area indicates that Coal Measures may dip to the east and therefore underlie the Penrith Sandstone.
Surface Coal Resource Area	The Coal Authority states; '*coal resources capable of being extracted by* *surface mining methods, often referred to as 'opencast*'.	The *Coal Authority viewer* indicates the scheme located in a surface coal resource area. However, the BGS memoir and 1:50,000 mapping for the area demonstrates that shallow or surface coal has not been encountered within the study area.
Coal Mining Reporting Area	The *Coal Authority viewer* indicates that the M6 J40 is not located within a coal mining reporting area.	N/A
Abandoned Mine Catalogue	The *Coal Authority viewer* indicates that there are no abandoned mine locations within M6 J40 scheme boundary.	N/A

Strata	Description	Distribution
Active Quarries	The *BGS viewer* indicates that there are no active quarries within the M6 J40 scheme boundary.	N/A

9.6.17 Groundwater is anticipated to exist within the bedrock; groundwater strikes were recorded in the different glacial deposits in historical borehole records. Such strikes are interpreted to be perched groundwater bodies and are unlikely to be continuous. No water strikes were recorded within the Alluvium, though water is anticipated to be present at depth, possibly in continuity with local streams and rivers.

9.6.18 No karstic features were noted within the scheme boundary.

Geodiversity sites

9.6.19 No geodiversity sites have been identified in the study area.

Soils

9.6.20 The resulting soils which are mapped as Newbiggin Association close to the boundary with Wick 1 Association typically have well drained fine loamy to coarse loamy soils with some rock at depth. They are typically well to moderately well drained and in this part of the country fall into Wetness Class (WC) 1 or 2 and so into ALC Grade 3a. The soil grades, distribution across the scheme and receptor value (sensitivity) are summarised in Table 9-7: Soil resources: M6 Junction 40 to Kemplay Bank.

Table 9-7: Soil resources: M6 Junction 40 to Kemplay Bank

Soil	Description	Distribution (%) of scheme area	Value
Grade 3a	Land that is capable of consistently producing moderate to high yields of a narrow range of arable crops (e.g. cereals) or moderate yields of a wide range of crops (e.g. cereals, grass, oilseed rape, potatoes, sugar beet and less demanding horticultural crops)	28	High
Urban	Areas within an urban area such as housing, industry, commerce, education, religious buildings and cemeteries are known as 'hard' use because of the little potential for a return to agricultural land. This is due to the fact that the land is hard to restore after use	72	Negligible

9.6.21 The *ALC Strategic Map* Information shows the M6 Junction 40 to Penrith area as most likely to have a moderate proportion of BMV land i.e. 20-60% of the agricultural area

Contamination sources

9.6.22 Following the first stage of screening, a number of potentially contaminative sites have been identified which could be impacted by the project. These include railway lines, a disused quarry, an historical landfill, industrial sites and farms, as detailed in Appendix 9.1: Contamination Sources and Receptors.

Contamination receptors

9.6.23 A number of potential contamination receptors have been identified in the study area. These include residential properties, industrial estates and recreation areas, a principal aquifer and groundwater abstractions and surface waters including Thacka Beck and the River Eamont. Further information on groundwater and surface water receptors is provided in Chapter 14: Road Drainage and the Water Environment and in Appendix 9.1: Contamination Sources and Receptors.

9.6.24 There are two designated ecological receptors within the study area, the River Eden Special Area of Conservation (SAC) and the River Eden Tributaries Site of Special Scientific Interest (SSSI). Further detail on these statutory designated sites, and their qualifying habitats and vegetative communities, is provided in Chapter 6: Biodiversity.

Penrith to Temple Sowerby

Geological context

9.6.25 The Penrith to Temple Sowerby scheme is indicated to be underlain by Made Ground, followed by natural superficial deposits comprising Glacial Till, Glaciofluvial Deposits, River Terrace Deposits and Alluvium. Thicknesses for the superficial deposits were highly variable, with thicknesses of Glacial Till between c. 0.35 to at least 7.32m, and the thickness of Alluvium proven to a maximum thickness of c.1.7m. The anticipated bedrock below the scheme is the Penrith Sandstone Formation, which has typically been encountered between 3.7 and 7m BGL.

9.6.26 The distribution of superficial deposits and bedrock is shown in Figures 9.2: Solid Geology and 9.3: Drift Geology with the ground conditions described in more detail in Table 9-8: Summary of geology and ground conditions: Penrith to Temple Sowerby.

Table 9-8: Summary of geology and ground conditions: Penrith to Temple Sowerby

Strata	Description	Distribution
Superficial deposits		
Made Ground	Potentially variable materials described as an intermixture of granular and cohesive material, between 0.63m and 1.80m in thickness. The existing A66 alignment is situated on embankments, within cuttings and at-grade. Consequently, extensive engineered fill and/or reworked natural ground is anticipated in areas of the embankments.	The 1:50,000 scale BGS viewer did not identify the presence of any artificial ground within the study area. Not shown on published geology maps but anticipated locally associated with previous development within the scheme, including embankments and cuttings.
Peat	BGS 1:50,000 viewer indicates the presence of peat. However, peat was not encountered in the logs summarised in the *PSSR*.	Anticipated to north of the scheme, in the vicinity of High Moss Cottages.
Alluvium	Described as a soft to firm brown, grey sandy clay with ‘stones’.	Anticipated to be located within the river corridor of the Light Water and an un-named

Strata	Description	Distribution
		watercourse which runs through Whinfell Park in the west of the scheme. Deposits also present in the east of the scheme, in the vicinity of Swine Gill Plantation and a small pocket running approximately parallel to an un-named road between Woodside Farm Cottage and Wanderwort Farm.
Alluvial Fan Deposits	BGS 1:50,000 viewer indicates the presence of Alluvial Fan Deposits. Although not summarised within the PSSR, the BGS description indicates deposit comprise '*gently sloping masses of loose rock material, shaped like a fan or segment of a cone'*.	Anticipated at the junction between the unnamed water course and the River Eamont in the west of the scheme.
Glaciofluvial Deposits	Described as 'brown gravelly sand and sandy gravel with frequent cobbles and boulders. Clayey and silty sand and gravel was also recorded within the exploratory hole records.' Deposits ranged between 0.50 to 3.75m in thickness.	Anticipated to the east of Barn Hill Cottage, with a further deposit running parallel to the River Eamont in the north of the study area.
Till	Deposits with variable lithology. Usually encountered as a '*firm to very stiff red brown sandy and silty clay with occasional layers of clayey sands, gravel and cobbles*.'	Anticipated to underlie the majority of the scheme area.
Bedrock		
Penrith Sandstone Formation	Penrith Sandstone Formation	Coarse-grained cross-bedded aeolian sandstone, up to 100m in thickness
Coal Mining and Mineral Extraction		
Deep Coal	The *BGS interactive viewer* states; '*deep coal between 50m and 1200m'*.	The BGS 1:50,000 scale viewer indicates the scheme is located in an area of deep coal seams. The BGS memoir for the area indicates that Coal Measures may dip to the east and therefore underlie the Penrith Sandstone.
Surface Coal Resource Area	The *Coal Authority* states; '*coal resources capable of being extracted by*	The Coal Authority viewer indicates the scheme is located in a surface coal resource area.

Strata	Description	Distribution
	surface mining methods, often referred to as 'opencast"	However, the BGS memoir and 1:50,000 mapping for the area demonstrates that shallow or surface coal has not been encountered within the scheme boundary.
Coal Mining Reporting Area	The *Coal Authority viewer* indicates that this scheme is not located within a coal mining reporting area.	N/A
Abandoned Mine Catalogue	The *Coal Authority viewer* indicates that there are no abandoned mine locations within the study area.	N/A
Active Quarries	The *BGS viewer* indicates that there are no active quarries within the study area boundary.	N/A

9.6.27 Groundwater is anticipated to exist within the bedrock. However, perched groundwater is also expected within the Glaciofluvial and Glacial Till Deposits. No water strikes were recorded within the Alluvium, though water is anticipated to be present at depth, possibly in continuity with local streams and rivers.

9.6.28 No karstic features were noted within the scheme boundary.

Geodiversity sites

9.6.29 No geodiversity sites have been identified in the study area.

Soils

9.6.30 The soils are mapped as Newport 1 Association. They are typically well drained deep sandy and coarse loamy soils and in this part of the country fall predominantly into WC 1 (ALC Grade 2) but contain 10% of subordinate soils (i.e. Blackwood) which, where drained fall into WC 1 and where undrained fall into WC 3 and 4 (ALC Grade 3a/b).

9.6.31 In the north western corner of the scheme, areas of Wick 1 Association are mapped. They typically have deep well drained coarse loamy soils and are well to moderately well drained and in this part of the country fall into WC 1 or 2 and so into ALC Grade 2. The soil grades, distribution across the scheme and receptor value (sensitivity) are summarised in Table 9-9: Soil resources: Penrith to Temple Sowerby below.

Table 9-9: Soil resources: Penrith to Temple Sowerby

Soil	Description	Distribution (%) of scheme area	Value
2	Has minor limitations which affect crop yield, cultivations or harvesting. It can support a wide range of agricultural and horticultural crops but there can be some reduced flexibility on land within the grade, which	58.4	Very High

Soil	Description	Distribution (%) of scheme area	Value
	causes difficulty in the production of more demanding crops e.g. winter harvested vegetables and arable root crops		
3a	Land that is capable of consistently producing moderate to high yields of a narrow range of arable crops (e.g. cereals) or moderate yields of a wide range of crops (e.g. cereals, grass, oilseed rape, potatoes, sugar beet and less demanding horticultural crops)	40.1	High
3b	Land is capable of producing moderate yields of a narrow range of crops (mainly cereals and grass) or lower yields of a wider range of crops, or high yields of grass (for grazing/harvesting).	0.1	Medium
Non-agricultural	Land which can be returned relatively easily to agriculture. Known as a 'soft' use this is commonly referred to areas such as golf courses, private parklands, public open spaces and sports fields. Active mineral workings and refuse tips also fall under this category as the land can be easily restored after use.	0.6	Negligible
Urban	Areas within an urban area such as housing, industry, commerce, education, religious buildings and cemeteries are known as 'hard' use because of the little potential for a return to agricultural land. This is due to the fact that the land is hard to restore after use	0.8	Negligible

9.6.32 The ALC Strategic Map Information shows the Penrith to Temple Sowerby area as most likely to have a high proportion of BMV land i.e. >60% of the agricultural area.

Contamination sources

9.6.33 Following screening, a number of potentially contaminative sites have been identified which could be impacted by the project. These include farms, a historical tank and a sewage works, see Appendix 9.1: Contamination Sources and Receptors.

Contamination receptors

9.6.34 A number of potential receptors to contamination have been identified in the study area. Further details are provided in Apendix 9.1: Contamination Sources and Receptors. These include residents of nearby properties, principal aquifer and source protection zone and surface water bodies including the River Lowther and River Eamont. Further information on groundwater and surface water receptors is provided in Chapter 14: Road Drainage and the Water Environment.

9.6.35 There are two designated ecological receptors within the study area, the River Eden SAC and the River Eden Tributaries SSSI, 60m and 80m north west of the scheme, respectively. Further detail on these statutory designated sites, and their qualifying habitats and vegetative communities, is provided in Chapter 6: Biodiversity.

Temple Sowerby to Appleby

9.6.36 The distribution of superficial deposits and bedrock is shown in Figures 9.2: Drift Geology and 9.3: Solid Geology with the ground conditions described in more detail in Table 9-10: Summary of geology and ground conditions: Temple Sowerby to Appleby (all alternatives).

Table 9-10: Summary of geology and ground conditions: Temple Sowerby to Appleby (all alternatives)

Strata	Description	Distribution
Superficial deposits		
Made Ground	Potentially variable materials described as an intermixture of granular and cohesive material, between 0.30m and 3.68m in thickness. The existing A66 alignment is situated on embankments, within cuttings and at-grade. Consequently, extensive engineered fill and/or reworked natural ground is anticipated in areas of the embankments.	The 1:50,000 scale BGS viewer indicates an area of infilled ground is located to the north of the scheme, located to the north east of Temple Sowerby. An area of artificially modified ground is underlying the British Gypsum works. The viewer did not indicate the presence of any other artificial ground along the route. Made ground deposits are anticipated locally, associated with previous development, including embankments and cuttings.
Peat	BGS 1:50,000 mapping indicates that the Alluvium located to the north of the Kirby Thore scheme '*may conceal deposits of peat and lacustrine alluvium in hollows'*. Peaty clay and traces of peat were recorded in historical borehole 636 (located to the south west of Kirkby Thore), with a layer of peat encountered up to 3.35m in thickness, as summarised in the *PSSR*. Peaty clay and traces of peat were recorded in three locations to the south east of Crackenthorpe (19787100, 19787103 and 19787204), with peat here summarised as an accumulation of wet, dark brown and partially decomposed	An area of Peat is recorded between Kirby Thore and 'The Bungalow', although no other areas are highlighted on geological maps. That area of peat is the same area highlighted within the PSSR at approximate national grid reference (E) 364818, (N) 525394 and is shown on British Gypsum mine plans as a peat deposit. Borehole 636 is located in the vicinity as the aforementioned peat deposit. Peat is also anticipated in the vicinity of historic boreholes (19787100, 19787103, 19787204), all located between Crackenthorpe and the Appleby Bypass.

Strata	Description	Distribution
Landslip Deposits	The BGS 1:50,000 viewer indicates the presence of slip deposits. No other details are provided in the BGS viewer.	Anticipated to run to the south of the existing section of the A66 located directly north of Colby Lathes.
Alluvium	Described as comprising '*clay, silt, sand and gravel'.*	Anticipated around the River Eden, which runs to the south west of the scheme in an approximate north-west to south-east orientation; the river intersects the existing A66 near Temple Sowerby Park in the north west of the scheme. Alluvium is also associated with Trout Beck, which insects the current A66 alignment to the south west of Kirkby Thore, and to the north of the scheme, along Birk Sike.
Glaciofluvial Deposits	Not shown on BGS mapping. However, Glacial Sands and Gravels were located within historical exploratory hole records, described as '*a fine to coarse sandy gravel with some cemented horizons and cobbles. Very dense coarse sand and gravel with traces of clay and gravelly sand were also recorded.*'	The 1:50,000 scale BGS viewer indicates the closest pocket of Glaciofluvial deposits located in the vicinity of Langton, c. 2.6km to the east of the scheme. Historical borehole locations not specified within the PSSR.
Till	Historic borehole logs describe the Till as comprising variable lithologies, usually comprising sandy, silty clay with pebbles, but can contain gravel-rich, or laminated sand layers.	Anticipated to underlie the majority of the scheme area.
Bedrock		
Eden Shales and interbedded Gypsums (beds A to D)	Shales described as '*red shales and mudstones with local beds of gypsum and anhydrite, rare dolomitic limestones'* and are up to 100m thick. The Eden Shales and Gypsum 'A' bed were encountered in historical borehole logs reviewed within the PSSR.	Anticipated to underlie the north east portion of the scheme, in the vicinity of Kirkby Thore.
Penrith Sandstone Formation	Coarse-grained cross-bedded aeolian sandstone, up to 100m in thickness.	Anticipated to underlie the majority of the scheme.
Stainmore Formation	Cyclical repetition of sandstones, siltstones mudstones and thin limestones with some coals. The formation is up 1km in thickness.	Located between Castrigg House and St Nicholas's and in the lower topography areas surrounding

Strata	Description	Distribution
		Limekiln and Thistley Hill, all located in the south of the scheme.
Coal Mining and Mineral Extraction		
Deep Coal	The BGS interactive viewer states; '*deep coal between 50m and 1200m'.*	The BGS 1:50,000 scale viewer indicates the Kirkby Thore scheme is located in an area of deep coal seams. The BGS memoir for the area indicates that Coal Measures underlie the Penrith Sandstone.
Surface Coal Resource Area	The Coal Authority states; '*coal resources capable of being extracted by* *surface mining methods, often referred to as 'opencast'.*	The *Coal Authority viewer* indicates Kirkby Thore is located in a surface coal resource area. However, the BGS memoir and 1:50,000 mapping for the area demonstrates that shallow or surface coal has not been encountered within the scheme boundary.
Coal Mining Reporting Area	The *Coal Authority viewer* indicates that the Kirkby Thore scheme is not located within a coal mining reporting area.	N/A
Abandoned Mine Catalogue	The *Coal Authority viewer* indicates that there are a number of abandoned mine catalogue entries within the scheme boundary.	Numerous catalogue entries are located to the north, north east, east and south east of Kirkby Thore. No mine entries or other categories on the Coal Authority viewer are present.
Active Quarries	The *BGS viewer* indicates that there are no active quarries within the M6 J40 boundary.	N/A
Gypsum mining	Gypsum 'A' bed was encountered in historical borehole logs reviewed within the *PSSR*.	The Gypsum 'A' bed has been mined close to the Blue alignment, adjacent to Bowrang Plantation (previously known as alignment 6E1).

Blue alternative

Geological context

9.6.37 It is anticipated that the Temple Sowerby to Appleby blue alternative scheme is underlain by Made Ground, above natural superficial deposits comprising Glacial Till, Alluvium and Peat. Thicknesses for the superficial deposits were highly variable. The thickness of the superficial deposits range between 0.35m and 28.10m and were proven to a maximum depth of 30.05m BGL. Landslip deposits are indicated to the north of Crackenthorpe. The anticipated bedrock below the scheme comprises the Penrith Sandstone Formation and Eden Shale Formation, which has typically been encountered between 0.3m to 30.05m BGL and 2.13m to 33.37m BGL respectively.

9.6.38 Groundwater was recorded within the Made Ground, Glacial Till, Glacial Sands and Gravels and within the Penrith Sandstone. No water strikes were recorded within the Alluvium, though water is anticipated to be present at depth, possibly in continuity with local streams and rivers.

9.6.39 Four seams of gypsum and anhydrite are present in the Eden Shale Formation sequence. Mining is restricted to the highest-grade section of the lowest, thickest seam – 'A-bed'. The A-bed seam is up to 30 metres thick and is a series of alternating gypsum and gypsiferous shale beds, however the mining horizon is typically 7m thick at Longriggs Mine. The highest-grade sections contain secondary satin spar gypsum bands. Historically B-bed gypsum seam has also been extensively mined.

9.6.40 Karstic features have been identified in the vicinity of Kirkby Thore in both the Penrith Sandstone Formation and Eden Shales Formation. Therefore, Eden Shales, and the Penrith Sandstone due to its faulted contact with the shales, are considered to have a high karst risk.

Geodiversity sites

9.6.41 No geodiversity sites have been identified in the study area.

Soils

9.6.42 Soils within the scheme boundary are mapped mainly as Clifton Association. They are typically slowly permeable clayey soils and in this part of the country fall into WC 4 (ALC Grade 3b or Grade 4) but contain 30% of subordinate soils (i.e. Salwick and Quarndon), which are better drained and fall into WC 2 and 3 and so ALC Grade 2 and 3a.

9.6.43 In the central areas within the scheme boundary, Enborne and Wick 1 Association are mapped. Enborne Association are typically slowly permeable clayey soils in valleys, and in this part of the country fall into WC 3 and 4 (ALC Grade 3a/b or 4). Wick 1 Association typically have deep well drained coarse loamy soils and are well to moderately well drained and in this part of the country fall into WC 1 or 2 and so into ALC Grade 2. The soil grades and receptor value (sensitivity) are summarised in Table 9-11: Soil resources: Temple Sowerby to Appleby (all alternatives). Note that due to changes in the scheme boundary, the % distribution of soils was not available for each alternative route for inclusion in this PEI, but will be presented in the ES.

Table 9-11: Soil resources: Temple Sowerby to Appleby (all alternatives)

Soil	Description	Value
2	Has minor limitations which affect crop yield, cultivations or harvesting. It can support a wide range of agricultural and horticultural crops but there can be some reduced flexibility on land within the grade, which causes difficulty in the production of more demanding crops e.g. winter harvested vegetables and arable root crops	Very High
3a	Land that is capable of consistently producing moderate to high yields of a narrow range of arable crops (e.g. cereals) or moderate yields of a wide range of crops (e.g. cereals, grass, oilseed rape, potatoes, sugar beet and less demanding horticultural crops)	High
3b	Land is capable of producing moderate yields of a narrow range of crops (mainly cereals and grass) or lower yields of a wider range of crops, or high yields of grass (for grazing/harvesting).	Medium

Soil	Description	Value
Non-agricultural	Land which can be returned relatively easily to agriculture. Known as a 'soft' use this is commonly referred to areas such as golf courses, private parklands, public open spaces and sports fields. Active mineral workings and refuse tips also fall under this category as the land can be easily restored after use.	Negligible
Urban	Areas within an urban area such as housing, industry, commerce, education, religious buildings and cemeteries are known as 'hard' use because of the little potential for a return to agricultural land. This is due to the fact that the land is hard to restore after use	Negligible

9.6.44 The *ALC Strategic Map* Information shows the Temple Sowerby to Appleby area as most likely to have a high proportion of BMV land i.e. >60% of the agricultural area in the west and central parts of the scheme with moderate likelihood (20-60%) in the east and around Kirkby Thore.

Contamination sources

9.6.45 Following screening, a number of potentially contaminative sites have been identified which could be impacted by the project, including farms, dismantled railway, infilled ground, a garage/haulage yard and petrol filling station, as detailed in Appendix 9.1: Contamination Sources and Receptors.

Contamination receptors

9.6.46 A number of potential receptors to contamination have been identified in the study area. These include the residents of nearby properties, a principal groundwater aquifer and surface watercourses including Trout Beck, as detailed in Appendix 9.1: Contamination Sources and Receptors. Further information on groundwater and surface water receptors is provided in Chapter 14: Road Drainage and the Water Environment.

9.6.47 The River Eden SAC and the River Eden Tributaries SSSI are within all alternative route alignments for this scheme. Further detail on these statutory designated sites, and their qualifying habitats and vegetative communities, is provided in Chapter 6: Biodiversity.

Red alternative

Geological context

9.6.48 The anticipated ground conditions present are as described for the Blue alternative, shown in Figures 9.2: Solid Geology and 9.3: Drift Geology and Table 9-10: Summary of geology and ground conditions: Temple Sowerby to Appleby (all alternatives).

Geodiversity sites

9.6.49 No geodiversity sites have been identified in the study area.

Soils

9.6.50 Soils within the scheme area are as described for the Blue alternative, summarised in Table 9-10: Summary of geology and ground conditions: Temple Sowerby to Appleby (all alternatives).

Contamination sources

9.6.51 Following screening of these sites, a number of potentially contaminative sites have been identified which could be impacted by the project. These included a dismantled railway, farms, a petrol filling station and a wood processing works.

Contamination receptors

9.6.52 A number of potential receptors to contamination have been identified in the study area. These include the residents of nearby properties, schools, a principal aquifer and surface water bodies including the River Eden and Keld Syke. Further information on groundwater and surface water receptors is provided in Chapter 14: Road Drainage and the Water Environment.

9.6.53 The River Eden SAC and the River Eden Tributaries SSSI are within all alternative route alignments for this scheme. Further detail on these statutory designated sites, and their qualifying habitats and vegetative communities, is provided in Chapter 6: Biodiversity.

Orange alternative

Geological context

9.6.54 The anticipated ground conditions present within the Orange alternative study area are as described for the Blue alternative, shown in Figures 9.2: Solid Geology and 9.3: Drift Geology and Table 9-10: Summary of geology and ground conditions: Temple Sowerby to Appleby (all alternatives).

Geodiversity sites

9.6.55 No geodiversity sites have been identified in the study area.

Soils

9.6.56 Soils within the scheme area are as described for the Blue alternative, summarised in Table 9-10: Summary of geology and ground conditions: Temple Sowerby to Appleby (all alternatives).

Contamination sources

9.6.57 Following screening, a number of potentially contaminative sites have been identified which could be impacted by the project. These include farms, infilled ground, a sewage works, garage/haulage yard, petrol filling station and railway, as detailed in Appendix 9.1: Contamination Sources and Receptors.

Contamination receptors

9.6.58 A number of potential receptors to contamination have been identified in the study area. These include the residents of nearby properties, public open spaces, a principal aquifer and surface waterbodies including Trout Beck, as detailed in Appendix 9.1: Contamination Sources and Receptors. Further information on groundwater and surface water receptors is provided in Chapter 14: Road Drainage and the Water Environment.

9.6.59 The River Eden SAC and the River Eden Tributaries SSSI are within all alternative route alignments for this scheme. Further detail on these statutory designated sites, and their qualifying habitats and vegetative communities, is provided in Chapter 6: Biodiversity.

Appleby to Brough (Warcop)

Black route

Geological context

9.6.60 It is anticipated that the Black route of Appleby to Brough scheme is underlain by Made Ground, followed by natural superficial deposits comprising Glacial Till and Alluvium. The anticipated bedrock below the scheme comprises the Penrith Sandstone Formation.

9.6.61 The distribution of surface superficial deposits and bedrock at rockhead is shown in Figures 9.3: Drift Geology and 9.2: Solid Geology respectively with the ground conditions described in more detail in Table 9.12: Summary of geology and ground conditions: Appleby to Brough (Black route)

Table 9-12: Summary of geology and ground conditions: Appleby to Brough (Black route)

Strata	Description	Distribution
Superficial deposits		
Made Ground	Potentially variable materials described as an intermixture of granular and cohesive material, between of variable thickness. The existing A66 alignment is situated on embankments, within cuttings and at-grade. Consequently, extensive engineered fill and/or reworked natural ground is anticipated in areas of the embankments.	The 1:50,000 scale BGS viewer did not identify the presence of any artificial ground along the Appleby to Brough scheme. However, deposits are anticipated locally associated with previous development, including embankments and cuttings.
Peat	BGS 1:50,000 mapping indicates that a number of areas of peat are located within the scheme boundary. These were not summarised within the PSSR.	The 1:50,000 viewer indicates deposits located in the north west of the scheme, running roughly parallel to the existing and proposed alignment; the feeder road and settlement pond to the south of the scheme are located <0.10km of BGS recorded peat deposits.
Alluvium	Described from historical logs as comprising '*soft organic slightly sandy very silty clay with pockets of peat and soft to firm clay with lenses of silty sand.'*	Anticipated in the vicinity of Dyke Nook cottage, What Sheaf Farm, Walk Mill Barn, north of Warcop Train Station, north of Low Broomrigg and south of Desmere. Mapping indicates the deposits are anticipated below the scheme alignment.
River Terrace Gravels	BGS describe deposits as comprising sand and gravel with local lenses of silt, clay or peat. These deposits were not encountered within the historic	Anticipated in the east of the scheme, located south of Market Brough.

Strata	Description	Distribution
	borehole logs summarised within the PSSR.	
Glaciofluvial Deposits	A description of Glaciofluvial Deposits is not provided by the BGS. These deposits were not encountered within the historic borehole logs summarised within the PSSR.	BGS mapping indicates two pockets of Glaciofluvial Deposits are located to the south of the north western portion of the scheme. Two settlement ponds and small access roads are shown to intersect these deposits
Till	Historical borehole logs describe the Till as '*as a firm to stiff red brown slightly sandy slightly gravelly clay and layers of clayey slightly gravelly sands with occasional gravel and cobbles.'*	Anticipated to underlie the majority of the Appleby to Brough scheme area.
Bedrock		
Eden Shales Formation	Shales described as '*red shales and mudstones with local beds of gypsum and anhydrite, rare dolomitic limestones'* and are up to 100m thick.	Anticipated north east section of Appleby to Brough scheme alignment.
Penrith Sandstone Formation	Coarse-grained cross-bedded aeolian sandstone, up to 100m in thickness. Weathered sandstone was encountered as '*firm to stiff thinly laminated reddish brown sandy to very sandy slightly gravelly clay; a loose to dense slightly clayey, slightly silty sand; a medium dense fine to coarse slightly clayey slightly sandy gravel; a coarse red sand; or an extremely weak to weak poorly cemented sandstone.*'	Anticipated to underlie the majority of the scheme; located in the north east of Appleby to Brough scheme, and straddles south east alignment.
Stainmore Formation	BGS viewer logs indicate the formation is present below the scheme, described as a cyclical repetition of sandstones, siltstones mudstones and thin limestones with some coals. The formation is up 1km in thickness.	Anticipated in the east of the alignment and further north east within the Appleby to Brough scheme boundary.
Great Limestone Member	Bioclastic packstone which is dark blue grey in colour and '*thickly bedded with thin shaly mudstone partings along uneven*	Anticipated in the north east of the Appleby to Brough scheme boundary.

Strata	Description	Distribution
	or wavy bedding planes. Crinoid debris are noted throughout, with beds of brachiopods and or corals also noted.' The limestone group is estimated to be 14 to 18m in thickness.	
Coal Mining and Mineral Extraction		
Deep Coal	The BGS interactive viewer states does not indicate the presence of any deep coal within the scheme boundary.	N/A
Coal Mining Reporting Area	The Coal Authority viewer indicates part of the study area falls within the coal mining report area 'Notts'.	Reporting area does not include the Appleby to Brough scheme, however, encompasses some of the study area located in the north west.
Surface Coal Resource Area	The Coal Authority viewer does not indicate the presence of any shallow coal within the scheme boundary.	N/A
Abandoned Mine Catalogue	The Coal Authority viewer indicates that there are no abandoned mine locations within Appleby to Brough scheme boundary.	N/A
Active Quarries	The BGS viewer indicates that there are no active quarries within the Appleby to Brough scheme boundary.	N/A

9.6.62 Groundwater has been encountered within the Alluvium, Glacial Till, and Penrith Sandstone.

9.6.63 No karstic features were identified from the Light Detection and Ranging (LiDAR) and aerial photography stage of the karst assessment. However, a walkover conducted as part of the assessment did identifiy a seepage karst feature (SD3); boggy ground is located in the area of a spring labelled on OS mapping and had thereore be lablled as groundwater to surface water interaction. The location is situated on the Great Scar Limestone Group; although the specific location is not included within the report, the limestone group is located outside of the study area. As discussed in paragraph 9.5.2, a risk-based approach will be taken in the ES to capture impacts on receptors that lie outside the study area boundary.

Geodiversity sites

9.6.64 The Black route is located within the UNESCO Global Geopark (very high value) receptor) at the scheme's eastern end, see Figure 9.4: Geodiversity Sites.

9.6.65 The River Eden and Tributaries SSSI, which includes sites designated as GCR, is located outside the draft DCO boundary, to the south of the study area. The SSSI and GCR sites will not be directly disturbed as part of the scheme.

9.6.66 George Gill SSSI, a natural exposure in the Lower Permian Penrith Sandstone, is present close to the study area but not within it, located to the west of Appleby and approximately 300m to the north-northwest of the scheme. This site lies outside the draft DCO boundary and will not be directly disturbed as part of the scheme.

Soils

9.6.67 The soils are mapped as Wick 1 Association across the majority of the scheme. They typically have deep well drained coarse loamy soils and are well to moderately well drained and in this part of the country fall into WC 1 or 2 and so into ALC Grade 3a for the western and central areas of the scheme and Grade 3b for the eastern end of the scheme.

9.6.68 A small area to the west is mapped as Crannymore. These soils are well drained sandy soils and can be affected by groundwater. They typically fall into WC 1 (ALC Grade 3a) when they are drained and the regional watertable has been lowered and WC 4 (ALC Grade 3b) if undrained.

9.6.69 To the east of the scheme a small area of Clifton Association is mapped close to Langrigg. These soils are typically slowly permeable clayey soils which fall into WC 4 (ALC Grade 3b or 4) but contain 30% of subordinate soils (i.e. Salwick and Quarndon) which are better drained and fall into WC 2 and 3 (ALC Grade 3b or 4). The soil grades and receptor value (sensitivity) are summarised in Table 9-13: Soil resources: Appleby to Brough (all routes). Note that due to changes in the scheme boundary, the % distribution of soils was not available for each alternative route for inclusion in this PEI, but will be presented in the ES.

Table 9-13: Soil resources: Appleby to Brough (all routes)

Soil	Description	Value
3a	Land that is capable of consistently producing moderate to high yields of a narrow range of arable crops (e.g. cereals) or moderate yields of a wide range of crops (e.g. cereals, grass, oilseed rape, potatoes, sugar beet and less demanding horticultural crops)	High
3b	Land is capable of producing moderate yields of a narrow range of crops (mainly cereals and grass) or lower yields of a wider range of crops, or high yields of grass (for grazing and harvesting).	Medium
Non-agricultural	Land which can be returned relatively easily to agriculture. Known as a 'soft' use this is commonly referred to areas such as golf courses, private parklands, public open spaces and sports fields. Active mineral workings and refuse tips also fall under this category as the land can be easily restored after use.	Negligible
Urban	Areas within an urban area such as housing, industry, commerce, education, religious buildings and cemeteries are known as 'hard' use because of the little potential for a return to agricultural land. This is due to the fact that the land is hard to restore after use	Negligible

9.6.70 The *ALC Strategic Map* information shows the majority of the Appleby to Brough (Warcop) (dualling and junctions) area as most likely to have a high proportion of BMV land i.e. >60% of the agricultural area. To the east from Langrigg to Brough there is the likelihood of a moderate proportion of BMV land i.e. 20-60% of the agricultural area.

Contamination sources

9.6.71 Following screening, a number of potentially contaminative sites have been identified which could be impacted by the project, including a railway, farms, sewage discharge consent, a refuelling facility and garage, as detailed in Appendix 9.1: Potential Contamination Sources and Receptors. It is noted that the EIA Scoping Opinion, dated 23 July 2021, requires "a burial site on Warcop range" to be considered in the Environmental Statement. This burial site has not been identified in the information provided by the Ministry of Defence (MoD) to date, therefore this will be addressed in full in the Environmental Statement.

Contamination receptors

9.6.72 A number of potential receptors to contamination have been identified in the study area. These include the residents of nearby properties, Warcop MoD training ground, a principal aquifer, and surface watercourses including the River Eden, as detailed in Appendix 9.1: Potential Contamination Sources and Receptors. Further information on groundwater and surface water receptors is provided in Chapter 14: Road Drainage and the Water Environment.

9.6.73 The scheme passes to the south of the North Pennines AONB and to the south of the North Pennine Special Protected Area (SPA) and SAC. No statutory designated areas are within the study area. The River Eden SAC and River Eden Tributaries SSSI are outside the study area. Further detail on these statutory designated sites, and their qualifying habitats and vegetative communities, is provided in Chapter 6: Biodiversity.

Blue alternative

Geological context

9.6.74 It is anticipated that the Blue alternative for the Appleby to Brough scheme is underlain by Made Ground, followed by natural superficial deposits comprising Glacial Till and Alluvium. The anticipated bedrock below the scheme comprises the Penrith Sandstone Formation.

9.6.75 The distribution of surface superficial deposits and bedrock at rockhead is shown in Figures 9.2: Published Geology – Solid Geology and 9.3: Published Geology – Drift Geology with the ground conditions described in more detail in Table 9-12: Summary of geology and ground conditions: Appleby to Brough (Black route)

9.6.76 Groundwater was recorded within the Alluvium, Glacial Till, and Penrith Sandstone.

9.6.77 No karstic features were identified from the LiDAR and aerial photography stage of the karst assessment. However, a walkover conducted as part of the assessment did identifiy a seepage karst feature (SD3) within the Great Scar Limestone Group; although the specific location is not included within the report, the limestone group is located outside of the study area. The feature is therefore not carried through into the risk assessment.

Geodiversity sites

9.6.78 The Blue alternative is partially located within the UNESCO Global Geopark (very high sensitivity receptor), see Figure 9.4: Geodiversity Sites .

9.6.79 The River Eden and Tributaries Site of Special Scientific Interest (SSSI), which includes sites designated as GCR, is located outside the draft DCO boundary, to the south of the study area. The SSSI and GCR sites will not be directly disturbed as part of the scheme.

Soils

9.6.80 The soil grades, distribution across the scheme and receptor value (sensitivity) are as described for the Black route, as summarised Table 9-13: Soil resources: Appleby to Brough (all routes)

Contamination sources

9.6.81 Following screening of these sites, a number of potentially contaminative sites have been identified which could be impacted by the project, including farms, historic gravel pit, railway, MoD land and vehicle refuelling facilities, as detailed in Appendix 9.1: Potential Contamination Sources and Receptors

Contamination receptors

9.6.82 A number of potential receptors to contamination have been identified in the study area. These include residents of nearby properties, Warcop training camp, a principal aquifer, groundwater abstraction and surface water receptors including the River Eden, as detailed in Appendix 9.1: Potential Contamination Sources and Receptors. Further information on groundwater and surface water receptors is provided in Chapter 14: Road Drainage and the Water Environment.

9.6.83 The scheme passes to the south of the North Pennines AONB and to the south of the North Pennine SPA and SAC. No statutory designated areas are within the study area. The River Eden SAC and River Eden Tributaries SSSI are outside the study area. Further detail on these statutory designated sites, and their qualifying habitats and vegetative communities, is provided in Chapter 6: Biodiversity.

Orange alternative

Geological context

9.6.84 It is anticipated that the Orange alternative for the Appleby to Brough scheme is underlain by Made Ground, followed by natural superficial deposits comprising Glacial Till and Alluvium. The anticipated bedrock below the scheme comprises the Penrith Sandstone Formation.

9.6.85 The distribution of surface superficial deposits and bedrock at rockhead is shown in Figures Figures 9.2: Published Geology – Solid Geology and 9.3: Published Geology – Drift Geology respectively with the ground conditions described in more detail in Table 9-12: Summary of geology and ground conditions: Appleby to Brough (Black route)Geodiversity sites

9.6.86 The Orange alternative route is not located within the UNESCO Global Geopark (very high sensitivity receptor), however the draft DCO boundary does include part of the Geopark, see Figure 9.4: Geodiversity Sites.

9.6.87 The River Eden and Tributaries SSSI, which includes sites designated as GCR, is located outside the draft DCO boundary, to the south of the study area. The SSSI and GCR sites will not be directly disturbed as part of the scheme.

Soils

9.6.88 The soil grades, distribution across the scheme and receptor value (sensitivity) are as described for the Black route, as summarised in Table 9-13: Soil resources: Appleby to Brough (all routes)

Contamination sources

9.6.89 Following screening of these sites, a number of potentially contaminative sites have been identified which could be impacted by the project, including a historic gravel pit, farms, railway historical tank and fuel storage, as detailed in Appendix 9.1: Potential Contamination Sources and Receptors

Contamination receptors

9.6.90 A number of potential receptors to contamination have been identified in the study area. These include residents of nearvy properties, Warcop training camp, a principal aquifer and groundwater abstractions, and several surface watercourses, as detailed in Appendix 9.1: Potential Contamination Sources and Receptors . Further information on groundwater and surface water receptors is provided in Chapter 14: Road Drainage and the Water Environment.

9.6.91 The scheme passes to the south of the North Pennines AONB and to the south of the North Pennine SPA and SAC. No statutory designated areas are within the study area. The River Eden SAC and River Eden Tributaries SSSI are outside the study area. Further detail on these statutory designated sites, and their qualifying habitats and vegetative communities, is provided in Chapter 6: Biodiversity.

Bowes Bypass

Geological context

9.6.92 Bowes Bypass is indicated to be underlain by Made Ground, followed by natural superficial deposits comprising Alluvium, River Terrace Gravels, Glaciofluvial deposits and Glacial Till. The anticipated bedrock below the scheme comprises sequence of the Stainmore Formation, the Great Limestone Member, the Alston Formation and the Four Fathom Limestone Member moving from west to east. The distribution of surface superficial deposits and bedrock at rockhead is shown in Figures 9.2: Published Geology – Solid Geology and 9.3: Published Geology – Drift Geology respectively with the ground conditions described in more detail in Table 9-14: Summary of geology and ground conditions: Bowes Bypass .

Table 9-14: Summary of geology and ground conditions: Bowes Bypass

Strata	Description	Distribution
Superficial deposits		
Made Ground	Potentially variable materials described as an intermixture of granular and cohesive material, of variable thickness; granular Made Ground had a recorded thickness between 0.25m to 1.90m. A thickness of cohesive Made Ground was not included in the PSSR. The existing A66 alignment is situated on embankments, within cuttings and at-grade. Consequently, extensive engineered fill and/or reworked	The 1:50,000 scale *BGS viewer* did not identify the presence of any artificial ground along the Bowes Bypass scheme. However, deposits are anticipated locally associated with previous development within the Bowes Bypass scheme, including embankments and cuttings.

Strata	Description	Distribution
	natural ground is anticipated in areas of the embankments.	
Alluvium	BGS viewer indicates the presence of alluvium comprising clay, silt, sand and gravel. These deposits were not encountered within the historic borehole logs summarised within the PSSR.	Anticipated in the most south easterly corner of the study area, located along a section of the River Greta.
River Terrace Gravels	BGS viewer indicates the presence of deposits comprising sand and gravel with local lenses of silt, clay or peat. These deposits were not encountered within the historic borehole logs summarised within the *PSSR*.	Anticipated along the south of Bowes Bypass buffer.
Glaciofluvial Deposits	*BGS viewer* indicates the presence of sands and gravels. Deposits not described under Section 10 of the *PSSR*.	Anticipated in the south west of Bowes Bypass.
Peat	BGS 1:50,000 maps do not indicate the presence of peat. However, peat was encountered within a historical borehole log	Localised peat deposit encountered in historic borehole (649630), to the north west of Stone Bridge Farm located to the
Till	Historical borehole logs describe the Till as '*silty clay, sandy clay with gravel and occasional limestone and sandstone boulders.'*	Anticipated to underlie the majority of Bowes Bypass.
Bedrock		
Bottom Little Limestone	*BGS viewer* does not provide a description of member.	Anticipated to run to the north and c. parallel to the current A66 alignment, within the Bowes Bypass buffer.
Stainmore Formation	Cyclical repetition of sandstones, siltstones mudstones and thin limestones with some coals. The formation is up 1km in thickness.	Anticipated to underlie the west of Bowes Bypass Formation encountered within historical borehole logs.
Great Limestone Member	A bioclastic packstone which is dark blue grey in colour and '*thickly bedded with thin shaly mudstone partings along uneven or wavy bedding*	Anticipated to underlie the central and most easterly portion of the scheme. Formation encountered within historical borehole logs.

Strata	Description	Distribution
	planes.' Fossil beds common. The limestone member is estimated to be 14 to 18m in thickness.	
Alston Formation	Comprising '*bioclastic limestones, sandstones, mudstones and siltstones and rare coals typically in a regular cyclothymic sequence'*. The formation is up to 340m in thickness.	Anticipated to underlie the majority of the eastern portion of Bowes Bypass. Formation encountered within historical borehole logs.
Four Fathom Limestone Member	A fine grained grey packstone with thick, wavy beds and mudstone partings, becoming more argillaceous towards the top. The member is 7 to 10m in thickness,	Anticipated to underlie the junction of the scheme alignment and 'the Street'. Formation not encountered in historical borehole logs.
Coal Mining and Mineral Extraction		
Deep Coal	The *BGS interactive viewer* states does not indicate the presence of any deep coal within the scheme boundary.	N/A
Surface Coal Resource Area	The *Coal Authority viewer* does not indicate the presence of any shallow coal within the scheme boundary.	N/A
Coal Mining Reporting Area	The *Coal Authority viewer* indicates that the Bowes Bypass scheme is not located within a coal mining reporting area.	N/A
Abandoned Mine Catalogue	The *Coal Authority viewer* indicates that there are no abandoned mine locations the Bowes Bypass scheme.	N/A
Shallow Mine Workings	The karst walkover identified historic shallow mine workings within the Great Limestone Member (95, 96, 97, 104).	N/A
Hulands Quarry	The *BGS viewer* indicates that an active limestone quarry is located within the scheme buffer.	Quarry is located to the north west of the Bowes Bypass scheme buffer.

9.6.93 Groundwater was recorded within the Stainmore Formation and Great Limestone Member. Perched groundwater encountered within the Glacial Till. No water strikes were recorded within the Alluvium, though water is anticipated to be present at depth, possibly in continuity with local streams and rivers

9.6.94 LiDAR and aerial photography identified ten potential karst landforms within 2km of the scheme alignment, including God's Bridge natural arch and God's Bridge River Cave, located to the west. Several features were also identified adjacent to the quarries located to the east. All landforms in the Bowes area occur within the Great Limestone Member. The survey identified seven enclosed depressions, 19 groundwater springs and two caves. Though no karst features were identified under the alignment itself, the Great Limestone Member is considered to have a moderate karst risk.

Geodiversity sites

9.6.95 The western edge of the scheme partly extends into the AONB UNESCO Global Geopark, see Figure 9.4: Geodiversity Sites.

WesSoils

9.6.96 Soils to the west are mapped as Brickfield 3 they typically consist of slowly permeable seasonally waterlogged fine loamy over clayey soils and in this part of the country are likely to fall into WC 4 and so into ALC Grade 3b or 4. The soils to the east of the area are mapped as Dunkeswick they typically consist of slowly permeable seasonally logged fine loamy over clayey soils they are likely to fall into WC 4 and into ALC Grade 3b or 4. The soil grades, distribution across the scheme and receptor value (sensitivity) are summarised in Table 9-15: Soil resources: Bowes Bypass below.

Table 9-15: Soil resources: Bowes Bypass

Soil	Description	Distribution (%) of scheme area	Value
3b	Land is capable of producing moderate yields of a narrow range of crops (mainly cereals and grass) or lower yields of a wider range of crops, or high yields of grass (for grazing and harvesting).	88.3	Medium
Non-agricultural	Land which can be returned relatively easily to agriculture. Known as a 'soft' use this is commonly referred to areas such as golf courses, private parklands, public open spaces and sports fields. Active mineral workings and refuse tips also fall under this category as the land can be easily restored after use.	1.4	Negligible
Urban	Areas within an urban area such as housing, industry, commerce, education, religious buildings and cemeteries are known as 'hard' use because of the little potential for a return to agricultural land. This is due to the fact that the land is hard to restore after use	10.3	Negligible

9.6.97 The *ALC Strategic Map* Information shows the Bowes Bypass area as most likely to have a moderate proportion of BMV land i.e. 20-60% of the agricultural area.

Contamination sources

9.6.98 Following screening of these sites, a number of potentially contaminative sites have been identified which could be impacted by the project, including a disused quarry, cemetery, railway land, farms and a landfill, as detailed in Appendix 9.1: Potential Contamination Sources and Receptors .

Contamination receptors

9.6.99 A number of potential receptors to contamination have been identified in the study area. These include allotments, a primary school, Secondary A aquifers, and numerous surface watercourses, detailed in Appendix 9.1: Potential Contamination Sources and Receptors . Further information on groundwater and surface water receptors is provided in Chapter 14: Road Drainage and the Water Environment.The scheme is located at the eastern edge of the North Pennines AONB. The North Pennines Moors SAC, the North Pennines Moors SPA and the Bowes Moor SSSI are located 300m and 350m north west, immediately outside the study area. Further detail on these statutory designated sites, and their qualifying habitats and vegetative communities, is provided in Chapter 6: Biodiversity.

Cross Lanes to Rokeby

9.6.100 This scheme has a whole route option and alternative junction options at Cross Lanes and Rokeby, as described in Chapter 2: The Project. The baseline presented for this scheme is based on a combined study area for the three options: the black route and red and blue alternative junctions, as shown in Figure 9.1: Study Area.

Geological context

9.6.101 It is anticipated that Cross Lanes to Rokeby is underlain by Made Ground, followed by natural superficial deposits comprising predominantly Glacial Till and some Alluvium. The anticipated bedrock below the scheme comprises of the Great Limestone Member as the geological boundary runs to the south and roughly parallel to the alignment. The sandstone beds of the Alston Formation are anticipated to the south of the Rokeby scheme alignment.

9.6.102 The distribution of surface superficial deposits and bedrock at rockhead is shown in Figures 9.2: Published Geology – Solid Geology and 9.3: Published Geology – Drift Geology respectively with the ground conditions described in more detail in Table 9-16: Summary of geology and ground conditions: Cross Lanes to Rokeby.

Table 9-16: Summary of geology and ground conditions: Cross Lanes to Rokeby

Strata	Description	Distribution
Superficial deposits		
Made Ground	Potentially variable materials described as an intermixture of granular and cohesive material, of variable thickness; granular Made Ground had a recorded thickness between 0.50m to 0.62m. The existing A66 alignment is situated on embankments, within cuttings and at-grade.	The 1:50,000 scale BGS viewer did not identify the present of any artificial ground along the Cross lanes to Rokeby scheme. However, deposits are anticipated locally associated with previous development within the Cross Lanes to Rokeby scheme,

Strata	Description	Distribution
	Consequently, extensive engineered fill and/or reworked natural ground is anticipated in areas of the embankments.	including embankments and cuttings.
Landslip Deposits	The *BGS viewer* indicates the presence of slip deposits. Unknown or unclassified entry.	Anticipated to be located to the north of Garden House, located in the north eastern corner of the study area boundary.
Alluvium	*BGS viewer* indicates the presence of alluvium comprising clay, silt, sand and gravel. These deposits were not encountered within the historic borehole logs summarised within the *PSSR*.	Anticipated to the south of the scheme, along Tutta Beck which runs parallel to the south of the alignment. Two separate pockets of Alluvium are anticipated to the north west, associated with two unnamed watercourses spurring from the Manyfold Beck; the north westerly portion of the Cross Lanes Junction is antipated to intersect one of these areas of Alluvium.
Glaciofluvial Deposits	*BGS viewer* indicates the presence of sands and gravels.	Anticipated to the north east of the alignment, within the study area.
Glacial Till	Historical borehole logs describe the Till as '*very soft to firm sandy to very sandy 'stony' clay; a silty 'stony' clay; or as a gravelly clay'.*	Anticipated to underlie the majority of the scheme area.
Bedrock		
Stainmore Formation (sandstone)	BGS viewer logs indicate the formation is present below the scheme, described as a cyclical repetition of sandstones, siltstones mudstones and thin limestones with some coals. The formation is up 1km in thickness. There is no distinction of the sandstone beds from the rest of the formation on the *BGS viewer*.	Anticipated to underlie the most northerly end of Cross Lanes Junction overbridge, in the western end of the scheme.
Stainmore Formation	*BGS viewer* logs indicate the formation is present below the scheme, described as a cyclical repetition of sandstones, siltstones mudstones and thin limestones with some coals. The formation is up 1km in thickness.	Anticipated to underlie the northerly end of Cross Lanes Junction overbridge, in the western end of the scheme.
Great Limestone Member	Bioclastic packstone which is dark blue grey in colour and '*thickly bedded with thin shaly mudstone*	Anticipated to underlie the majority of the Cross Lanes to Rokeby scheme.

Strata	Description	Distribution
	partings along uneven or wavy bedding planes.' Fossil beds common. The limestone member is estimated to be 14 to 18m in thickness.	
Alston Formation (sandstone)	*BGS viewer* indicates that the formation is present below the scheme, comprising '*bioclastic limestones, sandstones, mudstones and siltstones and rare coals typically in a regular cyclothymic sequence'*. The total formation thickness is estimated to be 340m. There is no distinction of the sandstone beds from the rest of the formation on the *BGS viewer*.	Anticipated to underlie the portion of the scheme directly to the south of the proposed alignment.
Alston Formation	Comprising '*bioclastic limestones, sandstones, mudstones and siltstones and rare coals typically in a regular cyclothymic sequence'*. The formation is up to 340m in thickness.	Anticipated to underlie access roads and a portion of the overbridge in the south of scheme.
Four Fathom Limestone Member	A fine grained grey packstone with thick, wavy beds and mudstone partings, becoming more argillaceous towards the top. The member is 7 to 10m in thickness.	Anticipated to underlie the cutting below the southern access road to the Cross Lanes Junction.
Coal Mining and Mineral Extraction		
Deep Coal	The *BGS interactive viewer* states does not indicate the presence of any deep coal within the scheme boundary.	N/A
Surface Coal Resource Area	The *Coal Authority viewer* does not indicate the presence of any shallow coal within the scheme boundary.	N/A
Coal Mining Reporting Area	The *Coal Authority viewer* indicates that the Bowes Bypass scheme is not located within a coal mining reporting area.	N/A
Abandoned Mine Catalogue	The *Coal Authority viewer* indicates that there are no abandoned mine locations the Bowes Bypass scheme.	N/A

Strata	Description	Distribution

9.6.103 Groundwater is likely to be present at depth within the bedrock deposits. Recorded groundwater strikes are interpreted as perched groundwater within in the Glacial Till. No water strikes were recorded within the Alluvium, though water is anticipated to be present at depth, possibly in continuity with local streams and rivers.

9.6.104 LiDAR and aerial photography did not identifiy any karst landforms within the Great Limestone Member. Springs were identidied from OS mapping, but were discounted due to their occurrence within sandstone. The site walkover did encounter hummocky wet ground adjacent to a small tributary to Tutta Beck (S21). The Karst assessment considers the Great Limestone Member to have a moderate karst risk. Although the Alston Formation was not considered within the orignal risk assessment for the Cross Lanes to Rokeby scheme, it was assessed for other schemes as having a low karst risk.

Geodiversity sites

9.6.105 No geodiversity sites have been identified in the study area.

Soils

9.6.106 The soils are mapped as Wick 1 Association. They typically have deep well drained coarse loamy soils and are well to moderately well drained and in this part of the country fall into WC 1 or 2 and so into ALC Grade 3a for the majority of the area, ALC Grade 2 in the far east of the scheme and ALC Grade 3b in the far west of the scheme. The soil grades, distribution across the scheme and receptor value (sensitivity) are summarised in Table 9-17: Soil resources: Cross Lanes to Rokeby.

Table 9-17: Soil resources: Cross Lanes to Rokeby

Soil	Description	Distribution (%) of scheme area	Value
3a	Land that is capable of consistently producing moderate to high yields of a narrow range of arable crops (e.g. cereals) or moderate yields of a wide range of crops (e.g. cereals, grass, oilseed rape, potatoes, sugar beet and less demanding horticultural crops)	84.8	High
3b	Land is capable of producing moderate yields of a narrow range of crops (mainly cereals and grass) or lower yields of a wider range of crops, or high yields of grass (for grazing/harvesting).	14.4	Medium
Urban	Areas within an urban area such as housing, industry, commerce, education, religious buildings and cemeteries are known as ‘hard’ use because of the little potential for a return to agricultural land. This is due to the fact that the land is hard to restore after use	0.8	Negligible

9.6.107 The *ALC Strategic Map* Information shows the Cross Lanes to Rokeby (dualling and junctions, bypass) area as most likely to have a high proportion of BMV land i.e. >60%

of the agricultural area across the majority of the scheme. To the far west of the area there is the likelihood of moderate BMV land i.e. 20-60% of the agricultural area.

Contamination sources

9.6.108 Following screening of these sites, a number of potentially contaminative sites have been identified which could be impacted by the project, including potential fly tipping, a poultry house, discharge consents, farms and potential scrapyard, as detailed in Appendix 9.1: Contamination Sources and Receptors.

Contamination receptors

9.6.109 A number of potential receptors to contamination have been identified in the study area. These include residents of nearby properties, Secondary A aquifers and small abstractions, and numerous surface watercourses, see Appendix 9.1: Contamination Sources and Receptors. Further information on groundwater and surface water receptors is provided in Chapter 14: Road Drainage and the Water Environment.

9.6.110 No statutory designated sites are located within the study area. Rokeby Park and Mortham Woods Local Wildlife Site are adjacent to this scheme. Further detail on potentially sensitive habitats and specieswithin the study area is provided in Chapter 6: Biodiversity.

Stephen Bank to Carkin Moor

Geological context

9.6.111 It is anticipated that Stephen Bank to Carkin Moor is underlain by Made Ground, followed by natural superficial deposits comprising predominantly of Glacial Till. Pockets of Alluvium and Glaciofluvial deposits are anticipated to the south-west. The anticipated bedrock below the scheme comprises of the Alston Formation, Four Fathom Limestone Member, the Alston Formation (sandstone) and the Five Yard Limestone Member.

9.6.112 The distribution of surface superficial deposits and bedrock at rockhead is shown in Figures 9.2: Published Geology – Solid Geology and 9.3: Published Geology – Drift Geology respectively with the ground conditions described in more detail in Table 9-18: Summary of geology and ground conditions: Stephen Bank to Carkin Moor.

Table 9-18: Summary of geology and ground conditions: Stephen Bank to Carkin Moor

Strata	Description	Distribution
Superficial deposits		
Made Ground	Potentially variable materials described as an intermixture of granular and cohesive material, of variable thickness. The existing A66 alignment is situated on embankments, within cuttings and at-grade. Consequently, extensive engineered fill and/or reworked natural ground is anticipated in areas of the embankments.	The 1:50,000 scale BGS viewer did not identify the presence of any artificial ground along the scheme. However, deposits are anticipated locally associated with previous development within the scheme, including embankments and cuttings.
Alluvium	*BGS viewer* indicates the presence of alluvium comprising clay, silt, sand and gravel. These deposits	Anticipated to the north-west of the scheme.

Strata	Description	Distribution
	were not encountered within the historic borehole logs summarised within the *PSSR*.	
Glaciofluvial Deposits	*BGS viewer* indicates the presence of sands and gravels. These deposits were not encountered within the historic borehole logs summarised within the PSSR.	Anticipated to the north-west of the scheme.
Glaciofluvial Sheet Deposits	*BGS viewer* indicates the presence of '*sands and gravel, locally with lenses of silt, clay or organic material*.' These deposits were not encountered within the historic borehole logs summarised within the PSSR.	Anticipated to the south-west of the scheme, in the vicinity of Foxholme and Foxwell Farm
Glacial Till	Historical borehole logs describe the Till as '*a very soft to stiff sandy slightly silty clay with subangular to subrounded fine to coarse sandstone gravel with occasional limestone cobbles; clayey sand was encountered locally.'*	Anticipated to underlie the majority of the scheme area.
Bedrock		
Four Fathoms Limestone Member	Fine grained grey packstone with thick, wavy beds and mudstone partings, becoming more argillaceous towards the top. The member is 7 to 10m in thickness.	Anticipated to underlie the north western tip of the Scheme boundary, between Rokeby Close Farm and Stephen Bank. Also runs roughly parallel with the alignment until being truncated by a series of faults located in the central part of the scheme.
Alston Formation (sandstone)	*BGS viewer* indicates that the formation is predominantly comprised of sandstone in this area. The total formation thickness is estimated to be 340m.	Anticipated to underlie the north western tip of the scheme boundary, to the south-east of Stephen Bank. Also runs roughly parallel with the alignment until being truncated by a series of faults located in the central part of the scheme.
Three Yard Limestone Member	BGS viewer describes the member as a '*dark grey limestone with an intercalated thin black fossiliferous calcareous mudstone'*. The member is estimated to be 3 to 8.5m in thickness.	Anticipated to underlie the most south easterly portion of the scheme.

Strata	Description	Distribution
Alston Formation	*BGS viewer* described as comprising '*bioclastic limestones, sandstones, mudstones and siltstones and rare coals typically in a regular cyclothemic sequence*'. The formation is up to 340m in thickness.	Anticipated to underlie the majority of the north western portion of the scheme between Stephen bank and West Layton and the majority of the of the south eastern portion, between Foxwell Farm and Black Hill.
Coal Mining and Mineral Extraction		
Deep Coal	The *BGS interactive viewer* does not indicate the presence of any deep coal within the scheme boundary.	N/A
Surface Coal Resource Area	The *Coal Authority viewer* does not indicate the presence of any shallow coal within the scheme boundary.	N/A
Abandoned Mine Catalogue	The *Coal Authority viewer* indicates that an abandoned mine shaft (ref 416507-001) is located within the study area boundary.	A shaft is located c. 400m to the south-west of the draft DCO boundary. The abandoned mine catalogue extends immediately south of the current alignment.
Carkin Moor Quarry	The *BGS viewer* indicates that an active sandstone quarry is located within the Stephen Bank to Carkin Moor scheme Boundary.	The quarry is located to the south west of Carkin Moor Farm and to the north west of the Scheme.

9.6.113 Groundwater is likely to be present at depth within the bedrock deposits. Perched groundwater strikes were recorded within the Glacial Till. No water strikes were recorded within the Alluvium, though water is anticipated to be present at depth, possibly in continuity with local streams and rivers.

9.6.114 LiDAR and aerial photography identified fifteen enclosed depressions located within 2km of this alignment upgrade section. The walkover identified four of these enclosed depressions and one spring, but all depressions were confirmed as not karst. A small number of karst features were identified on the Four Fathom Limestone Member, but these features are typical of small-scale karst related to local fracturing or weathered zones that facilitate groundwater flow. Of note within the assessment is an enclosed doline near the mapped outcrop of the Four Fathom Limestone Member near West Layton (ID 40), which lies adjacent to an attenuation basin on the proposed road alignment. Although the potential karst feature is shallow, it forms a wide depression that appears to be associated with localised seasonal flooding. Both the Four Fathom Limestone Member and Alston Formation were caterogised as a low karst risk. A low karst risk has been concluded for the Five Yard Limestone Member. This assessment was made based on the thin nature of the member but also due to the low occurrence of karst features in the area of the alignment. Those features identified are generally shallow features. There are no recorded features on the Five Yard Limestone.

Geodiversity sites

9.6.115 No geodiversity sites have been identified in the study area.

Soils

9.6.116 Across the majority of the area to the west the soils are mapped as Wick 1 Association. They typically have deep well drained coarse loamy soils and are well to moderately well drained and in this part of the country fall into WC 1 or 2 and so into ALC Grade 2.

9.6.117 To the far east of Stephen Bank to Carkin Moor (dualling and junctions, bypass) the soils are mapped as Brickfield 2 Association. These soils typically consist of slowly permeable, seasonally waterlogged fine loamy soils and largely fall into WC 4 when undrained (ALC Grade 3b or 4) and WC 3 with artificial drainage (ALC Grade 3a/b). The soil grades, distribution across the scheme and receptor value (sensitivity) are summarised in Table 9-19: Soil resources: Stephen bank to Carkin Moor.

Table 9-19: Soil resources: Stephen bank to Carkin Moor

Soil	Description	Distribution (%) of scheme area	Value
3a	Land that is capable of consistently producing moderate to high yields of a narrow range of arable crops (e.g. cereals) or moderate yields of a wide range of crops (e.g. cereals, grass, oilseed rape, potatoes, sugar beet and less demanding horticultural crops)	63.7	High
3b	Land is capable of producing moderate yields of a narrow range of crops (mainly cereals and grass) or lower yields of a wider range of crops, or high yields of grass (for grazing and harvesting).	28.7	Medium
Urban	Areas within an urban area such as housing, industry, commerce, education, religious buildings and cemeteries are known as 'hard' use because of the little potential for a return to agricultural land. This is due to the fact that the land is hard to restore after use	7.6	Negligible

9.6.118 The *ALC Strategic Map* Information shows the Stephen Bank to Carkin Moor (dualling *and* junctions, bypass) area as most likely to have a high proportion of BMV land i.e. >60% of the agricultural area across the majority of the scheme. To the far east of the area there is the likelihood of a moderate proportion of BMV land i.e. 20-60% of the agricultural area.

Contamination sources

9.6.119 Following screening of these sites, a number of potentially contaminative sites have been identified which could be impacted by the project, including disused quarries, farms, tanks and an anaerobic digestion facility, see Appendix 9.1: Potential Contamination Sources and Receptors.

Contamination receptors

9.6.120 A number of potential receptors to contamination have been identified in the study area. These residents, secondary A aquifers and numerous surface watercourses, see Appendix 9.1: Potential Contamination Sources and Receptors. Further information on groundwater and surface water receptors is provided in Chapter 14: Road Drainage and the Water Environment.

9.6.121 There are no designated sites within the study area.

A1(M) J53 Scotch Corner

Geological context

9.6.122 Scotch Corner is indicated to be underlain by Made Ground, followed by natural superficial deposits comprising predominantly of Glacial Till. An area just south of the A1 Junction with the A66 is not shown to be underlain by any superficial deposits; as such, bedrock is anticipated to be shallow in this area of Scotch Corner. The anticipated bedrock below the scheme comprises Four Fathom Limestone Member.

9.6.123 The distribution of surface superficial deposits and bedrock at rockhead is shown in Figures Figures 9.2: Published Geology – Solid Geology and 9.3: Published Geology – Drift Geology respectively with the ground conditions described in more detail in Table 9-20:Summary of geology and ground conditions: A1 (M) J53 Scotch Corner.

Table 9-20:Summary of geology and ground conditions: A1 (M) J53 Scotch Corner

Strata	Description	Distribution
Superficial deposits		
Made Ground	Potentially variable materials described as an intermixture of granular and cohesive material, between of variable thickness. The existing A66 alignment is situated on embankments, within cuttings and at-grade. Consequently, extensive engineered fill and/or reworked natural ground is anticipated in areas of the embankments.	The 1:50,000 scale BGS viewer did not identify the presence of any artificial ground within the study area. However, deposits are anticipated locally associated with previous development within the Scotch Corner scheme, including embankments and cuttings.
Glacial Till	Historical borehole logs describe the Till as comprising a weathered top of orange, brown sandy clay with occasional cobbles and boulders, passing into grey, brown clay with cobbles and occasional boulders. The gravel and cobble content increases with depth.	Anticipated to underlie the majority of the scheme area.
Bedrock		
Four Fathoms Limestone Member	BGS viewer described the member as a fine grained grey packstone with thick, wavy beds and mudstone partings, becoming more argillaceous towards the top. The member is 7 – 10m in thickness.	Anticipated to underlie the entirety of the Scotch Corner scheme.
Coal Mining and Mineral Extraction		
Deep Coal	The BGS interactive viewer states does not indicate the presence of any deep coal within the scheme boundary.	N/A

Strata	Description	Distribution
Surface Coal Resource Area	The Coal Authority viewer does not indicate the presence of any shallow coal within the scheme boundary.	N/A
Coal Mining Reporting Area	The Coal Authority viewer indicates that Scotch Corner is not located within a coal mining reporting area.	N/A
Abandoned Mine Catalogue	The Coal Authority viewer indicates that there are no abandoned mine locations within Scotch Corner Scheme Boundary.	N/A
Active Quarries	The BGS viewer indicates that there are no active quarries within the Scotch Corner boundary.	N/A

9.6.124 Groundwater is likely to be present as discontinuous pockets of perched water within made ground and superficial deposits; deep groundwater is also likely to exist within the Four Fathoms Limestone Bedrock.

9.6.125 A1(M) J53 Scotch Corner was not included within the karst assessment. Although the Four Fathoms Limestone Member was not considered within the original risk assessment for the scheme, it was assessed for other schemes as having a low karst risk and will not be considered further for this scheme.

Geodiversity sites

9.6.126 No geodiversity sites have been identified in the study area.

Soils

9.6.127 Soils assessment was not undertaken for Scotch Corner as a preferred route option was not available at the time of the assessment being undertaken.

Contamination sources

9.6.128 The study area is located within a predominantly agricultural area. The proposed works in this area are predominantly at-grade, therefore no potential contamination sources were identified as a result of the screening process.

Contamination receptors

9.6.129 A small number of potential receptors to contamination have been identified in the study area. These include residents, Secondary A aquifers and abstractions and Ludburn Beck surface watercourse, see Appendix 9.1: Potential Contamination Sources and Receptors. Contamination Sources and Receptors. Further information on groundwater and surface water receptors is provided in Chapter 14: Road Drainage and the Water Environment.

9.6.130 There are no designated sites within the study area.

9.7 Potential Impacts

9.7.1 This section identifies the construction and operational stage impacts associated with each of geodiversity, soils and contamination.

Construction

Geodiversity

9.7.2 The draft DCO boundary includes parts of the North Pennines AONB UNESCO Global Geopark in the Appleby to Brough (Warcop) and Bowes Bypass schemes. This receptor has a very high sensitivity, although only approximately 2km^2 of the Geopark is within the study area for the Appleby to Brough (Warcop) scheme and less than 0.3km^2 of the study area is within the Geopark for the Bowes Bypass scheme, compared to the total Geopark area of 1,983km^2. Potential impacts could arise from land disturbance within the designated Geopark area during construction, for example if any existing exposures are covered over, or there are changes to land accessibility that impair the enjoyment of the Geopark temporarily.

Soils

9.7.3 The project would result in the loss of agricultural land resources through permanent and temporary land take. Permanent land take would consist of land permanently acquired for the project and would be permanently lost to agriculture or habitat.

9.7.4 Temporary land take would consist of land required for the site compounds, construction working space and access during the construction phase. Land temporarily used for construction may be subject to changes in soil structure and other characteristics due to compaction by heavy plant and vehicles or throughhandling and storage. Compacted soil reduces water infiltration and can lead to increased rates of surface water run-off and associated soil erosion as well as reduced agricultural productivity.

9.7.5 Poor reinstatement of any temporary land take would lead to a loss in agricultural land quality and habitat. There is potential for soils outside of the land take areas to be affected by construction works, through dust and run-off waters.

9.7.6 Soil and vegetation disturbance during construction, such as soil stripping and storage or vehicle movements can also create suitable conditions for the establishment of invasive plants from which seeds can spread.

Agricultural land

9.7.7 Potential land take shows the approximate agricultural land take associated with the schemes based on the draft DCO boundary. The draft DCO boundary is currently insufficiently developed to separate the permanent and temporary land take, therefore as a worst case it is assumed that all the land take is permanent land take.

9.7.8 This includes land which would be permanently sealed (i.e. under hardstanding) or land which would not be sealed but would not be returned to agriculture (e.g. landscaping, surface water management etc.).

9.7.9 Soil resources which would not be sealed under hardstanding would still be used to provide some ecosystem services. However, as none of this land would be retained for commercial agriculture, it is all considered as lost agricultural land for the purpose of this assessment.

9.7.10 During construction there will be a loss of agricultural soils, some of which will be High Value soils, falling within the BMV classification (i.e. Grades 1, 2 and 3a). This loss will comprise routwide areas, for example required for construction compounds and access.

9.7.11 There will also be potential disruption to ongoing agricultural activities and potential fragmentation of land parcels. For areas of temporary development during

construction (e.g. the formation of construction compound and storage areas, haul roads etc.) some BMV degradation will also occur. Evidence for the degree and extent of degradation will be quantified by comparison against the pre-construction baseline ALC survey data, which will in turn inform post-construction soil restoration standards.

9.7.12 There is the potential that leaks or spills could occur from construction materials and equipment. It is envisaged that, with appropriate site controls, these are likely to be limited in extent.

Contamination

9.7.13 It is considered that, without mitigation, a number of potential impacts could arise associated with the disturbance or mobilisation of contamination during construction. The relevance and significance of these impacts will vary according to the nature and levels of contamination present for different sources, the proximity and nature of receptors and works proposed. General impacts could include:

Human health

9.7.14 Made ground, infill materials, and natural soils underlying the proposed scheme may have been contaminated by historical and current land use activities including historical landfill sites, infilled mineral extraction pits, fuel storage, industrial areas and farmyards. Disturbance of potentially contaminated soils may cause an increase in leaching and mobilising of contaminants, along new or existing surface or sub-surface pollution pathways. These could create new pathways to receptors.

9.7.15 Ground gases or vapours may be associated with the existing historical landfills for example, at Skirsgill Farm off the M6 roundabout, which could migrate to a small number of commercial or residential properties in close proximity to the proposed scheme. In the current scheme design there would be limited interaction with the landfills, however this may have to be reassessed for future project stages as part of the ES. Vapours could also be associated with existing and former fuel storage sites where there is residual contamination which could also migrate to adjacent properties.

9.7.16 The information presented in the *PSSR* and reviewed as part of the *Environmental Scoping Report*[31] [28] identified that there is not likely to be a significant risk of Unexploded Ordnance (UXO) and therefore the risks associated with UXO were scoped out for geological purposes, as such risks will be managed as for any other construction-related risk.

9.7.17 It is noted that the EIA Scoping Opinion, dated 23 July 2021, requested that the ES should explain the proposed approach used to assess UXO risk in the context of the Ministry of Defence facility at Warcop and include the Zetica Maps from the *PSSR*, alongside any Pre-Desk Study Assessment (PDSA) in justifying that further detailed assessment is not required. The ES will include a description of mitigation / control measures in the Environmental Management Plan (EMP) in event that unknown UXO are encountered.

Groundwater and surface water

9.7.18 Several potentially contaminated land sites have been identified along the proposed scheme, including:

- Historical landfills
- Former or existing fuel sites

[31] Highways England (2021) A66 Northern Trans-Pennine. PCF Stage 3 Environment Scoping Report

- Sewage treatment works
- Railway land
- Diffuse pollutants from agricultural land and farmyards.

9.7.19 Disturbance of potentially contaminated soils from these sites could be caused due to earthworks and/or use of piled foundations for structures. This may cause an increase in leaching of contaminants in soils and mobilising of contaminants along new or existing surface or sub-surface pollution pathways. This in turn may lead to the quality of surface waters and groundwater aquifers being impacted through run-off, infiltration and vertical and horizontal movement of contaminated groundwater and leachate.

Summary

9.7.20 The potential geology and soils construction stage impacts for each scheme are summarised below in Table 9-21: Summary of potential construction impacts by scheme.

Table 9-21: Summary of potential construction impacts by scheme

Scheme	Potential impact				
	Geodiversity	Soils	Human Health	Groundwater quality	Surface water quality
M6 Junction 40 to Kemplay Bank	No geodiversity sites identified in study area	Loss of Grade 3a agricultural land through permanent and temporary land take	Potential exposure of nearby residents, schools, commercial and industrial properties, users recreation grounds and public site users to contamination as a result of disturbance or mobilisation during construction e.g. via dust inhalation, inhalation of ground gases, impacts on groundwater quality	Potential exposure of Principal Aquifer, Secondary A aquifer, Source Protection Zone (SPZ) (Zone 3), abstraction to contamination as a result of ground disturbance during construction e.g. increase in leaching and mobilisation of contamination along new or existing pathways	Potential exposure of SSSI and SAC, watercourses not classified under Water Framework Directive (WFD) to contamination as a result of ground disturbance causing an increase in leaching or mobilisation of contamination along new or existing pathways
Penrith to Temple Sowerby	No geodiversity sites identified in study area	Loss of Grade 2, 3a and 3b agricultural land through permanent and temporary land take	Potential exposure of nearby residents, users of commercial and industrial properties and public site users to contamination as a result of disturbance or mobilisation during construction e.g. via dust inhalation, impacts on groundwater quality	Potential exposure of Principal Aquifer, Secondary A aquifer, SPZ (Zone 3), abstraction to contamination as a result of ground disturbance during construction e.g. increase in leaching and mobilisation of contamination along new or existing pathways	Potential exposure of SSSI and SAC, watercourses not classified under WFD to contamination as a result of ground disturbance causing an increase in leaching or mobilisation of contamination along new or existing pathways

Scheme	Potential impact				
	Geodiversity	Soils	Human Health	Groundwater quality	Surface water quality
Temple Sowerby to Appleby (Blue alternative)	No geodiversity sites identified in study area	Loss of Grade 2, 3a and 3b agricultural land through permanent and temporary land take	Potential exposure of nearby residents, users of schools, commercial and industrial properties and public site users to contamination as a result of disturbance or mobilisation during construction e.g. via dust inhalation, impacts on groundwater quality	Potential exposure of Principal Aquifer, Secondary A aquifer, Secondary B aquifer to contamination as a result of ground disturbance during construction e.g. increase in leaching and mobilisation of contamination along new or existing pathways	Potential exposure of SSSI and SAC, watercourses not classified under WFD to contamination as a result of ground disturbance causing an increase in leaching or mobilisation of contamination along new or existing pathways
Temple Sowerby to Appleby (Red alternative)	No geodiversity sites identified in study area	Loss of Grade 2, 3a and 3b agricultural land through permanent and temporary land take	Potential exposure of nearby residents, users of schools, commercial and industrial properties and public site users to contamination as a result of disturbance or mobilisation during construction e.g. via dust inhalation, impacts on groundwater quality	Potential exposure of Principal Aquifer, Secondary A aquifer, Secondary B aquifer to contamination as a result of ground disturbance during construction e.g. increase in leaching and mobilisation of contamination along new or existing pathways	Potential exposure of SSSI and SAC, watercourses not classified under WFD to contamination as a result of ground disturbance causing an increase in leaching or mobilisation of contamination along new or existing pathways
Temple Sowerby to Appleby (Orange alternative)	No geodiversity sites identified in study area	Loss of Grade 2, 3a and 3b agricultural land through permanent and	Potential exposure of nearby residents, users of schools, commercial and industrial properties and public site users to contamination as a result of disturbance or	Potential exposure of Principal Aquifer, Secondary A aquifer, Secondary B aquifer to contamination as a result of ground disturbance during construction e.g.	Potential exposure of SSSI and SAC, watercourses not classified under WFD to contamination as a result of ground disturbance causing an

Scheme	Potential impact				
	Geodiversity	Soils	Human Health	Groundwater quality	Surface water quality
		temporary land take	mobilisation during construction e.g. via dust inhalation, impacts on groundwater quality	increase in leaching and mobilisation of contamination along new or existing pathways	increase in leaching or mobilisation of contamination along new or existing pathways
Appleby to Brough (Warcop) (Black route)	Potential damage or loss of geological exposures within UNESCO Global Geopark	Loss of Grade 3a and 3b agricultural land through permanent and temporary land take	Potential exposure of nearby residents, users of commercial and industrial properties and public site users to contamination as a result of disturbance or mobilisation during construction e.g. via dust inhalation, impacts on groundwater quality	Potential exposure of Principal and Secondary A aquifers to contamination as a result of ground disturbance during construction e.g. increase in leaching and mobilisation of contamination along new or existing pathways	Potential exposure of SSSI and SAC, watercourses classified under WFD and watercourses not classified under WFD to contamination as a result of ground disturbance causing an increase in leaching or mobilisation of contamination along new or existing pathways
Appleby to Brough (Warcop) (Blue alternative)	Potential damage or loss of geological exposures within UNESCO Global Geopark	Loss of Grade 3a and 3b agricultural land through permanent and temporary land take	Potential exposure of nearby residents, users of commercial and industrial properties and public site users to contamination as a result of disturbance or mobilisation during construction e.g. via dust inhalation, impacts on groundwater quality	Potential exposure of Principal and Secondary A aquifers to contamination as a result of ground disturbance during construction e.g. increase in leaching and mobilisation of contamination along new or existing pathways	Potential exposure of watercourses classified under WFD and watercourses not classified under WFD to contamination as a result of ground disturbance causing an increase in leaching or mobilisation of contamination along

Scheme	Potential impact				
	Geodiversity	Soils	Human Health	Groundwater quality	Surface water quality
					new or existing pathways.
Appleby to Brough (Warcop) (Orange alternative	Potential damage or loss of geological exposures within UNESCO Global Geopark	Loss of Grade 3a and 3b agricultural land through permanent and temporary land take	Potential exposure of nearby residents, users of commercial and industrial properties and public site users to contamination as a result of disturbance or mobilisation during construction e.g. via dust inhalation, impacts on groundwater quality	Potential exposure of Principal and Secondary A aquifers to contamination as a result of ground disturbance during construction e.g. increase in leaching and mobilisation of contamination along new or existing pathways	Potential exposure of watercourses classified under WFD and watercourses not classified under WFD to contamination as a result of ground disturbance causing an increase in leaching or mobilisation of contamination along new or existing pathways.
Bowes Bypass	Potential damage or loss of geological exposures within UNESCO Global Geopark	Loss of Grade 3a and 3b agricultural land through permanent and temporary land take	Potential exposure of nearby residents, users of schools, allotments and public site users to contamination as a result of disturbance or mobilisation during construction e.g. via dust inhalation, impacts on groundwater quality	Potential exposure of Secondary A aquifer, Secondary (undifferentiated) aquifer, groundwater abstractions to contamination as a result of ground disturbance during construction e.g. increase in leaching and mobilisation of contamination along new or existing patthways.	Potential exposure of watercourses classified under WFD and watercourses not classified under WFD to contamination as a result of ground disturbance causing an increase in leaching or mobilisation of contamination along new or existing pathways.
Cross Lanes to Rokeby	No geodiversity	Loss of Grade 3a and	Potential exposure of nearby residents	Potential exposure of Secondary A aquifer,	Potential exposure of watercourses classified

Scheme	Potential impact				
	Geodiversity	Soils	Human Health	Groundwater quality	Surface water quality
	sites identified in study area	3b agricultural land through permanent and temporary land take	including farmers, public site users to contamination as a result of disturbance or mobilisation during construction e.g. via dust inhalation, impacts on groundwater quality	Secondary (undifferentiated) aquifer, groundwater abstractions to contamination as a result of ground disturbance during construction e.g. increase in leaching and mobilisation of contamination along new or existing pathways	under WFD and watercourses not classified under WFD to contamination as a result of ground disturbance causing an increase in leaching or mobilisation of contamination along new or existing pathways
Stephen Bank to Carkin Moor	No geodiversity sites identified in study area	Loss of Grade 3a and 3b agricultural land through permanent and temporary land take	Potential exposure of nearby residents and public site users to contamination as a result of disturbance or mobilisation during construction e.g. via dust inhalation, impacts on groundwater quality	Potential exposure of Secondary A aquifer, Secondary (undifferentiated) aquifer, groundwater abstractions to contamination as a result of ground disturbance during construction e.g. increase in leaching and mobilisation of contamination along new or existing pathways	Potential exposure of watercourses not classified under WFD to contamination as a result of ground disturbance causing an increase in leaching or mobilisation of contamination along new or existing pathways
A1(M) J53 Scotch Corner	No geodiversity sites identified in study area	Unknown (Soil assessment not undertaken)	Potential exposure of nearby residents and public site users to contamination as a result of disturbance or mobilisation during construction e.g. via	Potential exposure of Secondary A aquifer, Secondary (undifferentiated) aquifer, groundwater abstractions to contamination as a result of ground	Potential exposure of watercourses not classified under WFD to contamination as a result of ground disturbance causing an increase in leaching or

Scheme	Potential impact				
	Geodiversity	Soils	Human Health	Groundwater quality	Surface water quality
			dust inhalation, impacts on groundwater quality.	disturbance during construction e.g. increase in leaching and mobilisation of contamination along new or existing pathways	mobilisation of contamination along new or existing pathways.

Operation

Geodiversity

9.7.21 The draft DCO boundary for the Appleby to Brough (Warcop) and Bowes Bypass schemes includes parts of the North Pennines AONB UNESCO Global Geopark. The existing A66 road is within or close to the Global Geopark and therefore the presence of the road is likely to be currently having an impact on the Geopark. This situation will not change during operation.

9.7.22 Where cuttings are proposed in areas of the alignment within the Geopark, then these could provide an opportunity for enjoyment of new geological exposures, creating a beneficial operational impact. Assessment of the suitability of cuttings to expose the bedrock geology will need to be carried out using the information from ground investigation, to determine whether rock is likely to be exposed in cuttings.

Soils

9.7.23 Permanent loss of agricultural land, including BMV soils, will occur within the draft DCO boundary. In addition, near surface agricultural soils adjacent to the road could be exposed to road spray and accidental spillages.

Contamination

9.7.24 Operational impacts could occur if pollutant linkages are created or enhanced as a result of the project. Generally, however, operational impacts will be less signficant than construction impacts as the likelihood of mobilisation or exposure to contamination will generally reduce upon completion of construction. In any areas where remedial works are carried out, a beneficial impact may occur as a result of pollutant linkages being interrupted. General impacts could include:

Human health

9.7.25 The *PSSR* identified 'public site users' as potential on-site human receptors during operation. These receptors are drivers stranded within emergency refuge areas awaiting roadsite assistance. The proposed scheme will predominantly comprise hardstanding (road surfacing) which will remove potential direct contact contaminant linkages.

9.7.26 Human health risks to public site users will be assessed where the alignment interacts with, or passes close to, features such as landfill sites or fuel storage sites due to the possibility of such receptors being affected by ground gas or vapours by inhalation. This assessment will be carried out as part of the ES. If unnaceptable risks to health are identified by the assessment, remediation would be required during construction to sever the potential exposure pathway to public site users.

9.7.27 Appropriate site-specific risk assessment and method statements would be produced to control any likely future exposure to maintenence workers, as required under employers' obligations to protect workers health and safety.

Groundwater and surface water

9.7.28 Potential linkages between existing land contamination and groundwater and surface water would have been addressed during construction, i.e. contamination source removal or treatment, or breaking of potential contaminant linkages. If required, monitoring of groundwater, leachate and surface water could continue from the construction phase into the operational phase to confirm there are no additional impacts predicted, in relation to water receptors. Operational impacts on surface water and groundwater from historic land contamination were therefore scoped out of the operational assessment.

9.7.29 During operation there is the potential for contamination as a result of salt spray, run-off containing sediment, or leakage of various chemicals such as fuels from vehicles using the road which could impact controlled waters due to surface run-off from the road. The potential impacts on water receptors are addressed in Chapter 14: Road Drainage and the Water Environment.

Summary

9.7.30 The potential geology and soils operational stage impacts for each scheme are summarised below in Table 9-22: Summary of potential operational impacts by scheme.

Table 9-22: Summary of potential operational impacts by scheme

Scheme	Potential impact				
	Geodiversity	Soils	Health	Groundwater quality	Surface water quality
M6 Junction 40 to Kemplay Bank	No operational impacts identified	Loss of Grade 3a agricultural land through permanent land take Contamination from salt spray, run-off	No operational impacts identified	Potential contamination e.g. as a result of run-off, accidental spillage of fuel	Potential contamination e.g. as a result of run-off, accidental spillage of fuel
Penrith to Temple Sowerby	No operational impacts identified	Loss of Grade 2, 3a and 3b agricultural land through permanent land take Contamination from salt spray, run-off	No operational impacts identified	Potential contamination e.g. as a result of run-off, accidental spillage of fuel	Potential contamination e.g. as a result of run-off, accidental spillage of fuel
Temple Sowerby to Appleby (Blue alternative)	No operational impacts identified	Loss of Grade 2, 3a and 3b agricultural land through permanent land take Contamination from salt spray, run-off	No operational impacts identified	Potential contamination e.g. as a result of run-off, accidental spillage of fuel	Potential contamination e.g. as a result of run-off, accidental spillage of fuel
Temple Sowerby to Appleby (Red alternative)	No operational impacts identified	Loss of Grade 2, 3a and 3b agricultural land through permanent land take	No operational impacts identified	Potential contamination e.g. as a result of run-off, accidental spillage of fuel	Potential contamination e.g. as a result of run-off, accidental spillage of fuel

		Contamination from salt spray, run-off			
Temple Sowerby to Appleby (Orange alternative)	No operational impacts identified	Loss of Grade 2, 3a and 3b agricultural land through permanent land take Contamination from salt spray, run-off	No operational impacts identified	Potential contamination e.g. as a result of run-off, accidental spillage of fuel	Potential contamination e.g. as a result of run-off, accidental spillage of fuel
Appleby to Brough (Warcop) (Black route)	Potential for creation of new geological exposures in cuttings	Loss of Grade 3a and 3b agricultural land through permanent land take Contamination from salt spray, run-off	No operational impacts identified	Potential contamination e.g. as a result of run-off, accidental spillage of fuel	Potential contamination e.g. as a result of run-off, accidental spillage of fuel
Appleby to Brough (Warcop) (Blue alternative)	Potential for creation of new geological exposures in cuttings	Loss of Grade 3a and 3b agricultural land through permanent land take Contamination from salt spray, run-off	No operational impacts identified	Potential contamination e.g. as a result of run-off, accidental spillage of fuel	Potential contamination e.g. as a result of run-off, accidental spillage of fuel
Appleby to Brough (Warcop) (Orange alternative)	Potential for creation of new geological exposures in cuttings	Loss of Grade 3a and 3b agricultural land through permanent land take Contamination from salt spray, run-off	No operational impacts identified	Potential contamination e.g. as a result of run-off, accidental spillage of fuel	Potential contamination e.g. as a result of run-off, accidental spillage of fuel
Bowes Bypass	Potential for creation of new geological exposures in cuttings	Loss of Grade 3a and 3b agricultural land through permanent land take Contamination from salt spray, run-off	No operational impacts identified	Potential contamination e.g. as a result of run-off, accidental spillage of fuel	Potential contamination e.g. as a result of run-off, accidental spillage of fuel

Cross Lanes to Rokeby	No operational impacts identified	Loss of Grade 3a and 3b agricultural land through permanent land take Contamination from salt spray, run-off	No operational impacts identified	Potential contamination e.g. as a result of run-off, accidental spillage of fuel	Potential contamination e.g. as a result of run-off, accidental spillage of fuel
Stephen Bank to Carkin Moor	No operational impacts identified	Loss of Grade 3a and 3b agricultural land through permanent land take Contamination from salt spray, run-off	No operational impacts identified	Potential contamination e.g. as a result of run-off, accidental spillage of fuel	Potential contamination e.g. as a result of run-off, accidental spillage of fuel
A1(M) J53 Scotch Corner	No operational impacts identified	Unknown (soil assessment not undertaken) Contamination from salt spray, run-off	No operational impacts identified	Potential contamination e.g. as a result of run-off, accidental spillage of fuel	Potential contamination e.g. as a result of run-off, accidental spillage of fuel

9.8 Design, Mitigation and Enhancement Measures

Construction

9.8.1 Design, mitigation and enhancement measures will be required to ensure that the potential impacts identified above can be appropriately mitigated. The measures to be implemented projectwide are summarised below.

Geodiversity

9.8.2 The proposed route alignment is located in the vicinity of the North Pennines UNESCO Global Geopark in areas of the Appleby to Brough (Warcop) and Bowes Bypass schemes. There is potential for land take and disturbance of the Geopark during construction, particularly in the Appleby to Brough scheme where the existing A66 forms the southern boundary of the Geopark..

9.8.3 Alternative routes will be provided during construction where footpaths or bridleways have been affected to allow access to continue into the Geopark to limit the impact on enjoyment of the area during construction.

Soils

9.8.4 Due to the setting of the project, it will not be feasible to entirely mitigate impacts on agricultural soils, however, the following measures are proposed in order to reduce these impacts:

- An intrusive agricultural soil survey is to be completed, to determine the Agricultural Land Classification (ALC) grade of land affected by the project.

For areas of temporary development, ALC grade as determined from the soil survey will be used to inform the restoration criteria; BMV is to be returned to the same quality as far as reasonably practicable to minimise BMV losses and limit permanent impacts.

- Soils are to be managed and protected during the construction works in accordance with good practice; this includes Defra's Code of practice for the sustainable use of soils on construction sites, guidance contained within Highways England Manual of Contract Documents for Highway Works (Standards for Highways, 2020) and relevant British Standards for use of soil on construction sites.
- The proposed project shall have a restoration plan and statement which it is anticipated may include the following:
    i. An assessment of agricultural land and soil resource of the site will be undertaken before work commences (as per Natural England's Guide to assessing development proposals on agricultural land[32]) which is considered to represent UK good practice.
    ii. The methods by which the applicant intends to restore appropriate affected areas to agricultural use after works including excavations and placement of fill materials has finished. The exact areas to be restored will be determined in due course but are expected to comprise the temporary land take areas, i.e. site compounds, construction working space and access routes required during the construction phase.

Contamination

9.8.5 Contamination impacts as a result of the identified potential contamination sources, and any other localised contamination, will be assessed in line with current good practice measures, as set out in the *Land contamination risk management (LCRM)* guidance published by the Environment Agency[33].

9.8.6 Where levels of contamination are found to present unacceptable risks, the risk assessments will be used as a basis for developing an appropriate remediation strategy. Remediation approaches would be dependent on the form, distribution and levels of contaminants present and nature of works proposed in the area, and would be determined through a remediation options appraisal, integrated with the engineering design to ensure the most appropriate and sustainable solutions are adopted.. Further phases of ground investigation may need to be undertaken at later stages of the project to inform detailed remediation design, but such investigations are not required to inform a robust baseline for the ES.

9.8.7 Risks during construction are typically mitigated by applying good working practices which can help to reduce likelihood of pollution incidents occurring. These practices will be set out in the ES and contained within the EMP and Health and Safety Plan. A draft EMP will be prepared prior to construction commencing and will be submitted with the DCO.

[32] Natural England (2021) Guide to assessing development proposals on agricultural land, available at: https://www.gov.uk/government/publications/agricultural-land-assess-proposals-for-development/guide-to-assessing-development-proposals-on-agricultural-land [Accessed 31 August 2021]
[33] Environment Agency (2020) Land contamination risk management. Available at: https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm [Accessed 31 August 2021]

9.8.8 Waste hierarchy principles (reduce, reuse, recycle) should be adopted during the scheme design to identify opportunities for reuse of soils within each scheme and routewide and the sustainable reuse of excavated made ground and natural soils either within the scheme or at a receiver or hub site. A Materials Management Plan (MMP) will be prepared in accordance with the CL:AIRE *Definition of Waste: Development Industry Code of Practice* (Contaminated Land: Applications in Real Environments, 2011)[34] at a later stage in the development of the project, the objectives of which will be detailed in the EMP see Chapter 11: Material Assets and Waste.

9.8.9 Additional mitigation measures may also be developed to address specific identified impacts. At PEI stage, the requirement for specific mitigation measures in respect of contamination could include, for example:

- Earthworks phases could be monitored for evidence of potential contamination not anticipated based upon available information. If any such contamination is identified, this would be tested and assessed as appropriate to determine the scope of any further mitigation measures required;
- Specific areas within the construction site compounds would be designated for the storage of chemicals and fuel. These areas would be located away from surface watercourses, bunded and placed on hardstanding to prevent migration of contaminants into groundwater or surface water;
- An Emergency Response/Spill Response plan would be produced by the contractor. Clear protocols and communication channels would be provided to ensure that any spillages are dealt with immediately and adequately. It is envisaged that this could include protocols to deal with any buried animal carcases that may be encountered during construction.

Enhancement

9.8.10 Should any remedial works be required as part of the project, these could potentially act as an enhancement, resulting in a beneficial impact if contamination risks are reduced to below those present at baseline.

9.8.11 Earthworks such as cuttings and borrow pits can have the potential to offer an opportunity for the enhancement of geodiversity, where excavations create temporary or permanent exposures of scientific interest. Assessment of the suitability of cuttings to expose the bedrock geology within the UNESCO Global Geopark area will need to be carried out using the information from ground investigation, to determine whether rock is likely to be exposed in cuttings. Such assessment would be carried out at detailed design stage, when the nature of any rock exposures would be known.

Operation

Geodiversity

9.8.12 It is anticipated that the project will not have a significant impact on geodiversity during operation, in those schemes which pass through or close to the UNESCO Global Geopark (Appleby to Brough and Bowes Bypass), as the existing A66 road already passes close to, or withiin, the Geopark area. There may be opportunities for the enhancement of geodiversity during operation as a result of the creation of new exposures in cuttings or borrow pits, as described above.

[34] Contaminated Land: Applications in Real Environments (2011) Definition of Waste: Development Industry Code of Practice

Soils

9.8.13 The reinstatement of areas impacted by construction works to their previous ALC grade will be undertaken to limit permanent impacts. This would be with a view to enabling as much land as possible to be returned to agricultural use. The proposed project shall have a restoration plan and statement which includes:

- An assessment of agricultural land and soil resource of the site before work commences (as per Section 5 in the *Guide to assessing development proposals on agricultural land* (Natural England, 2021) which is considered to represent UK good practice;
- The methods by which the applicant intends to restore appropriate affected areas to agricultural use after works including excavations and placement of fill materials has finished. The exact areas to be restored will be determined in due course but are expected to comprise the temporary land take areas, i.e. site compounds, construction working space and access routes required during the construction phase, and
- An aftercare programme which would enable a satisfactory standard of agricultural after-use to be reached, with regards to cultivating, reseeding, draining or irrigating, applying fertiliser, or cutting and grazing the site.

9.8.14 Contamination of soils by salt spray can be limited through the use of efficient salt spreading techniques that reduce the amount of salt needed. Roadside barriers can reduce the impact of salt drift onto neighbouring land. The use of salt alternatives such as urea can be considered.

9.8.15 Any agricultural soils which become significantly affected by pollution incidents during operation would need to be assessed and if necessary, remediated to reduce the risk of any contamination migrating across a wider area.

Contamination

9.8.16 The road surface will restrict the exposure of public site users to any residual contamination remaining following any necessary remedial measures applied during construction. Provision of uncontaminated topsoil in landscaped areas adjacent to the road will further restrict the risk of exposure to any residual contamination.

9.8.17 Any soils which become significantly affected by pollution incidents during operation that pose a risk to human health or the water environment would need to be assessed and if necessary, remediated to reduce the risk of any contamination migrating across a wider area.

9.8.18 The operational impact on groundwater and surface water quality from spillages which enter surface water drainage will be mitigated by ensuring that the design of road drainage systems is compliant with the relevant standards and the Highways England water assessment tool, as described in Chapter 14: Road Drainage and the Water Environment.

9.8.19 The road surface will restrict infiltration into the ground, which in turn will reduce the potential for soil contaminants (if present) leaching and migrating into the wider water environment.

9.9 Assessment of the Likely Significant Effects

9.9.1 Based upon the PEI Report assessment, the following likely significant effects have been identified:

- Geodiversity (Appleby to Brough and Bowes Bypass only)
- Agricultural soils

9.9.2 These are summarised below in Table 9-23: Route wide - likely significant effects and by scheme in Table 9-24: M6 Junction 40 to Kemplay Bank - likely significant effects (Geology and Soils) to Table 9-35: A1(M) Junction 53 Scotch Corner - likely significant effects (Geology and Soils).

Route wide

9.9.3 The potential likely significant route wide effects are summarised in Table 9-23: Route wide - likely significant effects. Based on the PEI Report assessment, likely significant routewide effects have been identified to agricultural soils and soils supporting SAC and SSSI during construction, due to the area of temporary land take required. No significant effects are expected to result from impacts derived from multiple schemes as a result of ground contamination.

Table 9-23: Route wide - likely significant effects

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
Grade 2 Agricultural Land (Very High Value)	Loss of agricultural land resources as a result of permanent and temporary land take.	Permanent loss of agricultural land within the draft DCO boundary and damage from accidental	Construction: Intrusive survey to determine ALC grade of land affected. For areas of temporary development, ALC grade as determined from the soil survey will be used to inform restoration	Yes (construction) No (Operation)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
Grade 3a Agricultural Land (High Value)		spillage/spray from road.	criteria; BMV to be returned to the same quality as far as reasonably practicable to minimise BMV losses. Soils to be managed and protected during construction works in accordance with Defra's Code of practice for the sustainable use of soils on construction sites, guidance contained within Highways England Manual of Contract Documents for Highway Works (Standards for Highways, 2020) and relevant British Standards for use of soil on construction sites. A restoration plan and statement is to be prepared which includes a landscape maintenance programme for a 1 to 5 year period. Monitoring is included in the programme; monitoring of soil conditions will be undertaken to identify unsatisfactory growing conditions with regards to both agriculture and landscaping. Hand-excavated trial pits or auger holes will be undertaken multiple times during each year of the monitoring programme, with more frequent monitoring a few weeks after planting or turfing of landscaped	
Grade 3b Agricultural Land (Medium Value)				

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
			areas, to enable signs of adverse conditions to be detected early. Exact requirements may vary according to size and scale of soil replacement works and purpose / end use.. <u>Operation:</u> Utilising efficient salt spreading techniques that reduce the amount of salt needed. Roadside barriers can reduce the impact of salt drift. Use of salt alternatives such as urea. Hydrocarbons from exhaust or tyre and brake residues can be mitigated by settlement ponds.	
Soils supporting SAC or SSSI River Eden SAC, River Eden and Tributaries SSSI (Very High)	Loss of soil resources as a result of temporary and permanent land take and soil/vegetation disturbance.	Loss of soil required for permanent land take within the draft DCO boundary and damage from accidental spillage/spray from road.	<u>Construction:</u> Intrusive survey to determine ALC grade of land affected. For areas of temporary development, ALC grade as determined from the soil survey will be used to inform restoration criteria; BMV to be returned to the same quality as far as reasonably practicable to minimise BMV losses. Soils to be managed and protected during construction works in accordance with Defra's Code of practice for the sustainable use of	Yes (construction) No (Operation)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
			soils on construction sites, guidance contained within Highways England Manual of Contract Documents for Highway Works (Standards for Highways, 2020) and relevant British Standards for use of soil on construction sites. A restoration plan and statement is to be prepared which includes a landscape maintenance programme for a 1 to 5 year period. Monitoring is included in the programme; monitoring of soil conditions will be undertaken to identify unsatisfactory growing conditions with regards to both agriculture and landscaping. Hand-excavated trial pits or auger holes will be undertaken multiple times during each year of the monitoring programme, with more frequent monitoring a few weeks after planting or turfing of landscaped areas, to enable signs of adverse conditions to be detected early. Exact requirements may vary according to size and scale of soil replacement works and purpose / end use. <u>Operation:</u>	

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
			Utilising efficient salt spreading techniques that reduce the amount of salt needed. Roadside barriers can reduce the impact of salt drift. Use of salt alternatives such as urea. Hydrocarbons from exhaust or tyre and brake residues can be mitigated by settlement ponds.	
<u>Human health</u> Residential, schools, allotments (Very high)	Disturbance or mobilisation of contamination during construction causing an increase in leaching or mobilisation of contaminants along new or existing pathways. Exposure to contaminants such as gases or vapours.	Creation, enhancement or removal of pollutant linkages as a result of the project.	<u>Construction:</u> Contamination impacts will be assessed in line with current good practice Where contamination presents unacceptable risks to health, risk assessment will be used to develop appropriate remediation strategy Implementation of good practice measures to reduce likelihood of pollution Sustainable, controlled reuse of soil Monitoring of earthworks for unexpected contamination. <u>Operation</u> Provision of uncontaminated topsoil in landscaped areas	No (construction and operation)
<u>Human health</u> Public open space (High)				
<u>Human health</u> Commercial, industrial (Medium)				
<u>Human health</u> Highways and railways (Low)				

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
			Clean up of accidental spillages which cause pollution	
<u>Groundwater</u> Principal aquifer supporting potable abstraction (Very high) <u>Groundwater</u> Principal aquifer (High) <u>Groundwater</u> Abstraction wells (medium)	Disturbance of potentially contaminated soils causing an increase in leaching or mobilisationof contaminants along new or existing pathways. Degradation of groundwater quality from contaminated runoff to ground. Risk of accidental spillage of pollutants.	Potential for contamination as a result of salt spray, contaminated run-off or accidental spillage.	<u>Construction:</u> Contamination impacts will be assessed in line with current good practice. Where contamination presents unacceptable risks to groundwater, risk assessment will be used to develop appropriate remediation strategy. Implementation of good practice measures to reduce likelihood of pollution. Sustainable, controlled reuse of soil. Monitoring of earthworks for unexpected contamination. <u>Operation</u> Clean up of accidental spillages which cause pollution. Design road drainage systems in accordance with relevant standards.	No (construction and operation)
<u>Surface waters</u> Surface water courses, including designated sites	Disturbance of potentially contaminated soils causing an increase in leaching or mobilisationof contaminants along new or existing pathways.	Potential for contamination as a result of salt spray, contaminated run-off or accidental spillage.	<u>Construction:</u> Contamination impacts will be assessed in line with current good practice.	No (construction and operation)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
(Very high to negligible)	Degradation of water quality from contaminated runoff to nearby surface waters. Risk of accidental spillage of pollutants.		Where contamination presents unacceptable risks to surface water, risk assessment will be used to develop appropriate remediation strategy. Implementation of good practice measures to reduce likelihood of pollution. Sustainable, controlled reuse of soil. Monitoring of earthworks for unexpected contamination. <u>Operation</u> Clean up of accidental spillages which cause pollution. Design road drainage systems in accordance with relevant standards.	

M6 Junction 40 to Kemplay Bank

9.9.4 The potential likely significant effects identified within the M6 Junction 40 to Kemplay Bank scheme are summarised in Table 9-24: M6 Junction 40 to Kemplay Bank - likely significant effects (Geology and Soils).

Table 9-24: M6 Junction 40 to Kemplay Bank - likely significant effects (Geology and Soils)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
Grade 3a Agricultural Land (High Value)	Loss of agricultural land resources as a result of permanent and temporary land take.	Permanent loss of agricultural land within the draft DCO boundary and damage from accidental spillage/spray from road.	<u>Construction:</u> Intrusive survey to determine ALC grade of land affected. For areas of temporary development, ALC grade as determined from the soil survey will be used to inform restoration criteria; BMV to be returned to the same quality as far as reasonably practicable to minimise BMV losses. Soils to be managed and protected during construction works in accordance with Defra's Code of practice for the sustainable use of soils on construction sites, guidance contained within Highways England Manual of Contract Documents for Highway Works (Standards for Highways, 2020) and relevant British Standards for use of soil on construction sites. A restoration plan and statement is to be prepared which includes a landscape maintenance programme	Yes (Construction) No (Operation)
Soils supporting SAC or SSSI (Very High)	Loss of soil resources as a result of temporary and permanent land take and soil/vegetation disturbance.	Loss of soil required for permanent land take within the draft DCO boundary and damage from accidental spillage/spray from road.		Yes (Construction) No (Operation)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
			for a 1 to 5 year period. Monitoring is included in the programme; monitoring of soil conditions will be undertaken to identify unsatisfactory growing conditions with regards to both agriculture and landscaping. Hand-excavated trial pits or auger holes will be undertaken multiple times during each year of the monitoring programme, with more frequent monitoring a few weeks after planting or turfing of landscaped areas, to enable signs of adverse conditions to be detected early. Exact requirements may vary according to size and scale of soil replacement works and purpose / end use.. <u>Operation:</u> Utilising efficient salt spreading techniques that reduce the amount of salt needed. Roadside barriers can reduce the impact of salt drift. Use of salt alternatives such as urea. Hydrocarbons from exhaust or tyre and brake residues can be mitigated by settlement ponds.	

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
Human health Residential, schools (Very high) Human health Public open space (High) Human health Commercial, industrial (Medium) Human health Highways and railways (Low)	Disturbance or mobilisation of contamination during construction causing an increase in leaching or mobilisation of contaminants along new or existing pathways. Exposure to contaminants such as gases or vapours.	Creation, enhancement or removal of pollutant linkages as a result of the project.	Construction: Contamination impacts will be assessed in line with current good practice. Where contamination presents unacceptable risks to health, risk assessment will be used to develop appropriate remediation strategy Implementation of good practice measures to reduce likelihood of pollution. Sustainable, controlled reuse of soil Monitoring of earthworks for unexpected contamination. Operation Provision of uncontaminated topsoil in landscaped areas. Clean up of accidental spillages which cause pollution.	No (construction and operation)
Groundwater Principal aquifer (High)	Disturbance of potentially contaminated soils causing an increase in leaching or mobilisationof contaminants along new or existing pathways. Degradation of groundwater	Potential for contamination as a result of salt spray, contaminated run-off or accidental spillage.	Construction: Contamination impacts will be assessed in line with current good practice. Where contamination presents unacceptable risks to groundwater,	No (construction and operation)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
<u>Groundwater</u> Superficial aquifers (Medium)	quality from contaminated runoff to ground. Risk of accidental spillage of pollutants.		risk assessment will be used to develop appropriate remediation strategy. Implementation of good practice measures to reduce likelihood of pollution. Sustainable, controlled reuse of soil Monitoring of earthworks for unexpected contamination. <u>Operation</u> Clean up of accidental spillages which cause pollution. Design road drainage systems in accordance with relevant standards.	
<u>Groundwater</u> Abstraction wells (Medium)				
<u>Surface waters</u> Surface water courses (Very high to low)	Disturbance of potentially contaminated soils causing an increase in leaching or mobilisation of contaminants along new or existing pathways. Degradation of water quality from contaminated runoff to nearby surface waters. Risk of accidental spillage of pollutants.	Potential for contamination as a result of salt spray, contaminated run-off or accidental spillage.	<u>Construction:</u> Contamination impacts will be assessed in line with current good practice Where contamination presents unacceptable risks to surface water, risk assessment will be used to develop appropriate remediation strategy Implementation of good practice measures to reduce likelihood of pollution Sustainable, controlled reuse of soil	No (construction and operation)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
			Monitoring of earthworks for unexpected contamination. Operation Clean up of accidental spillages which cause pollution Design road drainage systems in accordance with relevant standards	

Penrith to Temple Sowerby

9.9.5 The potential likely significant effects identified within the Penrith to Temple Sowerby scheme are summarised in Table 9-25: Penrith to Temple Sowerby (Center Parcs) - likely significant effects (Geology and Soils).

Table 9-25: Penrith to Temple Sowerby (Center Parcs) - likely significant effects (Geology and Soils)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
Grade 2 Agricultural Land (Very High Value) Grade 3a Agricultural Land (High Value)	Loss of agricultural land resources as a result of permanent and temporary land take.	Permanent loss of agricultural land within the draft DCO boundary and damage from accidental spillage/spray from road.	<u>Construction:</u> Intrusive survey to determine ALC grade of land affected. For areas of temporary development, ALC grade as determined from the soil survey will be used to inform restoration criteria; BMV to be returned to the same quality as far as reasonably practicable to minimise BMV losses. Soils to be managed and protected during construction works in accordance with Defra's Code of practice for the sustainable use of soils on construction sites, guidance contained within Highways England Manual of Contract Documents for Highway Works (Standards for Highways, 2020) and relevant British Standards for use of soil on construction sites. A restoration plan and statement is to be prepared which includes a landscape maintenance programme for a 1 to 5 year period. Monitoring is included in the programme; monitoring of soil conditions will be undertaken to identify unsatisfactory growing conditions with regards to both agriculture and landscaping. Hand-excavated trial pits or auger holes will be	Yes (Construction) No (Operation)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
			undertaken multiple times during each year of the monitoring programme, with more frequent monitoring a few weeks after planting or turfing of landscaped areas, to enable signs of adverse conditions to be detected early. Exact requirements may vary according to size and scale of soil replacement works and purpose / end use. Operational: Utilising efficient salt spreading techniques that reduce the amount of salt needed. Roadside barriers can reduce the impact of salt drift. Use of salt alternatives such as urea. Hydrocarbons from exhaust or tyre and brake residues can be mitigated by settlement ponds.	
Human health Residential, schools, allotments (Very high) Human health Public open space (High) Human health	Disturbance or mobilisation of contamination during construction causing an increase in leaching or mobilisation of contaminants along new or existing pathways. Exposure to	Creation, enhancement or removal of pollutant linkages as a result of the project.	Construction: Contamination impacts will be assessed in line with current good practice. Where contamination presents unacceptable risks to health, risk assessment will be used to develop appropriate remediation strategy. Implementation of good practice measures to reduce likelihood of pollution. Sustainable, controlled reuse of soil.	No (construction and operation)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
Commercial, industrial (Medium) Human health Highways and railways (Low)	contaminants such as gases or vapours.		Monitoring of earthworks for unexpected contamination. Operation Provision of uncontaminated topsoil in landscaped areas. Clean up of accidental spillages which cause pollution.	
Groundwater Principal aquifer (High) Groundwater Secondary Aquifers (Medium) Groundwater Source protection zone (Medium)	Disturbance of potentially contaminated soils causing an increase in leaching or mobilisationof contaminants along new or existing pathways. Degradation of groundwater quality from contaminated runoff to ground. Risk of accidental spillage of pollutants.	Potential for contamination as a result of salt spray, contaminated run-off or accidental spillage.	Construction: Contamination impacts will be assessed in line with current good practice. Where contamination presents unacceptable risks to groundwater, risk assessment will be used to develop appropriate remediation strategy. Implementation of good practice measures to reduce likelihood of pollution. Sustainable, controlled reuse of soil Monitoring of earthworks for unexpected contamination. Operation Clean up of accidental spillages which cause pollution. Design road drainage systems in accordance with relevant standards.	No (construction and operation)
Surface water	Disturbance of potentially contaminated soils	Potential for contamination as a result of salt spray,	Construction: Contamination impacts will be assessed in line with current good practice	No (construction and operation)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
Surface water courses (Very high to low)	causing an increase in leaching or mobilisationof contaminants along new or existing pathways. Degradation of water quality from contaminated runoff to nearby surface waters. Risk of accidental spillage of pollutants.	contaminated run-off or accidental spillage.	Where contamination presents unacceptable risks to surface water, risk assessment will be used to develop appropriate remediation strategy Implementation of good practice measures to reduce likelihood of pollution Sustainable, controlled reuse of soil Monitoring of earthworks for unexpected contamination. <u>Operation</u> Clean up of accidental spillages which cause pollution Design road drainage systems in accordance with relevant standards	

Temple Sowerby to Appleby

Blue alternative

9.9.6 The potential likely significant effects identified within the Temple Sowerby to Appleby Blue alternative scheme are summarised in Table 9-26: Temple Sowerby to Appleby Blue alternative - likely significant effects (Geology and Soils).

Table 9-26: Temple Sowerby to Appleby Blue alternative - likely significant effects (Geology and Soils)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
Grade 2 Agricultural Land (Very High Value)	Loss of agricultural land resources as a result of permanent and temporary land take.	Permanent loss of agricultural land within the draft DCO boundary and damage from accidental spillage/spray from road.	Construction: Intrusive survey to determine ALC grade of land affected. For areas of temporary development, ALC grade as determined from the soil survey will be used to inform restoration criteria; BMV to be returned to the same quality as far as reasonably practicable to minimise BMV losses. Soils to be managed and protected during construction works in accordance with Defra's Code of practice for the sustainable use of soils on construction sites, guidance contained within Highways England Manual of Contract Documents for Highway Works (Standards for Highways, 2020) and relevant British Standards for use of soil on construction sites. A restoration plan and statement is to be prepared which includes a	Yes (Construction) No (Operation)
Grade 3a Agricultural Land (High Value)				Yes (Construction) No (Operation)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
			landscape maintenance programme for a 1 to 5 year period. Monitoring is included in the programme; monitoring of soil conditions will be undertaken to identify unsatisfactory growing conditions with regards to both agriculture and landscaping. Hand-excavated trial pits or auger holes will be undertaken multiple times during each year of the monitoring programme, with more frequent monitoring a few weeks after planting or turfing of landscaped areas, to enable signs of adverse conditions to be detected early. Exact requirements may vary according to size and scale of soil replacement works and purpose / end use. <u>Operational:</u> Utilising efficient salt spreading techniques that reduce the amount of salt needed. Roadside barriers can reduce the impact of salt drift. Use of salt alternatives such as urea. Hydrocarbons from exhaust or tyre and brake residues can be mitigated by settlement ponds.	

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
Grade 3b Agricultural Land (Medium Value)	Loss of agricultural land resources as a result of permanent and temporary land take.	Permanent loss of agricultural land within the draft DCO boundary and damage from accidental spillage/spray from road.	<u>Construction:</u> Intrusive survey to determine ALC grade of land affected. For areas of temporary development, ALC grade as determined from the soil survey will be used to inform restoration criteria; BMV to be returned to the same quality as far as reasonably practicable to minimise BMV losses. Soils to be managed and protected during construction works in accordance with Defra's Code of practice for the sustainable use of soils on construction sites, guidance contained within Highways England Manual of Contract Documents for Highway Works (Standards for Highways, 2020) and relevant British Standards for use of soil on construction sites. A restoration plan and statement is to be prepared which includes a landscape maintenance programme for a 1 to 5 year period. Monitoring is included in the programme; monitoring of soil conditions will be undertaken to identify unsatisfactory growing conditions with regards to both agriculture and landscaping.	No (Construction & Operation)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
			Hand-excavated trial pits or auger holes will be undertaken multiple times during each year of the monitoring programme, with more frequent monitoring a few weeks after planting or turfing of landscaped areas, to enable signs of adverse conditions to be detected early. Exact requirements may vary according to size and scale of soil replacement works and purpose / end use. <u>Operational:</u> Utilising efficient salt spreading techniques that reduce the amount of salt needed. Roadside barriers can reduce the impact of salt drift. Use of salt alternatives such as urea. Hydrocarbons from exhaust or tyre and brake residues can be mitigated by settlement ponds.	
Soils supporting SAC or SSSI (Very High)	Loss of soil resources as a result of temporary and permanent land take and soil/vegetation disturbance.	Loss of soil required for permanent land take within the draft DCO boundary and damage from accidental	<u>Construction:</u> Intrusive survey to determine ALC grade of land affected. For areas of temporary development, ALC grade as determined from the soil survey will be used to inform restoration criteria; BMV to be returned to the same	Yes (Construction) No (Operation)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
		spillage/spray from road.	quality as far as reasonably practicable to minimise BMV losses. Soils to be managed and protected during construction works in accordance with Defra's Code of practice for the sustainable use of soils on construction sites, guidance contained within Highways England Manual of Contract Documents for Highway Works (Standards for Highways, 2020) and relevant British Standards for use of soil on construction sites. A restoration plan and statement is to be prepared which includes a landscape maintenance programme for a 1 to 5 year period. Monitoring is included in the programme; monitoring of soil conditions will be undertaken to identify unsatisfactory growing conditions with regards to both agriculture and landscaping. Hand-excavated trial pits or auger holes will be undertaken multiple times during each year of the monitoring programme, with more frequent monitoring a few weeks after planting or turfing of landscaped areas, to enable signs of adverse	

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
			conditions to be detected early. Exact requirements may vary according to size and scale of soil replacement works and purpose / end use. Operational: Utilising efficient salt spreading techniques that reduce the amount of salt needed. Roadside barriers can reduce the impact of salt drift. Use of salt alternatives such as urea. Hydrocarbons from exhaust or tyre and brake residues can be mitigated by settlement ponds.	
Human health Residential, school (Very high) Human health Public open space (High) Human health Commercial, industrial (Medium)	Disturbance or mobilisation of contamination during construction causing an increase in leaching or mobilisation of contaminants along new or existing pathways. Exposure to contaminants such as gases or vapours.	Creation, enhancement or removal of pollutant linkages as a result of the project.	Construction: Contamination impacts will be assessed in line with current good practice. Where contamination presents unacceptable risks to health, risk assessment will be used to develop appropriate remediation strategy. Implementation of good practice measures to reduce likelihood of pollution. Sustainable, controlled reuse of soil	No (construction and operation)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
Human health Highways (Low)			Monitoring of earthworks for unexpected contamination. Operation Provision of uncontaminated topsoil in landscaped areas. Clean up of accidental spillages which cause pollution.	
Groundwater Principal aquifer (High)	Disturbance of potentially contaminated soils causing an increase in leaching or mobilisationof contaminants along new or existing pathways. Degradation of groundwater quality from contaminated runoff to ground. Risk of accidental spillage of pollutants.	Potential for contamination as a result of salt spray, contaminated run-off or accidental spillage.	Construction: Contamination impacts will be assessed in line with current good practice. Where contamination presents unacceptable risks to groundwater, risk assessment will be used to develop appropriate remediation strategy. Implementation of good practice measures to reduce likelihood of pollution. Sustainable, controlled reuse of soil. Monitoring of earthworks for unexpected contamination. Operation Clean up of accidental spillages which cause pollution. Design road drainage systems in accordance with relevant standards	No (construction and operation)
Groundwater Secondary aquifer (Medium)				

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
Surface water Surface watercourses (Very high to low)	Disturbance of potentially contaminated soils causing an increase in leaching or mobilisationof contaminants along new or existing pathways. Degradation of water quality from contaminated runoff to nearby surface waters. Risk of accidental spillage of pollutants.	Potential for contamination as a result of salt spray, contaminated run-off or accidental spillage.	Construction: Contamination impacts will be assessed in line with current good practice. Where contamination presents unacceptable risks to surface water, risk assessment will be used to develop appropriate remediation strategy. Implementation of good practice measures to reduce likelihood of pollution. Sustainable, controlled reuse of soil. Monitoring of earthworks for unexpected contamination. Operation Clean up of accidental spillages which cause pollution. Design road drainage systems in accordance with relevant standards.	No (construction and operation)

Red alternative

9.9.7 The potential likely significant effects identified within the Temple Sowerby to Appleby Red alternative scheme are summarised in Table 9-27: Temple Sowerby to Appleby Red alternative - likely significant effects (Geology and Soils).

Table 9-27: Temple Sowerby to Appleby Red alternative - likely significant effects (Geology and Soils)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
Grade 2 Agricultural Land (Very High Value)	Loss of agricultural land resources as a result of permanent and temporary land take.	Permanent loss of agricultural land within the draft DCO boundary and damage from accidental spillage/spray from road.	Construction: Intrusive survey to determine ALC grade of land affected. For areas of temporary development, ALC grade as determined from the soil survey will be used to inform restoration criteria; BMV to be returned to the same quality as far as reasonably practicable to minimise BMV losses. Soils to be managed and protected during construction works in accordance with Defra's Code of practice for the sustainable use of soils on construction sites, guidance contained within Highways England Manual of Contract Documents for Highway Works (Standards for Highways, 2020) and relevant British Standards for use of soil on construction sites. A restoration plan and statement is to be prepared which includes a landscape maintenance programme for a 1 to 5 year period. Monitoring is included in the programme; monitoring of soil conditions will be undertaken to identify unsatisfactory growing conditions with regards to	Yes (Construction) No (Operation)
Grade 3a Agricultural Land (High Value)				Yes (Construction) No (Operation)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
			both agriculture and landscaping. Hand-excavated trial pits or auger holes will be undertaken multiple times during each year of the monitoring programme, with more frequent monitoring a few weeks after planting or turfing of landscaped areas, to enable signs of adverse conditions to be detected early. Exact requirements may vary according to size and scale of soil replacement works and purpose / end use. <u>Operational:</u> Utilising efficient salt spreading techniques that reduce the amount of salt needed. Roadside barriers can reduce the impact of salt drift. Use of salt alternatives such as urea. Hydrocarbons from exhaust or tyre and brake residues can be mitigated by settlement ponds.	
Grade 3b Agricultural Land (Medium Value)	Loss of agricultural land resources as a result of permanent and temporary land take.	Permanent loss of agricultural land within the draft DCO boundary and damage from accidental	<u>Construction:</u> Intrusive survey to determine ALC grade of land affected. For areas of temporary development, ALC grade as determined from the soil survey will be used to inform restoration criteria;	No (Construction & Operation)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
		spillage/spray from road.	BMV to be returned to the same quality as far as reasonably practicable to minimise BMV losses. Soils to be managed and protected during construction works in accordance with Defra's Code of practice for the sustainable use of soils on construction sites, guidance contained within Highways England Manual of Contract Documents for Highway Works (Standards for Highways, 2020) and relevant British Standards for use of soil on construction sites. A restoration plan and statement is to be prepared which includes a landscape maintenance programme for a 1 to 5 year period. Monitoring is included in the programme; monitoring of soil conditions will be undertaken to identify unsatisfactory growing conditions with regards to both agriculture and landscaping. Hand-excavated trial pits or auger holes will be undertaken multiple times during each year of the monitoring programme, with more frequent monitoring a few weeks after	

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
			planting or turfing of landscaped areas, to enable signs of adverse conditions to be detected early. Exact requirements may vary according to size and scale of soil replacement works and purpose / end use. Operational: Utilising efficient salt spreading techniques that reduce the amount of salt needed. Roadside barriers can reduce the impact of salt drift. Use of salt alternatives such as urea. Hydrocarbons from exhaust or tyre and brake residues can be mitigated by settlement ponds.	
Soils supporting SAC or SSSI (Very High)	Loss of soil resources as a result of temporary and permanent land take and soil/vegetation disturbance.	Loss of soil required for permanent land take within the draft DCO boundary and damage from accidental spillage/spray from road.	Construction: Intrusive survey to determine ALC grade of land affected. For areas of temporary development, ALC grade as determined from the soil survey will be used to inform restoration criteria; BMV to be returned to the same quality as far as reasonably practicable to minimise BMV losses. Soils to be managed and protected during construction works in	Yes (Construction) No (Operation)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
			accordance with Defra's Code of practice for the sustainable use of soils on construction sites, guidance contained within Highways England Manual of Contract Documents for Highway Works (Standards for Highways, 2020) and relevant British Standards for use of soil on construction sites. A restoration plan and statement is to be prepared which includes a landscape maintenance programme for a 1 to 5 year period. Monitoring is included in the programme; monitoring of soil conditions will be undertaken to identify unsatisfactory growing conditions with regards to both agriculture and landscaping. Hand-excavated trial pits or auger holes will be undertaken multiple times during each year of the monitoring programme, with more frequent monitoring a few weeks after planting or turfing of landscaped areas, to enable signs of adverse conditions to be detected early. Exact requirements may vary according to	

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
			size and scale of soil replacement works and purpose / end use. Operational: Utilising efficient salt spreading techniques that reduce the amount of salt needed. Roadside barriers can reduce the impact of salt drift. Use of salt alternatives such as urea. Hydrocarbons from exhaust or tyre and brake residues can be mitigated by settlement ponds.	
Human health Residential, school (Very high) Human health Public open space (High) Human health	Disturbance or mobilisation of contamination during construction causing an increase in leaching or mobilisation of contaminants along new or existing pathways. Exposure to contaminants such as gases or vapours.	Creation, enhancement or removal of pollutant linkages as a result of the project.	Construction: Contamination impacts will be assessed in line with current good practice. Where contamination presents unacceptable risks to health, risk assessment will be used to develop appropriate remediation strategy. Implementation of good practice measures to reduce likelihood of pollution. Sustainable, controlled reuse of soil. Monitoring of earthworks for unexpected contamination.	No (construction and operation)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
Commercial, industrial (Medium) <u>Human health</u> Highways (low)			<u>Operation</u> Provision of uncontaminated topsoil in landscaped areas. Clean up of accidental spillages which cause pollution.	
<u>Groundwater</u> Principal aquifer (High)	Disturbance of potentially contaminated soils causing an increase in leaching or mobilisationof contaminants along new or existing pathways. Degradation of groundwater quality from contaminated runoff to ground. Risk of accidental spillage of pollutants.	Potential for contamination as a result of salt spray, contaminated run-off or accidental spillage.	<u>Construction:</u> Contamination impacts will be assessed in line with current good practice. Where contamination presents unacceptable risks to groundwater, risk assessment will be used to develop appropriate remediation strategy. Implementation of good practice measures to reduce likelihood of pollution. Sustainable, controlled reuse of soil. Monitoring of earthworks for unexpected contamination. <u>Operation</u> Clean up of accidental spillages which cause pollution. Design road drainage systems in accordance with relevant standards.	No (construction and operation)
<u>Groundwater</u> Secondary aquifer (Medium)				

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
Surface water Surface watercourses (Very high to low)	Disturbance of potentially contaminated soils causing an increase in leaching or mobilisationof contaminants along new or existing pathways. Degradation of water quality from contaminated runoff to nearby surface waters. Risk of accidental spillage of pollutants.	Potential for contamination as a result of salt spray, contaminated run-off or accidental spillage.	Construction: Contamination impacts will be assessed in line with current good practice. Where contamination presents unacceptable risks to surface water, risk assessment will be used to develop appropriate remediation strategy. Implementation of good practice measures to reduce likelihood of pollution. Sustainable, controlled reuse of soil Monitoring of earthworks for unexpected contamination. Operation Clean up of accidental spillages which cause pollution. Design road drainage systems in accordance with relevant standards.	No (construction and operation)

Orange alternative

9.9.8 The potential likely significant effects identified within the Temple Sowerby to Appleby Orange alternative scheme are summarised in Table 9-28: Temple Sowerby to Appleby Orange alternative - likely significant effects (Geology and Soils).

Table 9-28: Temple Sowerby to Appleby Orange alternative - likely significant effects (Geology and Soils)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
Grade 2 Agricultural Land (Very High Value)	Loss of agricultural land resources as a result of permanent and temporary land take.	Permanent loss of agricultural land within the draft DCO boundary and damage from accidental spillage/spray from road.	Construction: Intrusive survey to determine ALC grade of land affected. For areas of temporary development, ALC grade as determined from the soil survey will be used to inform restoration criteria; BMV to be returned to the same quality as far as reasonably practicable to minimise BMV losses. Soils to be managed and protected during construction works in accordance with Defra's Code of practice for the sustainable use of soils on construction sites, guidance contained within Highways England Manual of Contract Documents for Highway Works (Standards for Highways, 2020) and relevant British Standards for use of soil on construction sites. A restoration plan and statement is to be prepared which includes a landscape maintenance programme for a 1 to 5 year period. Monitoring is included in the programme; monitoring of soil conditions will be undertaken to identify unsatisfactory growing conditions with regards to	Yes (Construction) No (Operation)
Grade 3a Agricultural Land (High Value)				Yes (Construction) No (Operation)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
			both agriculture and landscaping. Hand-excavated trial pits or auger holes will be undertaken multiple times during each year of the monitoring programme, with more frequent monitoring a few weeks after planting or turfing of landscaped areas, to enable signs of adverse conditions to be detected early. Exact requirements may vary according to size and scale of soil replacement works and purpose / end use. <u>Operational:</u> Utilising efficient salt spreading techniques that reduce the amount of salt needed. Roadside barriers can reduce the impact of salt drift. Use of salt alternatives such as urea. Hydrocarbons from exhaust or tyre and brake residues can be mitigated by settlement ponds.	
Grade 3b Agricultural Land (Medium Value)	Loss of agricultural land resources as a result of permanent and temporary land take.	Permanent loss of agricultural land within the draft DCO boundary and damage from accidental	<u>Construction:</u> Intrusive survey to determine ALC grade of land affected. For areas of temporary development, ALC grade as determined from the soil survey will be used to inform restoration criteria;	No (Construction & Operation)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
		spillage/spray from road.	BMV to be returned to the same quality as far as reasonably practicable to minimise BMV losses. Soils to be managed and protected during construction works in accordance with Defra's Code of practice for the sustainable use of soils on construction sites, guidance contained within Highways England Manual of Contract Documents for Highway Works (Standards for Highways, 2020) and relevant British Standards for use of soil on construction sites. A restoration plan and statement is to be prepared which includes a landscape maintenance programme for a 1 to 5 year period. Monitoring is included in the programme; monitoring of soil conditions will be undertaken to identify unsatisfactory growing conditions with regards to both agriculture and landscaping. Hand-excavated trial pits or auger holes will be undertaken multiple times during each year of the monitoring programme, with more frequent monitoring a few weeks after	

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
			planting or turfing of landscaped areas, to enable signs of adverse conditions to be detected early. Exact requirements may vary according to size and scale of soil replacement works and purpose / end use. <u>Operational:</u> Utilising efficient salt spreading techniques that reduce the amount of salt needed. Roadside barriers can reduce the impact of salt drift. Use of salt alternatives such as urea. Hydrocarbons from exhaust or tyre and brake residues can be mitigated by settlement ponds.	
Soils supporting SAC or SSSI (Very High)	Loss of soil resources as a result of temporary and permanent land take and soil/vegetation disturbance.	Loss of soil required for permanent land take within the draft DCO boundary and damage from accidental spillage/spray from road.	<u>Construction:</u> Intrusive survey to determine ALC grade of land affected. For areas of temporary development, ALC grade as determined from the soil survey will be used to inform restoration criteria; BMV to be returned to the same quality as far as reasonably practicable to minimise BMV losses. Soils to be managed and protected during construction works in	Yes (Construction) No (Operation)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
			accordance with Defra's Code of practice for the sustainable use of soils on construction sites, guidance contained within Highways England Manual of Contract Documents for Highway Works (Standards for Highways, 2020) and relevant British Standards for use of soil on construction sites. A restoration plan and statement is to be prepared which includes a landscape maintenance programme for a 1 to 5 year period. Monitoring is included in the programme; monitoring of soil conditions will be undertaken to identify unsatisfactory growing conditions with regards to both agriculture and landscaping. Hand-excavated trial pits or auger holes will be undertaken multiple times during each year of the monitoring programme, with more frequent monitoring a few weeks after planting or turfing of landscaped areas, to enable signs of adverse conditions to be detected early. Exact requirements may vary according to	

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
			size and scale of soil replacement works and purpose / end use. Operational: Utilising efficient salt spreading techniques that reduce the amount of salt needed. Roadside barriers can reduce the impact of salt drift. Use of salt alternatives such as urea. Hydrocarbons from exhaust or tyre and brake residues can be mitigated by settlement ponds.	
Human health Residential, school (Very high) Human health Public open space (High) Human health	Disturbance or mobilisation of contamination during construction causing an increase in leaching or mobilisation of contaminants along new or existing pathways. Exposure to contaminants such as gases or vapours.	Creation, enhancement or removal of pollutant linkages as a result of the project.	Construction: Contamination impacts will be assessed in line with current good practice. Where contamination presents unacceptable risks to health, risk assessment will be used to develop appropriate remediation strategy. Implementation of good practice measures to reduce likelihood of pollution. Sustainable, controlled reuse of soil Monitoring of earthworks for unexpected contamination.	No (construction and operation)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
Commercial, industrial (Medium) <u>Human health</u> Highways (low)			<u>Operation</u> Provision of uncontaminated topsoil in landscaped areas Clean up of accidental spillages which cause pollution	
<u>Groundwater</u> Principal aquifer (High)	Disturbance of potentially contaminated soils causing an increase in leaching or mobilisationof contaminants along new or existing pathways. Degradation of groundwater quality from contaminated runoff to ground. Risk of accidental spillage of pollutants.	Potential for contamination as a result of salt spray, contaminated run-off or accidental spillage.	<u>Construction:</u> Contamination impacts will be assessed in line with current good practice. Where contamination presents unacceptable risks to groundwater, risk assessment will be used to develop appropriate remediation strategy. Implementation of good practice measures to reduce likelihood of pollution. Sustainable, controlled reuse of soil Monitoring of earthworks for unexpected contamination. <u>Operation</u> Clean up of accidental spillages which cause pollution. Design road drainage systems in accordance with relevant standards.	No (construction and operation)
<u>Groundwater</u> Secondary aquifer (Medium)				

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
<u>Surface water</u> Surface watercourses (Very high to low)	Disturbance of potentially contaminated soils causing an increase in leaching or mobilisationof contaminants along new or existing pathways. Degradation of water quality from contaminated runoff to nearby surface waters. Risk of accidental spillage of pollutants.	Potential for contamination as a result of salt spray, contaminated run-off or accidental spillage.	<u>Construction:</u> Contamination impacts will be assessed in line with current good practice. Where contamination presents unacceptable risks to surface water, risk assessment will be used to develop appropriate remediation strategy. Implementation of good practice measures to reduce likelihood of pollution. Sustainable, controlled reuse of soil. Monitoring of earthworks for unexpected contamination. <u>Operation</u> Clean up of accidental spillages which cause pollution . Design road drainage systems in accordance with relevant standards.	No (construction and operation)

Appleby to Brough (Warcop)

Black-black-black route (evolved version of Preferred Route announced in spring 2020)

9.9.9 The potential likely significant effects identified within the Appleby to Brough (Warcop) Black-black-black route are summarised in Table 9-29: Appleby to Brough (Warcop) Black-black-black route - likely significant effects (Geology and Soils).

Table 9-29: Appleby to Brough (Warcop) Black-black-black route - likely significant effects (Geology and Soils)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
Grade 3a Agricultural Land (High Value) Grade 3b Agricultural Land (Medium Value)	Loss of agricultural land resources as a result of permanent and temporary land take.	Permanent loss of agricultural land within the draft DCO boundary and damage from accidental spillage/spray from road.	Construction: Intrusive survey to determine ALC grade of land affected. For areas of temporary development, ALC grade as determined from the soil survey will be used to inform restoration criteria; BMV to be returned to the same quality as far as reasonably practicable to minimise BMV losses. Soils to be managed and protected during construction works in accordance with Defra's Code of practice for the sustainable use of soils on construction sites, guidance contained within Highways England Manual of Contract Documents for Highway Works (Standards for Highways, 2020) and relevant British Standards for use of soil on construction sites.	Yes (Construction) No (Operation)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
			A restoration plan and statement is to be prepared which includes a landscape maintenance programme for a 1 to 5 year period. Monitoring is included in the programme; monitoring of soil conditions will be undertaken to identify unsatisfactory growing conditions with regards to both agriculture and landscaping. Hand-excavated trial pits or auger holes will be undertaken multiple times during each year of the monitoring programme, with more frequent monitoring a few weeks after planting or turfing of landscaped areas, to enable signs of adverse conditions to be detected early. Exact requirements may vary according to size and scale of soil replacement works and purpose / end use. Operational: Utilising efficient salt spreading techniques that reduce the amount of salt needed. Roadside barriers can reduce the impact of salt drift. Use of salt alternatives such as urea.	

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
			Hydrocarbons from exhaust or tyre and brake residues can be mitigated by settlement ponds.	
Geodiversity UNESCO Global Geopark (Very high)	Potential disturbance during construction, covering over of existing exposures, changes to land accessibility.	Permanent loss of existing exposures, or for creation of new exposures e.g. in road cuttings.	Construction: Potential alternative routes being considered to limit disturbance within the Geopark/AONB area for the Appleby to Brough scheme. Operation: Potential for enhancement if cuttings or earthworks offer an opportunity to permanently expose geology of scientific interest.	No (construction) Yes (operation), if opportunities for enhancement
Human health Residential (Very high)	Disturbance or mobilisation of contamination during construction causing an increase in leaching or mobilisation of contaminants along new or existing pathways. Exposure to contaminants such as gases or vapours.	Creation, enhancement or removal of pollutant linkages as a result of the project.	Construction: Contamination impacts will be assessed in line with current good practice. Where contamination presents unacceptable risks to health, risk assessment will be used to develop appropriate remediation strategy. Implementation of good practice measures to reduce likelihood of pollution. Sustainable, controlled reuse of soil	No (construction and operation)
Human health Public open space (High)				
Human health Commercial (Medium)				

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
Human health Highways (low)			Monitoring of earthworks for unexpected contamination. Operation Provision of uncontaminated topsoil in landscaped areas Clean up of accidental spillages which cause pollution	
Groundwater Principal aquifer (high)	Disturbance of potentially contaminated soils causing an increase in leaching or mobilisationof contaminants along new or existing pathways. Degradation of groundwater quality from contaminated runoff to ground. Risk of accidental spillage of pollutants.	Potential for contamination as a result of salt spray, contaminated run-off or accidental spillage.	Construction: Contamination impacts will be assessed in line with current good practice. Where contamination presents unacceptable risks to groundwater, risk assessment will be used to develop appropriate remediation strategy. Implementation of good practice measures to reduce likelihood of pollution. Sustainable, controlled reuse of soil Monitoring of earthworks for unexpected contamination. Operation Clean up of accidental spillages which cause pollution. Design road drainage systems in accordance with relevant standards.	No (construction and operation)
Groundwater Secondary aquifer (Medium)				

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
Surface water Surface watercourses (Very high to low)	Disturbance of potentially contaminated soils causing an increase in leaching or mobilisationof contaminants along new or existing pathways. Degradation of water quality from contaminated runoff to nearby surface waters. Risk of accidental spillage of pollutants.	Potential for contamination as a result of salt spray, contaminated run-off or accidental spillage.	Construction: Contamination impacts will be assessed in line with current good practice. Where contamination presents unacceptable risks to surface water, risk assessment will be used to develop appropriate remediation strategy. Implementation of good practice measures to reduce likelihood of pollution. Sustainable, controlled reuse of soil Monitoring of earthworks for unexpected contamination. Operation Clean up of accidental spillages which cause pollution. Design road drainage systems in accordance with relevant standards.	No (construction and operation)

Blue alternative (central section)

The potential likely significant effects identified within the Appleby to Brough (Warcop) Blue alternative (central section) are summarised in

9.9.10 Table 9-30: Appleby to Brough (Warcop) Blue alternative (central section) - likely significant effects (Geology and Soils).

Table 9-30: Appleby to Brough (Warcop) Blue alternative (central section) - likely significant effects (Geology and Soils)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
Grade 3a Agricultural Land (High Value) Grade 3b Agricultural Land (Medium Value)	Loss of agricultural land resources as a result of permanent and temporary land take.	Permanent loss of agricultural land within the draft DCO boundary and damage from accidental spillage/spray from road.	Construction: Intrusive survey to determine ALC grade of land affected. For areas of temporary development, ALC grade as determined from the soil survey will be used to inform restoration criteria; BMV to be returned to the same quality as far as reasonably practicable to minimise BMV losses. Soils to be managed and protected during construction works in accordance with Defra's Code of practice for the sustainable use of soils on construction sites, guidance contained within Highways England Manual of Contract Documents for Highway Works (Standards for Highways, 2020) and relevant British Standards for use of soil on construction sites. A restoration plan and statement is to be prepared which includes a landscape maintenance programme for a 1 to 5 year period. Monitoring is included in the programme; monitoring of soil conditions will be undertaken to identify unsatisfactory growing	Yes (Construction) No (Operation)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
			conditions with regards to both agriculture and landscaping. Hand-excavated trial pits or auger holes will be undertaken multiple times during each year of the monitoring programme, with more frequent monitoring a few weeks after planting or turfing of landscaped areas, to enable signs of adverse conditions to be detected early. Exact requirements may vary according to size and scale of soil replacement works and purpose / end use. <u>Operational:</u> Utilising efficient salt spreading techniques that reduce the amount of salt needed. Roadside barriers can reduce the impact of salt drift. Use of salt alternatives such as urea. Hydrocarbons from exhaust or tyre and brake residues can be mitigated by settlement ponds.	
<u>Geodiversity</u> UNESCO Global Geopark (Very high)	Potential disturbance during construction, covering over of existing exposures, changes to land accessibility.	Permanent loss of existing exposures, or for creation of new exposures e.g. in road cuttings.	<u>Construction:</u> Potential alternative routes for the road are being considered to limit disturbance within the Geopark area for the Appleby to Brough scheme.	No (construction) Yes (operation), if opportunities

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
			Operation: Potential for enhancement if cuttings or earthworks offer an opportunity to permanently expose geology of scientific interest.	for enhancement
Human health Residential (Very high)	Disturbance or mobilisation of contamination during construction causing an increase in leaching or mobilisation of contaminants along new or existing pathways. Exposure to contaminants such as gases or vapours.	Creation, enhancement or removal of pollutant linkages as a result of the project.	Construction: Contamination impacts will be assessed in line with current good practice. Where contamination presents unacceptable risks to health, risk assessment will be used to develop appropriate remediation strategy. Implementation of good practice measures to reduce likelihood of pollution. Sustainable, controlled reuse of soil. Monitoring of earthworks for unexpected contamination. Operation Provision of uncontaminated topsoil in landscaped areas. Clean up of accidental spillages which cause pollution.	No (construction and operation)
Human health Public open space (High)				
Human health Commercial (Medium)				
Human health Highways (low)				

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
<u>Groundwater</u> Principal aquifer (high)	Disturbance of potentially contaminated soils causing an increase in leaching or mobilisationof contaminants along new or existing pathways. Degradation of groundwater quality from contaminated runoff to ground. Risk of accidental spillage of pollutants.	Potential for contamination as a result of salt spray, contaminated run-off or accidental spillage.	<u>Construction:</u> Contamination impacts will be assessed in line with current good practice. Where contamination presents unacceptable risks to groundwater, risk assessment will be used to develop appropriate remediation strategy. Implementation of good practice measures to reduce likelihood of pollution. Sustainable, controlled reuse of soil. Monitoring of earthworks for unexpected contamination. <u>Operation</u> Clean up of accidental spillages which cause pollution. Design road drainage systems in accordance with relevant standards	No (construction and operation)
<u>Groundwater</u> Secondary aquifer (Medium)				
<u>Surface water</u> Surface watercourses (Very high to low)	Disturbance of potentially contaminated soils causing an increase in leaching or mobilisationof contaminants along new or existing pathways. Degradation of water quality from contaminated runoff to nearby	Potential for contamination as a result of salt spray, contaminated run-off or accidental spillage.	<u>Construction:</u> Contamination impacts will be assessed in line with current good practice. Where contamination presents unacceptable risks to surface water, risk assessment will be used to	No (construction and operation)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
	surface waters. Risk of accidental spillage of pollutants.		develop appropriate remediation strategy. Implementation of good practice measures to reduce likelihood of pollution. Sustainable, controlled reuse of soil Monitoring of earthworks for unexpected contamination. <u>Operation</u> Clean up of accidental spillages which cause pollution Design road drainage systems in accordance with relevant standards	

Orange Alternative (eastern section)

9.9.11 The potential likely significant effects identified within the Appleby to Brough (Warcop) Orange alternative (eastern section) are summarised in Table 9-31: Appleby to Brough (Warcop) Orange alternative (eastern section) - likely significant effects (Geology and Soils).

Table 9-31: Appleby to Brough (Warcop) Orange alternative (eastern section) - likely significant effects (Geology and Soils)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
Grade 3a Agricultural	Loss of agricultural land resources as a result of	Permanent loss of agricultural land	<u>Construction:</u>	

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
Land (High Value) Grade 3b Agricultural Land (Medium Value)	permanent and temporary land take.	within the draft DCO boundary and damage from accidental spillage/spray from road.	Intrusive survey to determine ALC grade of land affected. For areas of temporary development, ALC grade as determined from the soil survey will be used to inform restoration criteria; BMV to be returned to the same quality as far as reasonably practicable to minimise BMV losses. Soils to be managed and protected during construction works in accordance with Defra's Code of practice for the sustainable use of soils on construction sites, guidance contained within Highways England Manual of Contract Documents for Highway Works (Standards for Highways, 2020) and relevant British Standards for use of soil on construction sites. A restoration plan and statement is to be prepared which includes a landscape maintenance programme for a 1 to 5 year period. Monitoring is included in the programme; monitoring of soil conditions will be undertaken to identify unsatisfactory growing conditions with regards to both agriculture and landscaping. Hand-excavated trial pits or auger holes will	Yes (Construction) No (Operation)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
			be undertaken multiple times during each year of the monitoring programme, with more frequent monitoring a few weeks after planting or turfing of landscaped areas, to enable signs of adverse conditions to be detected early. Exact requirements may vary according to size and scale of soil replacement works and purpose / end use. Operational: Utilising efficient salt spreading techniques that reduce the amount of salt needed. Roadside barriers can reduce the impact of salt drift. Use of salt alternatives such as urea. Hydrocarbons from exhaust or tyre and brake residues can be mitigated by settlement ponds.	
Geodiversity UNESCO Global Geopark (Very high)	Potential disturbance during construction, covering over of existing exposures, changes to land accessibility.	Permanent loss of existing exposures, or for creation of new exposures e.g. in road cuttings.	Construction: Potential alternative routes for the road are being considered to limit disturbance within the Geopark/AONB area for the Appleby to Brough scheme. Operation:	No (construction) Yes (operation), if opportunities for enhancement

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
			Potential for enhancement if cuttings or earthworks offer an opportunity to permanently expose geology of scientific interest.	
Human health Residential (Very high) Human health Public open space (High) Human health Commercial (Medium) Human health Highways (low)	Disturbance or mobilisation of contamination during construction causing an increase in leaching or mobilisation of contaminants along new or existing pathways. Exposure to contaminants such as gases or vapours.	Creation, enhancement or removal of pollutant linkages as a result of the project.	Construction: Contamination impacts will be assessed in line with current good practice. Where contamination presents unacceptable risks to health, risk assessment will be used to develop appropriate remediation strategy. Implementation of good practice measures to reduce likelihood of pollution. Sustainable, controlled reuse of soil Monitoring of earthworks for unexpected contamination. Operation Provision of uncontaminated topsoil in landscaped areas. Clean up of accidental spillages which cause pollution.	No (construction and operation)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
<u>Groundwater</u> Principal aquifer (high)	Disturbance of potentially contaminated soils causing an increase in leaching or mobilisationof contaminants along new or existing pathways. Degradation of groundwater quality from contaminated runoff to ground. Risk of accidental spillage of pollutants.	Potential for contamination as a result of salt spray, contaminated run-off or accidental spillage.	<u>Construction:</u> Contamination impacts will be assessed in line with current good practice. Where contamination presents unacceptable risks to groundwater, risk assessment will be used to develop appropriate remediation strategy. Implementation of good practice measures to reduce likelihood of pollution. Sustainable, controlled reuse of soil Monitoring of earthworks for unexpected contamination. <u>Operation</u> Clean up of accidental spillages which cause pollution. Design road drainage systems in accordance with relevant standards	No (construction and operation)
<u>Groundwater</u> Secondary aquifer (Medium)				
<u>Surface water</u> Surface watercourses (Very high to low)	Disturbance of potentially contaminated soils causing an increase in leaching or mobilisationof contaminants along new or existing pathways. Degradation of water quality from contaminated runoff to nearby	Potential for contamination as a result of salt spray, contaminated run-off or accidental spillage.	<u>Construction:</u> Contamination impacts will be assessed in line with current good practice. Where contamination presents unacceptable risks to surface water, risk assessment will be used to	No (construction and operation)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
	surface waters. Risk of accidental spillage of pollutants.		develop appropriate remediation strategy. Implementation of good practice measures to reduce likelihood of pollution. Sustainable, controlled reuse of soil. Monitoring of earthworks for unexpected contamination. <u>Operation</u> Clean up of accidental spillages which cause pollution. Design road drainage systems in accordance with relevant standards.	

Bowes Bypass

9.9.12 The potential likely significant effects identified within the Bowes Bypass scheme are summarised in Table 9-32: Bowes Bypass (A66/A67) - likely significant effects (Geology and Soils).

Table 9-32: Bowes Bypass (A66/A67) - likely significant effects (Geology and Soils)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
Grade 3b Agricultural Land (Medium Value)	Loss of agricultural land resources as a result of permanent and temporary land take.	Permanent loss of agricultural land within the draft DCO boundary and	<u>Construction:</u> Intrusive survey to determine ALC grade of land affected. For areas of temporary development, ALC grade	Yes (Construction) No (Operation)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
		damage from accidental spillage/spray from road.	as determined from the soil survey will be used to inform restoration criteria; BMV to be returned to the same quality as far as reasonably practicable to minimise BMV losses. Soils to be managed and protected during construction works in accordance with Defra's Code of practice for the sustainable use of soils on construction sites, guidance contained within Highways England Manual of Contract Documents for Highway Works (Standards for Highways, 2020) and relevant British Standards for use of soil on construction sites. A restoration plan and statement is to be prepared which includes a landscape maintenance programme for a 1 to 5 year period. Monitoring is included in the programme; monitoring of soil conditions will be undertaken to identify unsatisfactory growing conditions with regards to both agriculture and landscaping. Hand-excavated trial pits or auger holes will be undertaken multiple times during each year of the monitoring programme, with more frequent	

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
			monitoring a few weeks after planting or turfing of landscaped areas, to enable signs of adverse conditions to be detected early. Exact requirements may vary according to size and scale of soil replacement works and purpose / end use. Operation: Recently improved spreading techniques that reduce the amount of salt needed. Roadside barriers can reduce the likelihood of salt damage and temporary barriers could be considered as a protective measure. Alternatives to salt, such as urea have been proposed as more environmentally friendly but need to be carefully considered prior to use. Hydrocarbons from exhaust fumes or tyre and brake residues which are deposited on the road can be mitigated by the construction of settlement ponds, which provide the opportunity to clean the water before it reaches fields or watercourses.	
Geodiversity	Potential disturbance during construction, covering over of	Permanent loss of existing exposures,	Construction:	No (construction)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
UNESCO Global Geopark (Very high)	existing exposures, changes to land accessibility.	or for creation of new exposures e.g. in road cuttings.	Potential alternative routes for the road are being considered to limit disturbance within the Geopark/AONB area for the Appleby to Brough scheme. Operation: Potential for enhancement if cuttings or earthworks offer an opportunity to permanently expose geology of scientific interest.	Yes (operation), if opportunities for enhancement
Human health Residential, school, allotments (Very high) Human health Highways, (low)	Disturbance or mobilisation of contamination during construction causing an increase in leaching or mobilisation of contaminants along new or existing pathways. Exposure to contaminants such as gases or vapours.	Creation, enhancement or removal of pollutant linkages as a result of the project.	Construction: Contamination impacts will be assessed in line with current good practice. Where contamination presents unacceptable risks to health, risk assessment will be used to develop appropriate remediation strategy. Implementation of good practice measures to reduce likelihood of pollution. Sustainable, controlled reuse of soil. Monitoring of earthworks for unexpected contamination. Operation Provision of uncontaminated topsoil in landscaped areas.	No (construction and operation)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
			Clean up of accidental spillages which cause pollution.	
<u>Groundwater</u> Secondary aquifer (Medium) <u>Groundwater</u> General domestic water supplies (Medium)	Disturbance of potentially contaminated soils causing an increase in leaching or mobilisationof contaminants along new or existing pathways. Degradation of groundwater quality from contaminated runoff to ground. Risk of accidental spillage of pollutants.	Potential for contamination as a result of salt spray, contaminated run-off or accidental spillage.	<u>Construction:</u> Contamination impacts will be assessed in line with current good practice. Where contamination presents unacceptable risks to groundwater, risk assessment will be used to develop appropriate remediation strategy. Implementation of good practice measures to reduce likelihood of pollution. Sustainable, controlled reuse of soil. Monitoring of earthworks for unexpected contamination. <u>Operation</u> Clean up of accidental spillages which cause pollution.	No (construction and operation)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
			Design road drainage systems in accordance with relevant standards.	
<u>Surface water</u> Surface watercourses (Medium to low)	Disturbance of potentially contaminated soils causing an increase in leaching or mobilisationof contaminants along new or existing pathways. Degradation of water quality from contaminated runoff to nearby surface waters. Risk of accidental spillage of pollutants.	Potential for contamination as a result of salt spray, contaminated run-off or accidental spillage.	<u>Construction:</u> Contamination impacts will be assessed in line with current good practice. Where contamination presents unacceptable risks to surface water, risk assessment will be used to develop appropriate remediation strategy. Implementation of good practice measures to reduce likelihood of pollution. Sustainable, controlled reuse of soil. Monitoring of earthworks for unexpected contamination. <u>Operation</u> Clean up of accidental spillages which cause pollution.	No (construction and operation)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
			Design road drainage systems in accordance with relevant standards.	

Cross Lanes to Rokeby

9.9.13 The potential likely significant effects identified within the Cross Lanes to Rokeby scheme (all alternatives) are summarised in Table 9-33: Cross Lanes to Rokeby - likely significant effects (Geology and Soils).

Table 9-33: Cross Lanes to Rokeby - likely significant effects (Geology and Soils)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
Grade 3a Agricultural Land (High Value)	Loss of agricultural land resources as a result of permanent and temporary land take.	Permanent loss of agricultural land within the draft DCO boundary and damage from accidental spillage/spray from road.	<u>Construction:</u> Intrusive survey to determine ALC grade of land affected. For areas of temporary development, ALC grade as determined from the soil survey will be used to inform restoration criteria; BMV to be returned to the same quality as far as reasonably practicable to minimise BMV losses. Soils to be managed and protected during construction works in accordance with Defra's Code of practice for the sustainable use of soils on construction sites, guidance contained within Highways England	Yes (Construction) No (Operation)
Grade 3b Agricultural Land (Medium Value)				No (Construction & Operation)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
			Manual of Contract Documents for Highway Works (Standards for Highways, 2020) and relevant British Standards for use of soil on construction sites. A restoration plan and statement is to be prepared which includes a landscape maintenance programme for a 1 to 5 year period. Monitoring is included in the programme; monitoring of soil conditions will be undertaken to identify unsatisfactory growing conditions with regards to both agriculture and landscaping. Hand-excavated trial pits or auger holes will be undertaken multiple times during each year of the monitoring programme, with more frequent monitoring a few weeks after planting or turfing of landscaped areas, to enable signs of adverse conditions to be detected early. Exact requirements may vary according to size and scale of soil replacement works and purpose / end use.. <u>Operational:</u>	

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
			Utilising efficient salt spreading techniques that reduce the amount of salt needed. Roadside barriers can reduce the impact of salt drift. Use of salt alternatives such as urea. Hydrocarbons from exhaust or tyre and brake residues can be mitigated by settlement ponds.	
Human health Residential (Very high)	Disturbance or mobilisation of contamination during construction causing an increase in leaching or mobilisation of contaminants along new or existing pathways. Exposure to contaminants such as gases or vapours.	Creation, enhancement or removal of pollutant linkages as a result of the project.	Construction: Contamination impacts will be assessed in line with current good practice. Where contamination presents unacceptable risks to health, risk assessment will be used to develop appropriate remediation strategy. Implementation of good practice measures to reduce likelihood of pollution. Sustainable, controlled reuse of soil Monitoring of earthworks for unexpected contamination. Operation Provision of uncontaminated topsoil in landscaped areas.	No (construction and operation)
Human health Highways (low)				

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
			Clean up of accidental spillages which cause pollution.	
<u>Groundwater</u> Secondary aquifer (Medium)	Disturbance of potentially contaminated soils causing an increase in leaching or mobilisationof contaminants along new or existing pathways. Degradation of groundwater quality from contaminated runoff to ground. Risk of accidental spillage of pollutants.	Potential for contamination as a result of salt spray, contaminated run-off or accidental spillage.	<u>Construction:</u> Contamination impacts will be assessed in line with current good practice. Where contamination presents unacceptable risks to groundwater, risk assessment will be used to develop appropriate remediation strategy. Implementation of good practice measures to reduce likelihood of pollution. Sustainable, controlled reuse of soil Monitoring of earthworks for unexpected contamination. <u>Operation</u> Clean up of accidental spillages which cause pollution.	No (construction and operation)
<u>Groundwater</u> General domestic water supplies (Medium)				

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
			Design road drainage systems in accordance with relevant standards.	
<u>Surface water</u> Surface watercourses (Very high to low)	Disturbance of potentially contaminated soils causing an increase in leaching or mobilisationof contaminants along new or existing pathways. Degradation of water quality from contaminated runoff to nearby surface waters. Risk of accidental spillage of pollutants.	Potential for contamination as a result of salt spray, contaminated run-off or accidental spillage.	<u>Construction:</u> Contamination impacts will be assessed in line with current good practice. Where contamination presents unacceptable risks to surface water, risk assessment will be used to develop appropriate remediation strategy. Implementation of good practice measures to reduce likelihood of pollution. Sustainable, controlled reuse of soil. Monitoring of earthworks for unexpected contamination. <u>Operation</u> Clean up of accidental spillages which cause pollution.	No (construction and operation)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
			Design road drainage systems in accordance with relevant standards.	

Stephen Bank to Carkin Moor

9.9.14 The potential likely significant effects identified within the Stephen Bank to Carkin Moor scheme are summarised in Table 9-34: Stephen Bank to Carkin Moor - likely significant effects (Geology and Soils).

Table 9-34: Stephen Bank to Carkin Moor - likely significant effects (Geology and Soils)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
Grade 3a Agricultural Land (High Value) Grade 3b Agricultural Land (Medium Value)	Loss of agricultural land resources as a result of permanent and temporary land take.	Permanent loss of agricultural land within the draft DCO boundary and damage from accidental spillage/spray from road.	<u>Construction:</u> Intrusive survey to determine ALC grade of land affected. For areas of temporary development, ALC grade as determined from the soil survey will be used to inform restoration criteria; BMV to be returned to the same quality as far as reasonably practicable to minimise BMV losses. Soils to be managed and protected during construction works in accordance with Defra's Code of practice for the sustainable use of soils on construction sites, guidance contained within Highways England	Yes (Construction) No (Operation)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
			Manual of Contract Documents for Highway Works (Standards for Highways, 2020) and relevant British Standards for use of soil on construction sites. A restoration plan and statement is to be prepared which includes a landscape maintenance programme for a 1 to 5 year period. Monitoring is included in the programme; monitoring of soil conditions will be undertaken to identify unsatisfactory growing conditions with regards to both agriculture and landscaping. Hand-excavated trial pits or auger holes will be undertaken multiple times during each year of the monitoring programme, with more frequent monitoring a few weeks after planting or turfing of landscaped areas, to enable signs of adverse conditions to be detected early. Exact requirements may vary according to size and scale of soil replacement works and purpose / end use. <u>Operational:</u> Utilising efficient salt spreading techniques that reduce the amount of salt needed.	

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
			Roadside barriers can reduce the impact of salt drift. Use of salt alternatives such as urea. Hydrocarbons from exhaust or tyre and brake residues can be mitigated by settlement ponds.	
<u>Human health</u> Residential (Very high) <u>Human health</u> Open Space (High) <u>Human health</u> Highways (Low)	Disturbance or mobilisation of contamination during construction causing an increase in leaching or mobilisation of contaminants along new or existing pathways. Exposure to contaminants such as gases or vapours.	Creation, enhancement or removal of pollutant linkages as a result of the project.	<u>Construction:</u> Contamination impacts will be assessed in line with current good practice. Where contamination presents unacceptable risks to health, risk assessment will be used to develop appropriate remediation strategy Implementation of good practice measures to reduce likelihood of pollution. Sustainable, controlled reuse of soil Monitoring of earthworks for unexpected contamination. <u>Operation</u> Provision of uncontaminated topsoil in landscaped areas. Clean up of accidental spillages which cause pollution.	No (construction and operation)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
<u>Groundwater</u> Secondary aquifer (Medium)	Disturbance of potentially contaminated soils causing an increase in leaching or mobilisationof contaminants along new or existing pathways. Degradation of groundwater quality from contaminated runoff to ground. Risk of accidental spillage of pollutants.	Potential for contamination as a result of salt spray, contaminated run-off or accidental spillage.	<u>Construction:</u> Contamination impacts will be assessed in line with current good practice. Where contamination presents unacceptable risks to groundwater, risk assessment will be used to develop appropriate remediation strategy. Implementation of good practice measures to reduce likelihood of pollution. Sustainable, controlled reuse of soil Monitoring of earthworks for unexpected contamination. <u>Operation</u> Clean up of accidental spillages which cause pollution. Design road drainage systems in accordance with relevant standards.	No (construction and operation)
<u>Groundwater</u> General Farming and Domestic abstractions (Medium)				
<u>Surface water</u> Surface watercourses (Medium to low)	Disturbance of potentially contaminated soils causing an increase in leaching or mobilisationof contaminants along new or existing pathways. Degradation of water quality from contaminated runoff to nearby	Potential for contamination as a result of salt spray, contaminated run-off or accidental spillage.	<u>Construction:</u> Contamination impacts will be assessed in line with current good practice. Where contamination presents unacceptable risks to surface water, risk assessment will be used to	No (construction and operation)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
	surface waters. Risk of accidental spillage of pollutants.		develop appropriate remediation strategy. Implementation of good practice measures to reduce likelihood of pollution. Sustainable, controlled reuse of soil Monitoring of earthworks for unexpected contamination. <u>Operation</u> Clean up of accidental spillages which cause pollution. Design road drainage systems in accordance with relevant standards.	

A1(M) Junction 53 Scotch Corner

9.9.15 The potential likely significant effects identified within the A1(M) Junction 53 Scotch Corner scheme are summarised in Table 9-35: A1(M) Junction 53 Scotch Corner - likely significant effects (Geology and Soils).

Table 9-35: A1(M) Junction 53 Scotch Corner - likely significant effects (Geology and Soils)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
Agricultural soils	Not assessed - See paragraph 9.6.118	Not assessed - See paragraph 9.6.118	N/A	N/A
Human health Residential (Very high)	Disturbance or mobilisation of contamination during construction causing an increase in leaching or mobilisation of contaminants along new or existing pathways. Exposure to contaminants such as gases or vapours.	Creation, enhancement or removal of pollutant linkages as a result of the project.	Construction: Contamination impacts will be assessed in line with current good practice. Where contamination presents unacceptable risks to health, risk assessment will be used to develop appropriate remediation strategy. Implementation of good practice measures to reduce likelihood of pollution. Sustainable, controlled reuse of soil.	No (construction and operation)
Human health Open Space (High)				
Human health Commercial (Medium)				

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
Human health Highways (Low)			Monitoring of earthworks for unexpected contamination. Operation Provision of uncontaminated topsoil in landscaped areas Clean up of accidental spillages which cause pollution.	
Groundwater Secondary aquifer (Medium)	Disturbance of potentially contaminated soils causing an increase in leaching or mobilisationof contaminants along new or existing pathways. Degradation of groundwater quality from contaminated runoff to ground. Risk of accidental spillage of pollutants.	Potential for contamination as a result of salt spray, contaminated run-off or accidental spillage.	Construction: Contamination impacts will be assessed in line with current good practice. Where contamination presents unacceptable risks to groundwater, risk assessment will be used to develop appropriate remediation strategy	No (construction and operation)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
<u>Groundwater</u> General Farming and Domestic abstractions (Medium)			Implementation of good practice measures to reduce likelihood of pollution. Sustainable, controlled reuse of soil. Monitoring of earthworks for unexpected contamination. <u>Operation</u> Clean up of accidental spillages which cause pollution. Design road drainage systems in accordance with relevant standards.	
<u>Surface water</u> Surface watercourse (Medium)	Disturbance of potentially contaminated soils causing an increase in leaching or mobilisationof contaminants along new or existing pathways. Degradation of water quality from contaminated runoff to nearby surface waters. Risk of accidental spillage of pollutants.	Potential for contamination as a result of salt spray, contaminated run-off or accidental spillage.	<u>Construction:</u> Contamination impacts will be assessed in line with current good practice. Where contamination presents unacceptable risks to surface water, risk assessment will be used to develop appropriate remediation strategy. Implementation of good practice measures to reduce likelihood of pollution.	No (construction and operation)

Receptor	Potential Impacts (Construction)	Potential Impacts (Operation)	Design, Mitigation and Enhancement Measures	Likely Significant Effect Following Mitigation?
			Sustainable, controlled reuse of soil. Monitoring of earthworks for unexpected contamination. <u>Operation</u> Clean up of accidental spillages which cause pollution. Design road drainage systems in accordance with relevant standards.	

9.10 Monitoring

Route wide

9.10.1 A potential significant effect has been identified associated with (i) geodiversity (Appleby to Brough and Bowes Bypass, if opportunities for enhancement can be identified), (ii) land contamination during construction and (iii) agricultural soil receptors during construction.

9.10.2 With regards to agricultural soil receptors, all schemes are assessed to have significant adverse effects due to the loss of soil resources for agriculture. Penrith to Temple Sowerby (Center Parcs), Temple Sowerby to Appleby – Crackenthorpe (bypass) and Appleby to Brough (Warcop) (dualling and junctions) are predicted to result in very large adverse significance of effects due to the loss of large quantities of Grade 2 and or Grade 3a land, which are both BMV agricultural land. Only M6 Junction 40 to Kemplay Bank and Temple Sowerby to Appleby – Crackenthorpe (bypass) are associated with land take of a statutory designated site, the River Eden SAC and River Eden and Tributaries SSSI. Soils supporting a SAC are considered to be of very high value. The loss of less than 1ha of soils supporting bankside habitat is considered to be of negligible magnitude and slight adverse significance.

9.10.3 Further site investigations and specific risk assessments would be required to confirm the risks and inform the design of appropriate remediation measures and monitoring required.

9.10.4 Intrusive Agricultural Land Classification survey will be required to inform the design of appropriate mitigation and monitoring measures.

9.10.5 In accordance with Defra guidance, a detailed landscape maintenance programme should be prepared in conjunction with the landscape design proposals for each scheme. Landscaping contractors who undertake the installation are to be retained for a 1 to 5 year period to maintain the landscape scheme, often on a 'defects liability' arrangement.

9.10.6 Monitoring is included in the maintenance programme; monitoring of soil conditions will be undertaken to identify unsatisfactory growing conditions with regards to both agriculture and landscaping. Hand-excavated trial pits or auger holes at representative locations will be undertaken multiple times during each year of the monitoring programme, with more frequent monitoring a few weeks after planting or turfing of landscaped areas, to enable signs of adverse conditions to be detected early. Exact requirements may vary according to the size and scale of the soil replacement works and purpose / end use.