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6.2 ENVIRONMENTAL STATEMENT CHAPTER 9 GEOLOGY AND SOILS

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6.2 ENVIRONMENTAL STATEMENT

CHAPTER 9 GEOLOGY AND SOILS

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9 Geology and Soils

9.1 Introduction

9.1.1 Geology and soils are important factors in determining the environmental character of an area. They can impose constraints on road schemes, and the nature and condition of the soils and underlying rocks can be a key constraint on a scheme design.

9.1.2 This chapter of the Environmental Statement (ES) describes and characterises the baseline geology and soils of the scheme with respect to the following elements:

- geology and geomorphology (including geological designated sites, land stability and mineral resources);
- soils;
- land contamination.

9.1.3 The chapter identifies and assesses the potential effects of the construction and operational phases of the scheme with respect to geology and soils and is assessed in accordance with the Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3, Part 11 [1].

9.1.4 This chapter sets out a baseline conceptual site model with respect to soil and groundwater contamination, and identifies plausible contaminant linkages formed due to the construction and/or operational phases of the scheme. The chapter then assesses the subsequent potential for effects on the following receptors through disturbance of ground and groundwater quality conditions during construction and operation:

- human health;
- controlled waters (surface waters and groundwater/aquifers)

9.1.5 Whilst this chapter describes the potential effects on groundwater and surface water quality in a context of land contamination, **Road drainage and the water environment** (Volume 6 Document Ref 6.2 ES Chapter 13), describes the potential effects on groundwater and surface water of drainage and discharge and potential effects on hydrogeology associated with the construction and operation of the scheme.

9.1.6 **Material assets and waste** (Volume 6 Document Ref 6.2 ES Chapter 10), describes the use of materials and the generation and management of waste. It also describes the suitability for reuse of soils. **People and communities** (Volume 6 Document Ref 6.2 ES Chapter 12), describes the potential effects of the scheme on the agricultural use of soils.

9.1.7 The effects combined with the expected climate changes has been assessed within **Climate change** (Volume 6 Document Ref 6.2 ES Chapter 14).

9.1.8 This chapter describes the assessment methodology, baseline conditions, potential significant effects, mitigation measures and the likely residual effects remaining after implementation of mitigation measures. Mitigation measures reduce the significance of potential adverse effects on geological resources or receptors of soil and/or groundwater contamination.

9.2 Competent Expert

9.2.1 The Geology and Soils lead is a Chartered Geologist and a Fellow of the Geological Society of London. They have an MESci (Hons) degree in Geology and an MSc in Applied Environmental Geology, both from Cardiff University. The Geology and Soils co-author is a Chartered Geologist and a Fellow of the Geological Society of London, they hold an MGeol degree in Geology from the University of Southampton and is a Member of the Society of Brownfield Risk Assessment. Full details for both are provided in **Competent expert evidence** (Volume 6 Document Ref 6.4 Appendix 1.1).

9.3 Legislative, policy context and guidance

Legislation background

9.3.1 Geological sites of national importance are principally afforded protection under the Wildlife and Countryside Act 1981 (as amended) or the National Parks and Access to the Countryside Act 1949 by designation as a Site of Special Scientific Interest (SSSI) or National Nature Reserve (NNR). In addition, the Joint Nature Conservation Committee (JNCC) have carried out a Geological Conservation Review (GCR) and Earth Science Conservation Review (ESCR) to identify the best and most representative earth science sites in Great Britain, with a view to their long-term conservation. Although GCR/ESCR identification does not itself give any statutory protection, many GCR/ESCR sites have been notified as SSSIs/ASSIs.

9.3.2 Environmental legislation and regulation provide separate drivers to manage contamination. The main legislative drivers for managing risks to human health and the environment from land contamination are:

- Part IIA of the Environmental Protection Act (1990);
- Contaminated Land (England) Regulations (2006);
- Environment Act (1995); and
- Environmental Permitting Regulations (2016).

9.3.3 Under Part IIA of the Environmental Protection Act, sites are identified as 'contaminated land' if they are causing, or if there is a significant possibility of causing significant harm to human health or significant pollution of controlled waters (as defined by Section 104 of the Water Resources Act 1991).

9.3.4 In general terms, the legislation advocates the use of a risk assessment approach to assessing contamination and remedial requirements.

9.3.5 A list of additional key legislation considered within the assessment relating to contamination and the water environment include:

- Water Resources Act 1991 (Amendment) (England and Wales) Regulations 2009;
- EU Water Framework Directive (WFD) 2000/60/EC (as amended by supplementary directives and decisions);
- The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 which implement Water Framework Directive (2000/60/EC), and transpose aspects of the Groundwater Directive (2006/118/EEC) and the Priority Substances Directive (2008/105/EC);

- The Water Framework Directive (Standards and Classification) Directions England and Wales 2015;
- The Environmental Permitting (England and Wales) (Amendment) Regulations 2018
- Groundwater Daughter Directive (GWDD) (2006/118/EC);
- The Environmental Damage (Prevention and remediation) (England) Regulations 2009; and
- Flood and Water Management Act 2010.

9.3.6 The Geology and Soils chapter of this ES documents the assessments carried out in line with the requirements of DMRB Volume 11 Section 3 Part 11, which does not include the assessment of waste production, disposal or management, which are included in **Material assets and waste** (Volume 6 Document Ref 6.2 ES Chapter 10).

National and regional policy

9.3.7 Relevant national and regional policy documents include:

National Policy Statement for National Networks (2014)

9.3.8 The National Policy Statement for National Networks [2] states that “land instability may result in landslides, subsidence, or ground heave. Failing to deal with this issue could cause harm to human health, local property and associated infrastructure and the wider environment” (Paragraph 5.117). Appropriate assessment should be carried out at the earliest possible stage and investigations undertaken to ascertain that the site is and will remain stable or can be made so as part of the development (Paragraph 5.118). Mitigation measures are detailed in Paragraph 5.119.

National Planning Policy Framework (2018)

9.3.9 The National Planning Policy Framework [3] provides general guidance and information with regard to development planning in England and the south-west region. It provides information on the planning objectives for the region, and puts particular emphasis on the need for sustainable development in terms of the resources used, the maintenance of the environment, the economic use of land and consideration of society in the general area. Within the policy, the importance for the restoration of derelict and contaminated land is stated.

9.3.10 In relation to conserving and enhancing the natural environment, the National Planning Policy Framework [3] states that impacts on geodiversity should be minimised by preventing harm to geological conservation interests. In the UK, geological sites are afforded consideration at a local level by designation, including:

- Geological Conservation Review (GCR) sites (England, Scotland, Wales);
- Geoparks;
- Regionally Important Geological and Geomorphological Sites (RIGS);
- Locally Important Geological and Geomorphological Sites (LIGS);
- Sites of Importance for Nature Conservation (SINC).

9.3.11 The National planning guidance sets out the principles of the planning system with respect to the development on unstable land and land affected by contamination. It places an emphasis on the requirement to understand the

ground risks, and on the development of appropriate remediation to make ground hazards material considerations during the planning process.

9.3.12 The revised National Planning Policy Framework [3] paragraph 179 states: "*Where a site is affected by contamination or land stability issues, responsibility for securing a safe development rests with the developer and/or landowner*"

9.3.13 The Planning Practice Guidance to the NPPF, DCLG, 2016 [4], provides additional guidance to local planning authorities to ensure the effective implementation of the planning policy set out in the National Planning Policy Framework on development, in particular in relation to mineral extraction.

Local planning policy

Cornwall Local Plan (2016)

9.3.14 The Cornwall Local Plan [5] provides guidance with respect to development planning in Cornwall Council (CC). It provides information on the spatial strategy and places emphasis on the value and sensitivity of geodiversity. It provides guidance on the protection of geodiversity in accordance with international, national and local status and recommends mitigation. Development should avoid adverse impact on existing features as a first principle and enable net gains by designing in opportunities for geological conservation alongside new development.

Minerals Safeguarding Development Plan Document (2018)

9.3.15 CC is preparing a Minerals Safeguarding Development Plan Document [6] to identify areas of mineral resource and infrastructure that will be safeguarded for future use. The draft Development Plan [6] provides guidance on safeguarding of mineral areas. A list has been developed of strategically important shafts and mining areas. It states that its principal objective is "*to safeguard mineral resources, sites and infrastructure from other forms of incompatible development*". Safeguarding policy states that applicants for non-mineral development within Mineral Safeguarding Areas must demonstrate that no mineral resource in the area will be sterilised by the scheme as discussed in Sections 9.11.8 and 9.12.2.

Relevant guidance

9.3.16 This chapter of the Environmental Statement is undertaken with due consideration of the following guidance:

- Geotechnics and Drainage, Earthworks, Managing Geotechnical Risks DMRB Volume 4, Section 1, Part 2 HD22/08 [7];
- Assessment and Management of Environmental Effects, DMRB Volume 11, Section 2, Part 5 [8];
- Geology and Soils, Environmental Assessment, Environmental Assessment Techniques, Highways Agency, DMRB Volume 11, Section 3, Part 11 [9];
- Contaminated Land Statutory Guidance, Department for Environment, Food and Rural Affairs (Defra), 2012 [10];
- Model Procedures for the Management of Land Contamination (CLR11) Defra and Environment Agency, 2004 [11];
- CIRIA R132: A Guide for Safe Working on Contaminated Sites [12];
- CIRIA SP73: Roles and Responsibility in Site Investigations [13];

- BS 5930: 2015: Code of Practice for Site Investigations [14];
- BS 10175:2011 + A1 2013: Code of Practice for Investigation of Potentially Contaminated Sites [15];
- Groundwater protection [16];
- The Environment Agency's approach to groundwater protection [17];
- CIRIA 552: Contaminated Land Risk Assessment, A guide to good practice [18];
- BS 8485:2015: Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings [19];
- CIRIA 665: Assessing risks posed by hazardous ground gas to buildings [20];
- CIRIA 681: Unexploded ordnance (UXO) A guide for the construction industry [21];
- CIRIA 733: Asbestos in soil and made ground: a guide to understanding and managing risks [22];
- CIRIA C765: Asbestos in soil and made ground: good practice site guide [23];
- Eurocode 7 (BS EN 1997-1 [24] & EN 1997-2 [25]) and all relevant normative guidance;
- Planning Practice Guidance for land stability [26];
- Draft version of CIRIA RP940: Abandoned Mine Workings Manual [27].

9.4 Study Area

9.4.1 The scheme study area for all aspects of the Geology and Soils chapter (including geology, geomorphology, designated sites, land stability, mineral resources, hydrogeology and land contamination) comprises the maximum physical extent of the development works (the scheme) plus a buffer zone of 250m. This distance is referenced in best practice documents, including Guidance for the Safe Development of Housing on Land Affected by Contamination: R&D Publication 66 (NHBC, 2008 [28]), and is typical at the hazard identification stage of an assessment. It is also considered to be a suitable distance based on professional judgement of the practical extent of areas which could be impacted by the scheme.

9.4.2 Where there is potential for features outside of this buffer zone to be impacted by or to be constrained by the scheme, then these have been included in the assessment and presented in the Environmental Statement. It is noted that Volume 11 Section 3 of DMRB does not specify a minimum study area distance for the assessment of impacts to geology and soils.

9.5 Potential impacts of the scheme on geology and soils

Geology and geomorphology

9.5.1 The scheme has the potential to impact locally and nationally protected or designated areas with respect to geology and/or geomorphology, including Mineral Safeguarding Sites.

9.5.2 Rock exposures as a result of cuttings may have a beneficial effect as a result of exposing the geological formation.

9.5.3 The scheme could limit access to mineral resources beneath the proposed alignment and embankments could prevent future access to the underlying

mineral resource. The proposed cuttings would result in removal and potential effective use of mineral resources.

9.5.4 The scheme is located within areas that have been mined historically, both below ground and from the surface. If mine workings or mine entrances are present beneath the scheme there is an increased risk of collapse settlement of the ground surface. Potential stabilisation of mine workings may affect the hydrological and hydrogeological regime, including the chemical characteristics of the groundwater and surface water and the flow and supply of groundwater.

9.5.5 Temporary or even permanent drainage may be required in areas of cutting, which may affect the supply of water to springs, streams and other surface water features such as bogs, marshes and ponds. This is assessed within **Road drainage and water environment** (Volume 6 Document Ref 6.2 ES Chapter 13), and **Ecology and nature conservation** (Volume 6 Document Ref 6.2 ES Chapter 8). The potential hydrological and hydrogeological impacts on the Newlyn Downs SAC and the Breney Common and Goss and Tregoss Moors SAC has been considered and discussed within the **Statement to Inform the Appropriate Assessment** (Volume 6 Document Ref 6.5). Consideration has also been given to the proposed position of embankments to ensure that they do not block springs and streams.

Soils

9.5.6 Potential effects on soils within the study area would manifest as a result of the construction and operation of the scheme. The potential effects on the agricultural use of soils are considered within **People and communities** (Volume 6 Document Ref 6.2 ES Chapter 12).

9.5.7 Soil erosion as a result of new road cuttings has the potential to affect sediment loading within watercourses. This is considered within **Road drainage and water environment** (Volume 6 Document Ref 6.2 ES Chapter 13).

Contaminated land

9.5.8 Potential effects of the construction and operation of the scheme in relation to contaminated land may include:

- Creation of new migratory pathways between potentially contaminated soils and underlying aquifers through ground disturbance such as foundation construction activities;
- Re-use of site won or imported contaminated materials in the construction;
- Creation of migratory pathways between potentially contaminated land and construction workers and neighbouring site users;
- The migration of ground gas in association with mine workings/mine entrances, migration and accumulation in excavations, structures (drainage etc.);
- The introduction of contaminative materials, e.g. due to inappropriate storage and use of fuels, etc., or use of grout during mineworkings treatment works, which may impact water resources.
- Contamination of controlled waters as a result of potentially contaminated highway drainage from the scheme discharging into surface water bodies or groundwater resources have been discussed within **Road drainage and water environment** (Volume 6 Document Ref 6.2 ES Chapter 13).

9.5.9 Mitigation measures have been developed as the assessment has been carried out and are included in the scheme design.

9.5.10 It has been assumed that potential effects on human health (e.g. construction and maintenance workers) will be mitigated through adherence to all relevant health and safety legislation and advice, for example, the Control of Substances Hazardous to Health Regulations (COSHH) 2002, as amended, and the Construction Environmental Management Plan (CEMP). The assessment has also considered potential constraints on the scheme design relating to designated sites and existing land contamination, including the potential aggressivity of chemical agents in the ground, which are destructive to concrete.

9.6 Assessment methodology

Methodology for identification of baseline conditions

Approach to identification of baseline conditions

9.6.1 The identification of baseline conditions in relation to site geology, geomorphology and land contamination is primarily based on desk study information included within the **WSP Preliminary Sources Study Report (PSSR)** [29] (Volume 6 Document Ref 6.4 ES Appendix 9.1) prepared for the scheme and information obtained during the Phase 1, Phase 2 and Phase 2 Additional GI. The results of these investigations are presented within the Phase 1 factual report [30] (contained within **WSP Ground investigation report** (Volume 6 Document Ref 6.4 ES Appendix 9.2)), Phase 2 factual report [31] and Phase 2 Additional GI factual report [32] (both contained within **Arup GIR Addendum** (Volume 6 Document Ref 6.4 ES Appendix 9.3), along with the interpretations presented within the GIR [33] (contained within **WSP Ground investigation report** (Volume 6 Document Ref 6.4 ES Appendix 9.2)) and **GIR Addendum** [34] (contained within Volume 6 Document Ref 6.4 ES Appendix 9.3). Further pertinent information has been included from previous investigations and studies of the site as detailed in **Baseline Conditions** (Volume 6 Document Reference 6.4 ES Appendix 9.4)

9.6.2 The baseline conditions in relation to agricultural soils are presented in **People and communities** (Volume 6 Document Ref 6.2 ES Chapter 12).

9.6.3 The following studies and reports have also been reviewed as these had been referenced as key sources for the PSSR [29]:

- Hyder Consulting (2003), A30 Chiverton to Carland Cross PSSR [35];
- Parsons Brinckerhoff (2005), A30 Chiverton Cross roundabout improvement, geotechnical report [36].
- AccordMP (2008). A30 Chiverton Cross CCTV mast. Geotechnical Report for Highways Agency [37];
- Engineering Services Laboratory (CC) (2009). A30 Chiverton Cross Roundabout Improvement Preliminary Sources Study Report (PSSR) for CC [38].

9.6.4 The following factual reports of ground investigation have also been reviewed:

- Department for Transport (1988). London – Penzance Trunk Road A30 Penhale to Carland Cross Improvement factual report for Department of Transport [39].

- Soil Mechanics (2004). A30 Chiverton to Carland Cross preliminary ground investigation factual report for Hyder Consulting Ltd [40].
- Parsons Brinckerhoff (2005), A30 Chiverton Cross roundabout improvement, geotechnical report (including factual information) for Highways Agency [36].
- AccordMP (2008). A30 Chiverton Cross CCTV mast. Geotechnical Report (including factual information) for Highways Agency [37].

9.6.5 A gap analysis of the information contained within the PSSR has been undertaken and the existing information validated and updated where appropriate. The scope of baseline survey is discussed for specific topic areas below:

- Geology and geomorphology:
  - British Geological Survey (BGS) 1:50,000 scale geological map of Newquay, Sheet 346. 2012 [41];
  - BGS 'Geology of Britain' viewer [42];
  - Memoir for the Geological Map Sheet 346, Geology of the Newquay district [43];
  - Memoir for the Geological Map Sheet 352, Geology of the country around Falmouth [44];
  - Topographical survey [45];
  - BGS Onshore Geoindex [46].
- Current and historical land use:
  - Groundsure Enviroinsight Report [47] and Geoinsight [48] including historic 1:2,500 and 1:10,000 Ordnance Survey plans, included in the 2017 PSSR report [29] (see **WSP Preliminary sources study report** (Volume 6 Document Ref 6.4 ES Appendix 9.1))
  - Results of a site walkover carried out 4th August 2016 as reported within the 2017 PSSR [29] (see **WSP Preliminary sources study report** (Volume 6 Document Ref 6.4 ES Appendix 9.1));
  - Aerial photography interpretation;
  - Environment Agency 'What's In Your Backyard?' application [49];
  - Defra online 'Magic' map application [50].
- Hydrology and hydrogeology:
  - Meteorological Office website [51];
  - Groundsure Enviroinsight Report [47] and Geoinsight [48], included in the PSSR [29] (see **WSP Preliminary sources study report** (Volume 6 Document Ref 6.4 ES Appendix 9.1)).
- Mining and mineral safeguarding:
  - Highways Agency Geotechnical Data Management System (HAGDMS) [52]
  - CC online web viewer [53];
  - Cornwall Consultants mining records and assessment provided within the 2003 Hyder Consulting Ltd PSSR [35];
  - Updated Cornwall Consultants mining report and risk assessment [54];
  - The Review of Mining Instability in Great Britain – South West Regional report prepared by Arup for the Department of the Environment [55];
  - BGS report on the metalliferous mining region of south-west England [56];

  - BGS 1:100,000 Mineral Resource map for Cornwall and the accompanying Mineral Resource Information for Development Plans report [57];
  - Historic OS plans contained within the Groundsure report [29] have been used to identify the potential presence of historic quarries.

- Land stability:
  - Results of a site walkover carried out 4th August 2016 as reported within the PSSR [29] (see **WSP Preliminary sources study report** (Volume 6 Document Ref 6.4 ES Appendix 9.1));
  - Aerial photography interpretation [58];
  - Groundsure Enviroinsight Report [47] and Geoinsight [48], including historic 1:2,500 and 1:10,000 Ordnance Survey plans, included in the PSSR report [29] (see **WSP Preliminary sources study report** (Volume 6 Document Ref 6.4 ES Appendix 9.1)).

- Soil survey:
  - The land use baseline with respect to agricultural use is discussed within **People and communities** (Volume 6 Document Ref 6.2 ES Chapter 12).

- Ground conditions encountered during ground investigations:
  - Results of a site walkover carried out 4th August 2016 as reported within the 2017 PSSR [29] (see **WSP Preliminary sources study report** (Volume 6 Document Ref 6.4 ES Appendix 9.1));
  - Groundsure Enviroinsight Report [47] and Geoinsight [48], including historic 1:2,500 and 1:10,000 Ordnance Survey plans, included in the 2017 PSSR report [29] (see **WSP Preliminary sources study report** (Volume 6 Document Ref 6.4 ES Appendix 9.1));
  - Information from historical and recent ground investigations as listed within paragraph 9.6.4;
  - The BGS borehole records database has been reviewed and available borehole records obtained for the local area [42].

- Consultation with statutory and non-statutory bodies and agencies
  - Environment Agency (EA);
  - Natural England (NE);
  - Cornwall Council (CC);
  - Environmental Record Centre for Cornwall and the Isle of Scilly (ERCCIS).

Ground investigation survey methodology

9.6.6 Intrusive ground investigations have been undertaken in line with best practice current at the time of the ES production. The most recent investigations carried out by Structural Soils in 2017 were carried out in accordance with BS EN 1997-2 Eurocode 7 [59] and BS5930:2015 Code of Practice for Site Investigations [60]. These investigations involved a mixture of mechanically excavated trial pits and boreholes excavated using dynamic sampling and rotary coring techniques. Soil and rock samples were recovered and sent to suitably accredited laboratories for chemical and/or geotechnical testing.

9.6.7 As part of the investigations, boreholes were equipped with groundwater monitoring installations and groundwater level monitoring was undertaken from these installations. As part of the Structural Soils 2017 Phase 2 investigations,

samples of groundwater were obtained and were sent to a suitably accredited laboratory for chemical testing.

9.6.8 The exact details of the methodology employed by the ground investigation contractors are described within the ground investigation contractor's factual reports [30] [31].

Geophysical investigation survey methodology

9.6.9 Geophysical investigations were undertaken as part of the Phase 2 additional GI carried out by TerraDat for SOCOTEC in May 2018. These investigations were carried out at 8 no. areas across the alignment of the scheme with the aim of providing information on mining related features. The following geophysical techniques were used:

- Magnetics (Geometrics G858);
- Electromagnetics (Geophex GEM-2);
- Electrical Resistivity Tomography (ERT) (IRIS Syscal); and
- Microgravity (Scintrex CG-5).

9.6.10 The exact details of the methodology employed by the geophysics contractor is described within the contractor's report [32].

Baseline assessment methodology

9.6.11 The assessment of baseline conditions is based on the scope of baseline studies presented in paragraph 9.6.1 to 9.6.5. Geological and geomorphological features that have potential to be impacted by the scheme have been identified. This information has also informed the baseline information associated with land stability and land contamination.

9.6.12 The baseline Land Contamination Conceptual Site Model is based on the information reviewed as part of the baseline study preparation, as detailed in paragraph 9.6.1 to 9.6.5 and presents the identified potential pollution linkages, i.e. the presence of sources of contamination, receptors (both human and environmental) and pathways through which the contamination could have a detrimental impact on these receptors.

9.6.13 Sensitive receptors have been identified based on the review of the existing information and additional works undertaken to inform the EIA process. Identified receptors include:

- Areas of geological or geomorphological interest;
- Soils;
- Sensitive human receptors;
- Controlled waters (groundwater and surface water) that may be affected by contaminants; and
- Ecological receptors that may be affected by contaminants.

9.6.14 Potential sources of contamination within the study area have been identified based on the review of existing information, including the results of contamination testing from previous intrusive investigations and other works undertaken to inform the EIA process. These include:

- Historic industrial/commercial activities;
- Current industrial/commercial activities;

- Possible or known areas of made ground;
- Locations of pollution incidents or licensed discharges; and
- Review of past and present environmental permits, processes, licences.

9.6.15 Potential pathways through which the contamination from identified sources may reach the sensitive receptors have been based on the review of the study information and ground investigation information; relevant pathways include:

- Ingestion, inhalation, or dermal contact with soils/dust originating from the sources of contamination;
- Inhalation of ground gasses/hydrocarbon vapours originating from sources of contamination; and
- Leaching and migration of contamination.

Methodology for assessment of construction impacts

9.6.16 The assessment of the construction impacts on the geology, geomorphology and land contamination has been carried out through consideration of baseline conditions in the context of the extent, method and programme of proposed earthworks and construction activities. A detailed description of the scheme proposals is presented in **The project** (Volume 6 Document Ref 6.2 ES Chapter 2).

9.6.17 For the purpose of the assessment the following construction activities are considered:

- Construction of cuttings – the location, name and maximum depth of cutting are presented within **The project** (Volume 6 Document Ref 6.2 ES Chapter 2).
- Construction of earth embankments – the location, name and maximum height of embankments are presented within **The project** (Volume 6 Document Ref 6.2 ES Chapter 2).
- Construction of structures – the location, name and proposed design solution are presented within **The project** (Volume 6 Document Ref 6.2 ES Chapter 2). No piling is currently envisage as being required for the scheme. Culverts would be required to accommodate the watercourses and springs crossing the proposed alignment; these would be constructed as part of the embankment construction.

9.6.18 The methodology for assessing the construction impacts on the geology and soils has been undertaken in accordance with the procedure outlined in Volume 11 of DMRB (Section 3 Part 11, Geology and Soils). This is summarised below:

- Step 1: assess the importance/value of any geological or geomorphological feature or identified receptor using the criteria;
- Step 2: assess the magnitude of the effect of construction on the geological or geomorphological feature or identified receptor using the criteria; and
- Step 3: combine the importance and the magnitude of the effect of construction on the receptor using the relevant matrix to establish the overall significance of the effect.
- Step 4: determine the significance of cumulative effects using the relevant matrix.

9.6.19 A review of the baseline data identifies and refines the extent of potentially contaminated land within the study area. The need for further focussed assessment has been considered where existing or suspected contamination

may be affected by the route, i.e. by creating or altering pollutant linkages between sources and sensitive receptors.

9.6.20 For the assessment of construction impacts the Conceptual Site Model (CSM) has been revised to include new pollution linkages introduced during the construction phase. The revised Conceptual Model has been used to establish the risks posed and the potential need for further assessment.

9.6.21 Those contamination sources identified fully outside of the study area have been scoped out and therefore require no further assessment.

Methodology for detailed assessment of potential effects

9.6.22 An assessment of effects in relation to land instability (for mining, landsliding and natural cavities) has been undertaken in accordance with industry best practice as presented within Planning Practice Guidance on land stability [26]. More specific guidance in relation to mining has been followed, including the Abandoned Mine Workings Manual CIRIA C758 [27].

9.6.23 If land stability is considered to be a hazard, the steps set out in the Planning Practice Guidance on land stability [26] shall be carried out to manage the risks and identify further action that may be required. This would include appropriate desk study, site visits and other investigations. Investigations would be undertaken with the aim of ascertaining that the site is or can be made stable.

9.6.24 Assessment of effects in relation to contamination has been undertaken in accordance with industry best practice as presented in CLR11 [11]. The risk assessment process is underpinned throughout by the development of the Conceptual Site Model (CSM), which provides a description of the identified contaminated linkages.

9.6.25 The process comprises a tiered approach, which starts with a simple and conservative Tier 1 assessment of potential risks from possible Pollutant Linkages (Source-Pathway-Receptor). At this stage potential Pollutant Linkages are identified. Where suitable investigation data exists to assess these, the data has been used to ascertain whether a risk exists. If suitable investigation data does not exist, the required investigations to confirm whether such a linkage is viable will be defined, e.g. where there is a possibility of presence of made ground, soil sampling and laboratory testing will be identified as the required investigation.

9.6.26 Any potential risks identified at Tier 1 have been studied in more detail through a Tier 2: Generic Quantitative Risk Assessment (GQRA). The results of any investigations completed have been reviewed at this stage and quantitative assessment is undertaken. The methodology for a GQRA is presented in Sections 9.6.29 to 9.6.33.

9.6.27 If a Tier 2 assessment identifies potential risk, i.e. the applied generic assessment criteria are exceeded, a Tier 3: Detailed Quantitative Risk Assessment (DQRA) is required. This involves derivation of site specific assessment criteria and may involve additional targeted ground investigations to refine the Conceptual Site Model. Where pollutant linkages are identified as viable on completion of Tier 3 assessments, remediation mitigation measures would be identified. However, the detailed design of how required mitigation would be implemented, would be completed at a detailed design stage including remedial options appraisal and remediation and verification plan. It is also acknowledged that as per any other

highway scheme, further investigation work will be carried out and additional assessments will be completed as construction progresses. These however would follow the methodology set out above.

9.6.28 The assessment is on the basis of all soils that are suitable for reuse being retained on site as part of the scheme. Geotechnical and chemical acceptability criteria will be established for any soils proposed for reuse, with soil samples tested and screened against the acceptability criteria as the work progresses. This will ensure that the acceptability of soils for reuse is demonstrated and verified. Any soils that do not meet the chemical acceptability criteria shall be treated or disposed of to a suitably licenced facility. In addition, a discovery strategy will be developed to enable unforeseen ground conditions to be addressed if or when encountered. Any imported soils will also require verification prior to use within the scheme. This approach to soil sampling, testing and assessment will be defined in an earthworks specification for the construction works that will be prepared in accordance with the Specification for Highway Works Series 600 Earthworks – that is applicable for the scheme.

Generic quantitative risk assessments methodology – human health

9.6.29 Where a potential pollution linkage has been identified in relation to human health a generic quantitative risk assessment (GQRA) has been undertaken. This was done by screening available soil chemical test results against published generic assessment criteria for a suitable land use scenario, such as DEFRA Category 4 Screening Levels (C4SLs) [61], and where these are not available, the LQM/CIEH Suitable 4 Use Levels (S4ULs) [62].

The applied assessment criteria, as per paragraph above, have been derived using the Environment Agency Contaminated Land Exposure Assessment (CLEA) model. This model defines Age Classes for receptors within a number of generic end use scenarios.

Generic quantitative risk assessments methodology – controlled waters

9.6.30 Where a potential pollution linkage has been identified in relation to controlled waters a GQRA has been undertaken. Where impact of groundwater onto surface waters is being assessed, this is achieved by screening available water chemical testing results against the Environmental Quality Standards for annual average inland surface water (freshwater) values. Assessing the impact on drinking water resources is achieved by screening available water chemical testing results against UK Drinking Water Standards. Impact of hazardous leachable contaminants on the underlying groundwater has been assessed by comparing minimum reporting values (MRVs) against measured concentrations.

9.6.31 Where the FEQS is dependent on bioavailability, which is the case for copper, nickel and zinc, measured concentrations of these metals found within groundwater have been inputted into the UKTAG metal bioavailability assessment tool (M-BAT) [63]. The key output of the M-BAT is an estimate of the bioavailable concentration of a metal under the conditions found at a site, which can then be compared with the EQS bioavailable to assess compliance.

Ground gas risk assessment methodology

9.6.32 Where a potential pollution linkage is identified in relation to ground gas an initial screening exercise is undertaken based on a review of the potential for ground gas generation undertaken CIRIA C665, CL:AIRE RB17. On the basis of this

initial assessment the requirement for further intrusive ground gas monitoring has been derived.

9.6.33 Due to the nature of the scheme, i.e. no buildings are included within the development, the assessment involves only derivation of Gas Screening Values (GSVs) based on recorded maximum concentrations of methane and carbon dioxide, and the measured maximum gas flow. The derived GSV will be then compared to GSV thresholds to obtain a risk classification.

Methodology for assessment of operational impacts

9.6.34 The assessment of the operational impacts on the geology, geomorphology and land contamination has been carried out through consideration of baseline conditions in the context of the operational activities. Assessment of any new pollution linkages has been undertaken in line with the processes detailed in paragraphs 9.6.22 to 9.6.33.

9.6.35 The assessment has been undertaken based on all soils that are suitable for reuse being retained on site for reuse within the scheme. It is based on measures being taken to establish acceptable reuse criteria and procedures for the scheme to ensure that suitability of material for reuse can be demonstrated and verified. Some materials may need treatment, but this is anticipated to comprise drying and/or sorting. This approach is in line with the Specification for Highway Works, Series 600. Relationships with **Material assets and waste** (Volume 6 Document Ref 6.2 ES Chapter 10), would be captured relating to soil re-use.

Magnitude of impacts

9.6.36 The significance and magnitude of impacts has been assessed by attributing an environmental value or sensitivity to each receptor impacted, in combination with the magnitude of impact that would occur to it. (See **Baseline conditions** (Volume 6 Document Ref 6.4 ES Appendix 9.4) The sensitivity of each has been assessed based on Table 9-1, and the magnitude of impact in accordance with Table 9-2

Table 9-1 Criteria and DMRB definitions of sensitivity or value according to HA 205/08 [64].

Value (sensitivity)	Typical descriptors
Very high	**Geology/ Mineral Resources:** Very rare and of very high national and regional geological/geomorphological importance with no potential for replacement (e.g. designated sites of national importance including SSSI, active quarries and mining activities of national importance). **Groundwater:** Groundwater with a high quality and rarity on a regional or national scale with limited potential for substitution (e.g. principal aquifer providing potable water to a large population). **Surface water:** European Community (EC) Designated Salmonid/Cyprinid fishery Water Framework Directive (WFD) Class 'High' Site protected/designated under EC or UK wildlife legislation (SAC, SPA, SSSI, WPZ, Ramsar Site, salmonid water)/species protected by EC legislation. **Land Contamination:**

Value (sensitivity)	Typical descriptors
	Human health (High sensitivity land use scenario e.g. residential, public open space). **Unexploded ordnance (UXO)** Human health
High	**Geology/ Mineral Resources:** Medium national and high regional geological/ geomorphological importance with limited potential for replacement (e.g. currently non-designated GCR site, regionally important site, active quarries and mining activities of regional or local importance). **Groundwater:** Groundwater with a high quality and rarity on a local scale with limited potential for substitution, or attribute with a medium quality or rarity on a regional or national scale with limited potential for substitution (e.g. principal aquifer providing potable water to a small population and/or large resource potential). **Surface water:** WFD Class 'Good' Major Cyprinid Fishery Species protected under EU or UK habitat legislation **Land Contamination:** Sensitive receptor, which is the reason for SSSI designation. Human health (Lower sensitivity land use scenario e.g. commercial, industrial)
Medium	**Geology/Mineral Resources:** Low regional and high local geological/ geomorphological importance with some potential for replacement (e.g. allocated RIGS or recommended RIGS). **Groundwater:** Groundwater with a medium quality and rarity on a local scale with limited potential for substitution, or attribute with a low quality and rarity on a regional or national scale with limited potential for substitution (e.g. secondary aquifer unit supporting abstraction for agricultural or industrial use and/or moderate resource potential). **Surface Water:** WFD Class 'Moderate' **Land Contamination:** Receptor that is of regional importance.
Low	**Geology/Mineral Resources:** Of local geological/geomorphological importance with potential for replacement (e.g. non-designated exposure/former quarries and mining activities). **Groundwater:** Groundwater with a low quality and rarity on a local scale with limited potential for substitution (e.g. non-aquifer unit that does not afford protection to underlying water bearing units). **Surface Water:** WFD Class 'Poor' **Land Contamination:** Human health (Low sensitivity land use scenario e.g. highway construction). Receptor of local importance.
Negligible	**Geology/Mineral Resources:** Little local geological/geomorphological interest. **Land Contamination:** Receptor with low importance and rarity.

Table 9-2 Criteria and DMRB definitions of magnitude of impact according to HA 205/08 [64].

Magnitude of Impact	Typical Criteria Descriptors
Major	**Geology/Mineral Resources:** The proposals are very damaging to the geological environment/soils resource of the area. May result in loss or damage to areas designated as being of regional or national geological interest. Loss of resource and/or quality and integrity of resource. Severe damage to key characteristics, features or elements. Impacts cannot be mitigated for (e.g. destruction of a designated site (SSSI or RIGS)). (Adverse) **Controlled Waters (aquifers/surface water):** Reduction of water quality rendering groundwater or surface water unfit to drink and/or substantial adverse impact on groundwater dependent environmental receptors. (Adverse) **Land Contamination:** Major effect upon receptor. Severe or irreversible effect on human health. Temporary severe or irreversible effect on ground/surface water quality. (Adverse).
	Large scale or major improvement of resource quality; extensive restoration or enhancement; major improvement of attribute quality (Beneficial).
Moderate	**Geology/Mineral Resources:** The proposals may adversely affect the geological/hydrogeological conditions/soils resource existing at the site but would not result in the loss of, or damage to, areas designated as being of regional or national geological interest. Loss of resource, but not adversely affecting the integrity. Partial loss of/damage to key characteristics, features or elements. Some mitigation may be possible but would not prevent scarring of the geological environment, as some features of interest would be lost or partly destroyed. (Adverse) **Controlled Waters (aquifers/surface water):** Reduced reliability of a supply at a groundwater or surface water abstraction source. (Adverse) **Land Contamination:** Moderate effect upon receptor. Long term or short term moderate effect on human health. Moderate effect on ground/surface water quality, reversible with time. (Adverse)
	Benefit to, or addition of, key characteristics, features or elements; improvement of attribute quality (Beneficial).
Minor	**Geology/Mineral Resources:** The proposals would not affect areas with regional or national geological interest/soils resource but may result in the loss of, or damage to, areas of local geological/soils resource interest. Cannot be completely mitigated for but opportunities exist for the replacement of lost or damaged areas which may be of similar local geological/soils interest. (Adverse) **Controlled Waters (aquifers/surface water):** Marginal reduced reliability of a supply at a groundwater or surface water abstraction source. (Adverse) **Land Contamination:** Non-permanent health effects to human health (easily prevented by means such as personal protective clothing etc.). Slight effect on ground/surface water quality, reversible with time. (Adverse)

Magnitude of Impact	Typical Criteria Descriptors
	Minor benefit to, or addition of, one (maybe more) key characteristics, features or elements; some beneficial impact on attribute or a reduced risk of negative impact occurring (Beneficial).
Negligible	**Geology/Mineral Resources:** The proposals would result in very minor loss or damage to local area of geological interest/soils resource such that mitigation is not considered practical. Very minor loss or detrimental alteration to one or more characteristics, features or elements. (Adverse) **Controlled Waters (aquifers/surface water):** Non-measurable change to quality, level and flow. (Adverse) **Land Contamination:** Results in no discernible change or an impact on attribute of sufficient magnitude to affect the use/integrity. (Adverse) e.g. Soil contaminants present, but risk assessment suggests negligible/ low risk to human health. (Adverse)
	Very minor benefit to or positive addition of one or more characteristics, features or elements (Beneficial).
No change	No loss or alteration of characteristics, features or elements; no observable impact in either direction.

Assessment of significance

9.6.37 The assessment of significance for negative (adverse) and positive (beneficial) effects is based on consideration of the sensitivity or value of a receptor (within Table 9-1) combined with the magnitude of impact (within Table 9-2). The significance of an impact is then assessed by considering the combination of both the sensitivity of the receptor in combination with the magnitude of impact in accordance with Table 4-3 in **Approach to EIA** (Volume 6 Document Ref 6.2, ES Chapter 4).

9.7 Baseline Conditions

A full assessment of the baseline conditions can be found in **Baseline conditions** (Volume 6 Document Ref 6.4 ES Appendix 9.4) however a summary of the findings is presented below.

Topography and geomorphology

9.7.1 The scheme alignment follows a south-west to north-east striking ridge, which falls away on both sides to form a relative high in comparison with the surrounding topography. The landscape surrounding the route comprises numerous steep sided valleys, which have been cut by the fluvial action of watercourses. These watercourses are sourced from springs proximal to the scheme alignment that flow outwards. Watercourses create an undulating landscape, most notably towards the middle section of the route.

9.7.2 Only one feature of shallow slope movement was observed adjacent to observed seepage north of Carland Cross Junction. (Ch. 13+700 to 13+800) (see Volume 6 Document Ref 6.3 ES Figure 9-7).

Published geology

Artificial ground

9.7.3 Artificial ground is only indicated to be present underlying the scheme between chainage 12+675m and 12+775m.

Superficial geology

9.7.4 Head deposits are present within the base of fluvial valleys, consisting of a stratum that is largely heterogenous comprising sandy clay with quartz pebbles and small angular local rock fragments with dispersed blocks [66].

9.7.5 Active fluvial deposition by streams has resulted in the presence of Alluvium at valley bottoms, this is very thin and therefore generally absent on published geological maps.

Bedrock geology

9.7.6 The scheme alignment is predominantly underlain by Devonian bedrock of the Gramscatho Basin Succession. It transects the thrust fault separating the Gramscatho Basin succession and the Looe Basin Succession.

9.7.7 Metalliferous rich mineral veins are present originating from the emplacement of the St Austell and Carnmenellis Granite, the site also lies within the St Agnes Mining District.

Structural geology

9.7.8 The thrust fault separating successions to the north is cross cut, impacting the geological boundary between the Grampound Formation and the overlying Porthtowan Formation. A zone of degraded rock quality and a significantly deep weathering zone was encountered within BH-220 and BH-306 at approximate chainage 9+250m.

Site history

9.7.9 The main industrial activity in the study area are numerous mines, typically present on the earliest maps and noted as disused by 1879. Quarries are also located throughout the study area, most marked ‘old’ by 1879 and in later editions either being used as tips or no longer shown. Numerous tumuli were also found along the study area and other features of interest discussed in **Cultural heritage** (Volume 6 Document Ref 6.2 ES Chapter 6). Anthropic contamination sources are associated with mine waste, infilled quarries and use of Made Ground in previous upgrades. Features of contamination sources are presented within Volume 6 Document Ref 6.3 ES Figure 9-6.

Unexploded ordnance (UXO)

9.7.10 Based on the findings of a preliminary assessment within the PSSR [30] (see **WSP Preliminary sources study report** (Volume 6 Document Ref 6.4 ES Appendix 9.1), the UXO risk is considered to be low.

Mining and mineral resources

Introduction

9.7.11 The 1:100000 scale Mineral Resources map of Cornwall [58] indicates the scheme alignment to be underlain by a sandstone resource. The Cornwall Council Interactive Map [54] does not indicate the presence of any Mineral Safeguarding Areas within the scheme study area. The Air Photo Interpretation

Report [59] indicates areas of mottled soil between chainage 1+320m and 2+830m, resulting in poor drainage.

PSSR [30] and GIR [34] summary

9.7.12 No evidence of mining was observed beneath the proposed alignment, however there is a possibility of unrecorded workings.

Cornwall Consultants Ltd (2017) mining search [55]

9.7.13 Cornwall Consultants Ltd carried out a mining search and risk assessment, covering a buffer area of 500m either side of the scheme alignment. Six named mine sites and four unnamed trial workings were identified, also four further trial sites or mines lie on the boundary.

9.7.14 Unrecorded workings give rise to the greatest number of problems for land development. An Elvan dyke traverses the alignment, potentials indicate another unrecorded working. There are no recorded or expected shafts, adits or deep workings beneath the alignment, though it is interpreted an adit exists beneath the scheme at chainage 0+450m.

Hydrology and hydrogeology

9.7.15 The scheme alignment generally traverses a boundary between two watersheds. All surface water features are presented in Volume 6 Document Ref 6.3 ES Figure 9-4.

Groundwater flooding

9.7.16 BGS data contained with the Groundsure report [49] [48] shows the scheme alignment to traverse areas having moderate to high susceptibility to groundwater flooding within superficial deposits

Hydrogeology

9.7.17 Environmental Agency hydrogeological mapping provides information on the hydrogeology of England. The entire site is classed as a ‘Secondary A’ aquifer for bedrock geology. All the aquifers in this superficial geology are either ‘Secondary A’ or ‘Secondary undifferentiated’ and these correspond to the Head and Alluvium positions.

9.7.18 The environmental agency Groundwater Vulnerability Map [50] identifies the vulnerability of groundwater to contamination. These maps indicate most of the scheme lies within minor aquifer low and minor aquifer intermediate Groundwater Vulnerability Zones. A high minor aquifer groundwater vulnerability zone overlaps the scheme approximately 500m south-west of Two Barrows Junction.

9.7.19 Approximately 600m of the current A30, northeast of Carland Cross lies within a ‘Zone 2’ groundwater source protection zone. Two ‘Zone 1’ groundwater source protection zones directly underlie the scheme alignment. These source protection zones are for domestic and agricultural use.

Significant services

9.7.20 The **WSP Ground investigation report** [34](see Volume 6 Document Ref 6.4 ES Appendix 9.2) indicates the presence of a high pressure gas main and an abandoned disused pipeline is located between Ch. 11+700m and Ch. 12+200m

are located within the scheme boundaries. If not removed these services are considered a source of contamination.

Ground hazards

9.7.21 The geological risks potentially affecting the scheme alignment, as defined by the BGS, that are not neglible, are described below:

- Potential for collapsible ground stability hazards (Very Low);
- Potential for running sand ground stability hazards (Low (Alluvium), Very Low (Head) Negligible (bedrock);
- Potential for shrinking or swelling clay ground stability hazards (Very Low - Negligible).

Geological designated sites

9.7.22 There are no statutory or non-statutory designated geological sites within the Geology & Soils Study Area.

Environmental setting

9.7.23 The Groundsure report indicates that 2 fuel stations, 2 new vehicle sales units and a vehicle servicing centre are present along the site. Many of the entries within 250m of the route alignment relate to electrical infrastructure such as pylons, turbines, substations and solar electricity generation. Numerous tanks were also indicated though many if not all of them are in relation to agricultural irrigation, private water supply, or livestock/farm use.

9.7.24 Review of the historic uses listed in the Groundsure report [30] indicate that the majority of features within the study area are in relation to the historic mining.

9.7.25 Review of records of Environment Agency Recorded Pollution incidents indicate 3No. incidents have occurred within the study area. All three did not surpass the category 3 minor land impact.

9.7.26 Numerous environment agency discharge consents are noted within the study area. Many of these relate to domestic and farm property drainage and discharge systems. A soakaway at the Shell petrol station is also noted as defects with the fuel interceptor could result in potential contaminants being released.

9.7.27 Review of Designated Environmentally Sensitive Sites indicates that much of the scheme lies within a DEFRA designated Nitrate Vulnerable Zone.

Ground investigations

9.7.28 A number of historic ground investigations have been completed and these have been reviewed for information in this report. The relevant information from these investigations have been used to inform our understanding of the sub-surface conditions throughout the scheme.

9.7.29 Ground conditions are discussed in detail within the **WSP Ground investigation report** [34] (see Volume 6 Ref 6.4 ES appendix 9.2) and **GIR Addendum** [35] (see Volume 6 Ref 6.4 ES Appendix 9.3).

9.7.30 The bedrock varies; from Chiverton Cross to Marazanvose lies the Porthtowan Formation, from Marazonvose to Caland the Grampound Formation underlies and east of Carland Cross the bedrock is Trendrean Mudstone Formation.

9.7.31 Design groundwater levels vary from 1.1m to over 6m below existing level, therefore shallow groundwater may be encountered within excavations in the central third of the site.

Conceptual site model

9.7.32 Other than an oily sheen on the water in TP-219 (see Volume 6 Document Ref 6.3 ES Figure 9-6), no other visual or olfactory contamination was noted during works.

9.7.33 Given the natural geology and other potential contaminant sources present across the site, it is not considered there is a significant source of ground gas present. Alluvial soils could have presented a risk for ground gas contamination; however, they were largely found in discrete locations within the scheme area so are not deemed a risk in the baseline scenario.

9.7.34 Receptors at risk to contamination sources are the maintenance workers and the residents and workers in the nearby villages due to long term exposure. Users of agricultural land and users of the A30 at tie in points with the scheme are at low risk due to transient/short-term exposure.

Assessment of potential impact of current baseline conditions

Land contamination

9.7.35 In the baseline condition the potential plausible pollution linkages are:

- Maintenance workers impacted by direct exposure to contaminants in soils/made ground.
- Controlled waters impacted by potential contamination present in made ground or mine workings, leaks and spills, and current land use (petrol filling stations).

Human Health GQRA

9.7.36 The assessment criteria chosen for the GQRA are for residential with plant uptake end use, considered conservative given the likely exposure encountered by maintenance workers but will be suitable for establishing if further discussion or assessment is necessary.

9.7.37 Screening results indicate most chemical concentrations fall below screening criteria other than, 8 No. concentrations of arsenic, two of lead, one of benzo(a)pyrene and one of dibenzo(ah)anthracene.

9.7.38 Exceedances for arsenic were encountered in made ground and natural soils, largely reflective of the elevated background arsenic concentrations for this geography. Exceedances of lead can largely be related to mine waste and coal waste being used as an infilling material. Both these exceedances were noted in the same trial pit.

9.7.39 In general, soils encountered show little evidence of contamination, concentrations largely fall below the applied residential with plant uptake

screening criteria. Furthermore, the screening criteria are likely to be overly conservative and the risk from contaminants could be mitigated by PPE.

Controlled waters GQRA

9.7.40 Results of the screening assessment indicate; most heavy metals fall below screening criteria except copper, lead and zinc, numerous PAH compounds are recorded above laboratory limit and there were two samples of leachable levels of TPH.

9.7.41 With regards to the potential sources of heavy metals, review of the locations where the exceedances occurred does not indicate an obvious spatial relationship. Heavy metal concentrations correlate with typical background concentrations of the area geology(historic mining and metalliferous mineralisation). Reviewing the location of organic contaminants encountered did not indicate potential sources for hydrocarbon contaminants. The locations sat in agricultural areas, away from any likely source of hydrocarbon contamination.

9.8 Consultation

9.8.1 As mentioned in **Approach to EIA** (Volume 6.2, Document Ref 2, ES Chapter 4), a scoping report was issued for the scheme. The Planning Inspectorate responded on behalf of the Secretary of State within the **Scoping Opinion** (Volume 6 Document Ref 6.4 ES Appendix 4.1 [65]. The responses relevant to the Geology and Soils assessment and the respective changes made to the scope of this chapter are included within **Responses to scoping opinion** (Volume 6 Document Ref 6.4 ES Appendix 4.2). Late responses received from Cornwall Council, Historic England, St Agnes Parish Council and National Grid did not have any comments on the Geology and Soils chapter.

9.8.2 The Environmental Records Centre for Cornwall and the Isles of Scilly and the CC Environmental Protection Department were also consulted separately and provided information on the following:

- Regionally Important Geological Sites (RIGS);
- Part II A designations;
- Any known remediation that has been completed/ on-going/ planned;
- Ground investigations factual and interpretative reports;
- Sites of potential concern under Part II A;
- Historical underground storage tanks;
- Part A and B IPPC processes;
- Storage and usage of radioactive materials;
- Private water supply locations within 1km of the scheme alignment;
- Details of aggregate resources within the county (land bank figures);
- Local waste management infrastructure within the county;
- Any known issues associated with known mining features.
- Any anecdotal evidence of contamination, land owner complaints etc.

9.8.3 The received information forms part of the baseline conditions.

9.9 Assessment assumptions and limitations

9.9.1 All works for the scheme will need to take place within the limits of deviation (LOD) as defined by Article 8 of the Development Consent Order (DCO). The LOD allows limited flexibility in the positioning of the A30 in order that it can be positioned optimally reflecting factors identified during detailed design or during construction. The lines or situations of the authorised development shown on the works plans may deviate vertically and laterally by a maximum of 0.5m. It is assumed the scheme is as per the description outlined in **The project** (Volume 6 Document Ref 6.2 ES Chapter 2). However, there is the possibility of variation with the LOD, this has been assessed in the Limits of deviation section of **Approach to EIA** (Volume 6 Document Ref 6.2 ES Chapter 4).

9.9.2 It is assumed that measures would be put in place during the construction of the scheme to control potential pollution incidents caused by accidental leaks and spills of fuels and oils stored and used on site for construction plant and machinery. These measures will be included within a Construction Environmental Management Plan (CEMP). Adherence to the CEMP will mitigate the risk to identified receptors, however, in order to reinforce particular requirements, particular measures are outlined within Section 9.10 Design, Mitigation and Enhancement Measures.

9.9.3 The Phase 1 and Phase 2 ground investigations do not provide ground investigation data for the entire scheme. Nonetheless, the available ground investigation information is considered sufficient at preliminary design stage and to inform the environmental impact assessments.

9.9.4 It is assumed that prior to completion of construction, the areas adjacent to the scheme used for access, egress and other associated construction works are to be reinstated with turf and topsoil in keeping with the original land use.

9.9.5 The reuse of site won or imported materials to the scheme will be managed by a verification system applied via the Specification for Highway Earthworks Series 600, and only materials found suitable for use would be acceptable for construction works.

9.9.6 Professional judgement has been applied where necessary in assignment of sensitivity and magnitude of effects in line with definitions provided in Table 9-1 and Table 9-2.

9.9.7 The assessment of pollution release as a result of operational or construction activities and potential impacts on hydrogeology are covered in **Road drainage and water environment** (Volume 6 Document Ref 6.2 ES Chapter 13).

Limits of deviation

9.9.8 An assessment has been conducted within the limits of deviation outlined in Limits of Deviation within **Approach to EIA** (Volume 6 Document Ref 6.2 ES Chapter 4)

9.9.9 The assessment of the impact of the Scheme on the **Geology and soils** (Volume 6 Documents Reference 6.2 ES Chapter 9) has considered potential impacts within the proposed vertical and horizontal limits of deviation. The baseline conceptual site model has considered all potential contaminant linkages (formed

due to the construction and/or operational phases of the scheme) and all potential effects on human health and controlled waters. The assessment has also considered all potential impacts on land stability.

9.9.10 Minor changes to the alignment of the scheme within the limits of deviation are not considered likely to give rise to any new effects, or to any materially worse adverse or better beneficial effects from those predicted in the assessment.

9.10 Design, mitigation and enhancement measures

9.10.1 This section provides a description of the inherent design, mitigation and enhancement strategy for the scheme. It describes measures relied upon within the assessment and discusses the assumed development of these mitigation measures.

Engineering design

9.10.2 For all highways projects ground risks are managed through working in accordance with HD22/08 [66]. This Standard ensures that ground risks are properly managed by providing a consistent approach to the planning and reporting of ground investigations and the planning, design and construction of Geotechnical Works. Geotechnical certification is used to ensure that ground risk is correctly identified, reported and managed through the lifetime of a scheme.

9.10.3 The Standard comprises four key stages which relate to key stage of decision making, including:

- **Key Stage 1 – Initial Review of Project and Geotechnical Risks to determine its Geotechnical Classification and thus the requirement for Geotechnical Certification:** This stage ensures that potential geotechnical risks are identified at project inception. The requirements for specialist geotechnical processes are also assessed at this stage. The document required from the Designer at this stage is the Statement of Intent.
- **Key Stage 2 – Preliminary Assessment including Preliminary Certification:** This stage contributes to the preparation of the outline design and where necessary the requirement for land acquisition and orders preparation. The documents required from the Designer at this stage are the Preliminary Sources Study Report (Desk Study) and the Ground Investigation Report.
- **Key Stage 3 – Geotechnical Design and Construction Certification:** This stage provides the information for the detailed design and for the contractor to prepare and carry out construction. The output required from the Designer at this stage is a Geotechnical Design Report with all sections completed prior to construction of relevant areas.
- **Key Stage 4 - Geotechnical Feedback:** This stage reports on all construction work and particularly any unexpected ground conditions requiring changes to design that occurred. This Key Stage is a requirement in contracts let by the Overseeing Organisation. The output required from the Designer at this stage is the Geotechnical Feedback report.

9.10.4 At the time of writing the ES Stage 1 and 2 had been carried out and Stage 3 was in progress. Once written, the Geotechnical Design Report will document the design of the scheme in relation to the ground risk. The Environmental Team have been working closely with the geotechnical designers to ensure all ground

risks and mitigation measures identified during the preparation of the ES are incorporated into the geotechnical design.

9.10.5 All geotechnical works have been designed according to Eurocode 7 [59] and relevant British Standards summarised below:

- BS EN 1997-1:2004 – Eurocode 7. Geotechnical Design;
- BS 8004:2015 – Code of Practice for Foundation;
- BS 8002:2015 – Code of Practice for Earth Retaining Structures;
- BS 8006-1:2010 – Code of Practice for Strengthened/Reinforced Soils;
- BS 6031:2009 – Code of Practice for Earthworks;

9.10.6 Earthworks would be carried out using imported or site won materials that meet the requirements of an earthworks specification controlled by the requirements of Specification for Highways Works, Series 600. This ensures that no contaminated materials will be used within embankments.

Construction mitigation

Geology and geomorphology

9.10.7 There are no design, mitigation and enhancement measures over and above the standard engineering design process that have been carried out and will continue in accordance with DMRB HD22/08 Managing Geotechnical Risk [66].

9.10.8 Temporary works shall be appropriately designed by the temporary works designer. This will ensure mitigation of potential effects on the geology and geomorphology during construction.

Soils

9.10.9 There are no design, mitigation and enhancement measures over and above the standard engineering design process that has been carried out and will continue in accordance with DMRB HD22/08 Managing Geotechnical Risk [66].

9.10.10 Temporary works shall be appropriately designed by the temporary works designer. This will ensure mitigation of potential effects on the geology and geomorphology during construction.

9.10.11 The construction mitigation in relation to agricultural soils is discussed within **People and communities** (Volume 6 Document Ref 6.2 ES Chapter 12).

Contaminated land

9.10.12 The information used to produce the baseline assessment indicates potential areas of contamination may be present across the scheme study area. Intrusive ground investigations and analysis of contaminated land and groundwater have been undertaken to assess risk with respect to ground and groundwater contamination. Mitigation measures can be adopted to limit the impact of these potential risks without further assessment. The following section outlines the design, mitigation and enhancement measures incorporated into the scheme.

9.10.13 Construction activities will be undertaken on site in line with current best practice and guidance and in accordance with the outline Construction Environmental Management Plan (**Outline CEMP** (Volume 6 Document Ref 6.4 ES Appendix 16.1)). On this basis constructional related receptors and sources would be managed to negate their impact on the environment.

9.10.14 As a minimum or outline scope the **Outline CEMP** (Volume 6 Document Ref 6.4 ES Appendix 16.1) includes:

- Dust control measures during the works, wheel washers for offsite movements, construction of appropriate temporary transport networks within the construction area, covering of loads during on site transport.
- Health and safety training, guidance notes and signs and suitable welfare facilities. Promotion of good hygiene practices implemented for the duration of the works with no smoking, eating, or drinking in the locale of excavations in potentially contaminated areas.
- The use of protective clothing and equipment; appropriate Personal Protective Equipment (PPE) provided to all construction workers. The assessment of risks to construction workers and the provision of appropriate mitigation measures including PPE would be the responsibility of the contractor involved in the works.
- An Action Plan for safely dealing with unexpected contamination should be developed. This will include provisions to appoint a suitably qualified and experienced contaminated land practitioner to provide a watching brief and supervisory role should unexpected contamination be encountered. This role shall include assessment of the risks to the construction works and workers. In addition, measures shall be identified to minimise the spread or release of contamination by suitably storing contaminated materials and appropriate waste disposal procedures.
- Management of construction related waters with agreement and permits from the Environment Agency.
- Environmental monitoring throughout the construction period to ensure environmentally sound working practises are being adopted and adhered to.

9.10.15 In addition to the guidance provided in Section 9.10 Design, Mitigation and Enhancement Measures and the management of materials, including handling, re-use and removal from site, should be undertaken in accordance with the Outline Material Management Plan for the scheme, which forms Annex C of the **Outline CEMP** (Volume 6 Document Ref 6.4 ES Appendix 16.1). This will provide a framework via which potentially contaminated soils can be managed safely to limit the risk to identified receptors during both the construction phase and also during the operational lifetime of the scheme.

Operation mitigation

Geology and geomorphology

9.10.16 There are no design, mitigation and enhancement measures considered over and above the engineering design process that is currently being carried and will continue in accordance with DMRB HD22/08 Managing Geotechnical Risk [66]. This includes appropriate geotechnical design of embankments, cuttings, structures and pavements to ensure long term operation of the highway assets.

Soils

9.10.17 There are no design, mitigation and enhancement measures considered over and above the engineering design process that is currently being carried out and will continue in accordance with DMRB HD22/08 Managing Geotechnical Risk [66]. This includes appropriate geotechnical design of embankments, cuttings, structures and pavements to ensure long term operation of the highway assets.

9.10.18 The operation mitigation in relation to agricultural soils is discussed within **People and communities** (Volume 6 Document Ref 6.2 ES Chapter 12).

Contaminated Land

9.10.19 It is considered that the scheme will include measures to limit the risk to identified receptors during the operation since the design is being undertaken in line with current best practice, guidance and legislation.

9.10.20 The use of the CEMP and MMP throughout the construction process will prevent contamination being introduced into the environment and will prevent existing contamination being mobilised or pathways to contamination being present during operation.

9.10.21 Re-use of site won materials will be undertaken in line with a suitable earthworks specification which will include acceptability limits in relation to contaminant concentrations protective of human health and the wider environment.

9.10.22 It is assumed that operational maintenance of the scheme would be undertaken in accordance with best practice guidance and legislation and therefore the risk to maintenance workers would be reduced to an acceptable level or negated. Where necessary, remedial action will be undertaken to remove unacceptable risks.

Enhancement

9.10.23 There are no opportunities for enhancement with respect to geology and soils.

9.11 Assessment of effects – construction

9.11.1 This section presents the assessment of potential effects resulting from and during construction of the scheme on the geology and geomorphology, soils and land contamination. The potential effects of construction work on agricultural soils has been considered as part of **People and communities** (Volume 6 Document Ref 6.2 ES Chapter 12) of the Environmental Statement. The assessment of the effects on water resources, hydrogeology and flooding are considered in **Road drainage and water environment** (Volume 6 Document Ref 6.2 ES Chapter 13).

Geology and geomorphology

Assessment of potential impact of construction of embankments

9.11.2 The construction of embankments is unlikely to result in significant consolidation of the soils due to the applied load of the embankment materials. Some insignificant consolidation may occur in the upper layers of the weathered bedrock, near the surface, particularly where it consists of cohesive materials, or in localised areas of alluvium associated with the watercourses or made ground. The effect of this consolidation is considered to be negligible. Any soft materials prone to consolidation that are encountered during construction works would be removed and replaced with competent materials to prevent differential settlements. These deposits are of little local geological/geomorphological interest, therefore their sensitivity is very low and the magnitude of impact is negligible, hence the significance of effect is considered **Neutral**.

9.11.3 There are no geologically protected sites within the scheme study area, therefore construction of embankments will not impact any geologically designated sites and hence the significance of effect is considered **Neutral**.

9.11.4 The construction of embankments over areas of steeply sloping ground, such as the area of potential shallow instability between Ch 13+650 and Ch 13+850 (see **Topography and Geomorphology** (Volume 6 Document Ref 6.3 ES Figure 9.1)), is unlikely to result in shallow instability or more deep-seated failures. The design of geotechnical works will be carried out in accordance with the HD22/08 [7] workflow, Eurocode 7 [59] and relevant British Standards guidance documents, which will ensure global stability through design and implementation of mitigation measures. These deposits are of little local geological/geomorphological interest, therefore their sensitivity is very low and the magnitude of impact is negligible, hence the significance of effect is considered **Neutral**.

9.11.5 The construction of embankments over areas that may have been previously mined has the potential to accelerate the natural rate of subsidence/collapse of shallow underground mine workings. Embankments would be constructed over or within the vicinity of the mining features listed in Table 9-4. The risk level posed by these mining features has been initially derived through a mining assessment carried out by Cornwall Consultants [54]. This assessment has subsequently been reassessed based on the findings of the geophysical investigations carried out by TerraDat in May 2018 [32]. The results of this assessment and a short description of the reassessed mining hazard have been summarised within Table 9-3.

9.11.6 The significance of effect associated with these mining features has been assessed using the desk study information and the data obtained from geophysical investigations (see Table 9-3). This assessment assumes that mitigation measures will be implemented in accordance with the requirements of HD22/08 Managing Geotechnical Risk [66].

9.11.7 Remediation and stabilisation of mine workings and entrances has the potential to impact the chemistry, turbidity and flow of groundwater and surface water. The significance of the effect cannot be determined without a clear understanding of the potential mine working/entrance stabilisation measures. Depending on the stabilisation measures a more detailed assessment, such as a Hydrogeological Risk Assessment may also be required. The need for a detailed assessment will be determined following any further intrusive investigations. At this stage the significance of effect associated with the mining hazard is conservative and will be updated once further information is available.

Table 9-3 Summary of mining features affected by embankment construction

Embankment	Chainage (m)	Mining feature	Reassessed hazard description based on results of TerraDat 2018 geophysical investigations	Sensitivity	Magnitude of impact	Significance of effect
Chiverton Embankment	1+150 to 1+320	Potential prospective workings associated with surface outcrop of unnamed lode	Confirmation of mineral lode traversing the scheme, however no clear evidence of mine entrances or shallow mine workings. Mineral lode identified to be 35m south of mapped zone, therefore potential for loose backfilled materials and/or voided workings in areas not surveyed.	Medium	Moderate	**Moderate adverse**
	1+820 to 1+890	Backfilled quarry	No clear evidence of quarry in geophysics	N/A	No change	**Neutral**
Journey's End Embankment	12+030 to 12+160	Potential prospective working of the surface outcrop of an unnamed lode	Confirmation of mineral lode/ fault zone traversing the scheme approximately 20m to west of mapped location. Possible worked/disturbed ground associated with linear anomalies.	Medium	Moderate	**Moderate adverse**
	12+080	Shaft associated with Wheal Ennis – toe of embankment	Confirmation of northern shaft location and below ground void. Condition of shaft and backfill unknown. It is likely that the shaft is loosely backfilled and uncapped	Medium	Moderate	**Moderate adverse**
		Suspected adit associated with Wheal Ennis	No evidence of below ground adit within the scope of geophysics (12m bgl). Potential for adit to be at depths more than 12m below ground level.	Medium	Moderate	**Moderate adverse**
	12+060	Shaft associated with Wheal Ennis – 40m to south of embankment	Confirmation of the absence of a shaft to the south	N/A	No change	**Neutral**

9.11.8 The scheme alignment is underlain by a regionally important resource of interbedded sandstone and shale/slate. The construction of embankments would eliminate access to the deposits within the scheme footprint and in its direct vicinity. However, considering the limited extent of the impacted area, access to the vast majority of these resources will not be affected. Additionally, there are no Mineral Safeguarding Areas within the study area. This demonstrates that no mineral resource in the area will be sterilised by the scheme and the significance would be **Slight Adverse**.

9.11.9 Construction of embankments is unlikely to result in a reduction in the permeability of the ground relative to the expected natural permeability, and therefore little impact on the groundwater recharge and movement is anticipated. The groundwater has a medium sensitivity, however the magnitude of impact is considered to be minor, resulting in a **Slight Adverse** significance of effect.

9.11.10 The scheme alignment generally traverses a boundary between two watersheds. Several springs emerge along the flanks of this watershed boundary, flowing to the north and south. An assessment of potential impact of the affected embankments on the identified springs and headwater streams is presented in **Road drainage and water environment** (Volume 6 Document Ref 6.2 ES Chapter 13).

Assessment of potential impact of construction of cuttings

9.11.11 The construction of cuttings would result in the excavation of weathered bedrock, becoming gradually less weathered with depth. The locations and depths of the proposed new exposures are shown on Volume 6 Document Ref 6.3 ES Figure 9-8 and the strata affected for each cutting is summarised in Table 9-4.

Table 9-4 Summary of the bedrock geology to be exposed in cuttings

Strata	Chainage (m)		Cutting name affected
	From	To	
Porthtowan Formation	0+000	8+810	• Chiverton Cutting (0+600 to 0+950) • Four Burrows Earthworks 1 (2+850 to 3+100) • Hillview Cutting (5+100 to 5+850) • Nanteague Cutting (6+450 to 6+650 • Marazanvose Cutting (6+900 to 7+250) • Two Barrows Cutting (7+500 to 7+850) • Tolgroggan Earthworks (8+400 to 8+750)
Grampound Formation	8+810	13+720	• Zelah Earthworks 1 (8+950 to 9+200) • Zelah Earthworks 3 (9+400 to 9+500) • Trevalso Crossing (10+150 to 10+300) • Penglaze Cutting (11+400 to 11+600) • Quarry Retaining Wall (12+600 to 12+950)
Trendrean Mudstone	13+720	14+490	• Carland Cross Earthworks 3 (13+850 to 14+300)

9.11.12 There are no statutory or non-statutory geologically designated sites within the scheme study area, therefore construction of cuttings will have no impact on any geologically designated sites and the significance of effect is considered to be **Neutral**.

9.11.13 The scheme alignment is underlain by a regionally important resource of interbedded sandstone and shale/slate. The construction of cuttings would eliminate access to the deposits within the scheme footprint and in its direct vicinity. However, considering the limited extent of the impacted area, access to the vast majority of these resources will not be affected. Additionally, there are no Mineral Safeguarding Areas within the study area.

9.11.14 The sensitivity of the impacted mineral resources is considered to be medium due to their regional importance with some potential for replacement. The magnitude of impact is considered to be minor. This is because although the scheme may result in the partial loss of these resources of regional importance, the loss is not considered significant considering the extent of the potential resource. Consequently, the significance of effect of the construction of the cuttings on the mineral resources is considered to be **Slight Adverse**.

9.11.15 The construction of cuttings over areas that may have been previously mined has the potential to intersect mine workings/entrances and accelerate the natural rate of subsidence/collapse of shallow underground mine workings. Cuttings would be constructed over or within the vicinity of the mining features listed in Table 9-5.

9.11.16 The risk level posed by these mining features has been initially derived through a mining assessment carried out by Cornwall Consultants [54]. This assessment has subsequently been reassessed based on the findings of the geophysical investigations carried out by TerraDat in May 2018 [32]. The results of this assessment and a short description of the reassessed mining hazard have been summarised within Table 9-5. The significance of effect associated with these mining features has been assessed using the desk study information and the data obtained from geophysical investigations (see Table 9-5). This assessment assumes that mitigation measures will be implemented in accordance with the requirements of HD22/08 Managing Geotechnical Risk [66]. Mitigation measures might include capping of shafts and grouting of voids, but at this stage it is difficult to indicate the exact mitigation requirements. Further intrusive investigation is required to confirm the characteristics of anomalies.

9.11.17 Remediation and stabilisation of mine workings and entrances has the potential to impact the chemistry, turbidity and flow of groundwater and surface water. The significance of the effect cannot be determined without a clear understanding of the potential mine working/entrance stabilisation measures. Depending on the stabilisation measures a more detailed assessment, such as a Quantitative Groundwater Risk Assessment may also be required. The need for a detailed assessment will be determined following any further intrusive investigations. At this stage the significance of effect associated with the mining hazard is conservative and will be updated once further information is available.

Table 9-5 Summary of mining features affected by cutting construction

Cutting	Chainage (m)	Mining feature	Reassessed hazard description based on results of TerraDat 2018 geophysical investigations	Sensitivity	Magnitude of impact	Significance of effect
Nanteague Cutting	6+380 to 6+430	Potential prospective working of the surface outcrop of the Great South Chiverton lode and two possible shafts associated with the Great South Chiverton mine	Evidence of mineral lode and fault traversing the scheme along the approximate mapped location. No clear evidence of mine entrances or shallow mine workings, however the quality of the survey was impacted by surface features. Possible worked/disturbed ground associated with linear anomaly.	Medium	Moderate	**Moderate adverse**
Tolgroggan cutting and side road	8+150 to 8+250	Potential prospective working of the possible mineralisation along north-south trending fault	Evidence of fault zone traversing the scheme, possibly orientated north-south as opposed to the mapped north-west to south-east orientation. Possible worked/disturbed ground associated a magnetic feature.	Medium	Moderate	**Moderate adverse**
Trevalso Farm underpass cutting (north)	9+650 to 9+700 (side road north of A30)	Potential prospective working of the unnamed lode	Geophysical investigations were not carried out here. Potential for loose backfilled materials and/or voided workings associated with prospective unrecorded workings along surface outcrop of lode.	Medium	Moderate	**Moderate adverse**
Quarry Retaining Wall	12+650 to 12+780	Potential for loose backfilled materials within quarry and potential for adit workings from quarry face	Geophysical investigations were not carried out here. Observation of quarry face confirms the absence of adits coming from quarry face.	N/A	No change	**Neutral**
Carland Cross cutting	13+950 to 14+120	Backfilled quarry within cutting face	Confirmation of the presence of backfilled quarries. Some features need further confirmation/ground truthing.	Medium	Moderate	**Moderate adverse**

9.11.18 Where groundwater control measures are required to control the ingress of groundwater (e.g. Quarry Retaining Wall) the groundwater level may be affected. This may result in lowering of the groundwater level in proximity of the works. An assessment of potential impact of the affected cuttings on the identified surface water features and groundwater as a resource is presented in **Road drainage and water environment** (Volume 6 Document Ref 6.2 ES Chapter 13).

Assessment of potential impact of construction of structures

9.11.19 The construction of the structures such culverts or underpasses will be undertaken as part of the embankment construction and therefore will have no additional impact on the underlying geology.

9.11.20 The construction of the attenuation ponds will require shallow excavations and removal of the topsoil, superficial deposits (if present) and weathered bedrock. It is unlikely that the construction of ponds will involve the removal of the regionally important mineral resource (sandstone bedrock). This regionally important resource would have a medium sensitivity, however considering the localised nature of these works and the extent of the proposed ponds, the magnitude of impact is considered negligible and the significance of effect **Slight Adverse**.

9.11.21 The construction of the structures will require construction of the foundations. Considering the underlying ground conditions these structures are likely to require shallow foundations and therefore only localised excavations will be required. There are no geologically protected sites within the scheme study area, therefore construction of structures will not impact on any geologically designated sites. The construction of structures would eliminate access to the regionally important mineral resource beneath the scheme alignment. However, the impacted areas are limited and there are no Mineral Safeguarding Areas. There are also no structures that would be constructed over areas that may have been mined. Consequently, the regionally important resource would have a medium sensitivity and the magnitude of impact would be negligible. Therefore, the significance of effect of the construction of the structures on the geology and geomorphology and mineral resources is considered **Slight Adverse**.

Soils

9.11.22 The potential effects of construction works on agricultural soils has been considered as part of **People and communities** (Volume 6 Document Ref 6.2 ES Chapter 12) and **Material assets and waste** (Volume 6 Document Ref 6.2 ES Chapter 10), of this ES.

Land contamination

9.11.23 The construction of the scheme will introduce new receptors to potential contamination arising from the possible sources as identified in the baseline Conceptual Site Model presented in **Baseline conditions** (Volume 6 Document Ref 6.4 ES Appendix 9.4)

9.11.24 The review of the identified potential sources, receptors, and pathways and the plausible pollution linkages, as detailed in Table 9-6 to Table 9-9, allows for the assessment of the likely impacts of land contamination on the existing baseline conditions during the construction phase.

9.11.25 In addition to those sources identified during the baseline assessment and detailed in **Baseline conditions** (Volume 6 Document Ref 6.4 ES Appendix 9.4) the following sources of contamination would be present as a result of construction activities:

Table 9-6 Construction phase additional potential sources of contamination.

Potential Source	Potential Contaminants
On site	
Areas of unexpected/unknown contamination along the scheme.	Metals, hydrocarbons, asbestos, herbicides in soils and groundwater, ground gas
Site won or off site derived fill materials used in the scheme.	Metals, hydrocarbons, asbestos, ground gas.
Dust generated during construction from areas of made ground, mining waste, other contamination (unexpected/unknown)	Metals, hydrocarbons, asbestos.
Contaminated groundwater encountered during groundworks.	Heavy metals, hydrocarbons.
Mine workings treatment	Grout, mobilisation of possible heavy metals.

9.11.26 In addition to those receptors identified during the baseline assessment and detailed in **Baseline conditions** (Volume 6 Document Ref 6.4 ES Appendix 9.4) the following receptors would be introduced during the construction phase:

Table 9-7 Construction phase potential receptors.

Receptors	Discussion
Human:	
Construction workers 16 years of age upwards.	Short term duration for exposure during proposed works.

9.11.27 In addition to the pathways outlined during the baseline assessment and detailed in **Baseline conditions** (Volume 6 Document Ref 6.4 ES Appendix 9.4) the following additional pathways would be introduced during the construction phase.

Table 9-8 Construction phase additional potential pathways.

Pathway	Discussion
Human Health:	
Ingestion of soil and dust	Direct contact between construction workers and exposed soils and possibly groundwater on the scheme. Mobilisation of dust from soils on the scheme
Inhalation of soil dust	
Inhalation of gases and volatile organic contamination	
Dermal contact with soils and dust.	
Controlled Waters:	
Mobilisation of contaminants during the works.	Construction activities have the ability to introduce additional pathways between groundwater and surface water features via excavations, pumping etc. Pumping to ground or other receptor
Direct/indirect discharge	

Pathway	Discussion
Increased leachate generation.	Greater exposure of soils in excavations and earthworks to rainwater infiltration leading to increase leaching of potential contaminants.

9.11.28 Review of the likely pathway linkages during the construction phase indicates a change from the baseline scenario whereby nearby residents and workers, and recreational users of the study site may be impacted by dermal, inhalation and ingestion pathways via dust generated from the scheme. Assessment of dust generation impact is covered in **Air quality** (Volume 6 Document Ref 6.2 ES Chapter 5). However, the assessment of potential impact of potentially contaminated dust on humans is provided in this Chapter.

9.11.29 With regard to the other baseline source pathway receptor scenarios identified for nearby residents and workers, and recreational users it is not considered that the construction phase significantly alters these. For the same reasons as provided in the baseline assessment the pathways between potential sources and the receptors are not considered plausible and as such the source-pathway-receptor linkage is not present. the **Outline CEMP** (Volume 6 Document Ref 6.4 ES Appendix 16.1) will be employed as a control.

9.11.30 Review of the possible impact on maintenance workers indicates little change from the baseline scenario as a result of the construction phase. A plausible pollutant linkage still exists between maintenance workers and potential sources in relation to existing highways.

9.11.31 Similarly, it is not considered that the construction phase will result in a change in the pollution linkage for the existing users of the A30, or other highways in the scheme study area.

9.11.32 The construction phase does introduce a new potential pollutant linkage between construction workers and existing sources identified in the baseline scenario. In addition, the construction phase introduces new sources and pathways via which construction workers may be impacted.

9.11.33 The construction phase also introduces new sources and pathways in which Controlled waters may be impacted by construction phase activities.

9.11.34 On the basis of the above discussion, Table 9-9 presents the plausible pollutant linkages present during the construction phase for the scheme.

Table 9-9 Construction Source-Pathway-Receptor Linkages.

Sources	Pathways	Receptors	Comments
On Site **Made ground:** Existing road infrastructure Made ground identified during previous ground investigations **Historic Mining and Quarries** Mine waste used to fill/level areas. Backfilled mine workings with mine wastes (possible surface workings along lodes) Back filled quarries – unknown backfill with potential contamination. **Current or historic activities** Possible contamination associated with operation of A30 and other highways crossing the scheme alignment. Land use – filling stations, electrical distribution network, agriculture, oil and gas pipelines. Previous pollution incidents (recorded and un-recorded). ***Construction Phase:*** *Unexpected Contamination* *Site won or Imported soils* *Dust from exposed soils* *Contaminated Groundwater encountered during the works* *Mine workings treatment* **Off Site** **Made ground:** Possible made ground associated with the existing road infrastructure crossing the scheme alignment.	**Human Health** Ingestion of soil and dust Inhalation of soil and dust Inhalation of gasses and volatile organic contamination Dermal contact with soils, dust.	**Human Health** Maintenance workers on highways or other land that crosses the scheme alignment. ***Construction Phase:*** *Nearby residents and workers* *Construction workers*	**Human Health** Made ground, mining waste or backfilled workings, and potential current contaminative processes are considered likely to be present in locations in the study site. Maintenance workers on existing highways may be directly exposed to potential contaminated made ground. *Nearby residents and workers may be impacted by dermal, ingestion and inhalation routes via dust generated during the construction works.* *Construction workers involved in the scheme may come into direct contact with contaminated soils and made ground along the scheme. Significant levels of contamination are not expected based on the baseline information; however, there is a possibility of encountering unexpected contamination along the scheme. Similarly, they may be impacted by contact with contaminated groundwater in excavations or cuttings.*
	Controlled Waters Leaching of contaminants, vertical and horizontal migration within the subsurface.	**Controlled Waters** Groundwater beneath the scheme alignment (Secondary A Aquifers) Surface water features	**Controlled Waters** Migration of contaminants from spills or leaks or via leaching of soil based contamination is considered plausible.

Sources	Pathways	Receptors	Comments
Possible made ground associated with private developments, farm land. **Historic Mining and Quarries** Mine waste used to fill/level areas. Backfilled mine workings with mine wastes (possible surface workings along lodes) Back filled quarries – unknown backfill with potential contamination **Current or historic activities** Possible contamination associated with operation of A30 and other highways crossing the scheme alignment. Land use – filling stations, smithy's, electrical distribution network, horticulture, agriculture. Previous pollution incidents (recorded and un-recorded). Soakaway drainage as possible contamination pathways.	Direct discharge into surface waters via run off or from groundwater seepage/springs	Water Abstractions	Surface water features are present within the scheme, direct discharge of contamination possible as is indirect migration of contamination. Source protection zones related to abstractions exist beneath the scheme. These are considered likely to be impacted by any contamination present. *Direct release of construction related contaminants (fuels etc) into the groundwater is considered possible. It is considered that this will be assessed in* ***Road drainage and water environment.*** *(Volume 6 Document Ref 6.2 ES Chapter 13)* *Increased surface water run-off from potentially contaminated soils and impact on surface water receptors. It is considered that this will be assessed in* ***Road drainage and water environment.*** *(Volume 6 Document Ref 6.2 ES Chapter 13)* *Mobilisation of contamination as a result of excavations and directly discharged into ground or surface water features as part of dewatering, mine works treatment.* *Introduction of grout in mine works treatment.*

Potential impact of existing contaminated land on nearby residents and workers

9.11.35 It is considered that during the construction works, nearby residents and workers may be exposed to contaminated dust. The following pathways are considered to be plausible:

- Dermal contact with contaminated dust;
- Ingestion of contaminated dust;
- Inhalation of contaminated dust.

9.11.36 On the basis of the above it is considered that exposure would be to dust indoors and outdoors, the most sensitive receptor would be a young female present in a residential property exposure to dust generated. On this basis screening against criteria for Residential with plant uptake used previously under the baseline assessment is likely to be most appropriate to assess the risk. This identified that in general levels of contamination were below the applied screening criteria with the exception of isolated exceedances of arsenic and lead, and a single location with elevated levels of PAHs, present in made ground and topsoil.

9.11.37 In the absence of mitigation measures, there would be a risk to nearby residents and workers from dust generated during the construction works. The most sensitive receptor would be a female resident; on this basis the sensitivity of the receptor would be high. However, adoption of the mitigation measures (see **Outline CEMP** (Volume 6 Document Ref 6.4 ES Appendix 16.1)) described within Section 9.10 would limit the generation of dust, and as such it is considered that the impact would be that there would be no change from the baseline scenario. On this basis, the effect of construction generated dust on the identified receptor is considered to be **Neutral.**

Potential impact of existing contaminated land on construction workers

9.11.38 It is considered that during the construction works, construction workers are likely to come into direct contact with site soils and possible perched or shallow groundwater in the areas of the identified sources. The exposure period for these receptors is considered to be short term (acute) on the basis they would only be exposed during the construction phase, and only whilst works were being undertaken in areas identified as potential sources. The following pathways are considered likely to be plausible during the construction works:

- Dermal contact with contaminated soils, surface water and shallow groundwater;
- Ingestion of contaminated soils and dust, surface water and shallow groundwater;
- Inhalation of vapours and gases from soils or groundwater;
- Inhalation of dust from soils.

9.11.39 Published generic screening criteria for the assessment of human health impacts from contaminated land are based on long term (chronic) exposure models and are therefore not suitable for the assessment of short term (acute) scenarios. Nevertheless, the use of screening criteria for residential with plant uptake is considered to provide a suitably conservative approach in the absence of specific acute scenario screening criteria.

9.11.40 Review of the existing soils contamination testing presented as part of the baseline assessment indicates in general levels of contaminants in the sampled

made ground and natural soils are below conservative screening criteria for protection of human health. Exceedances were noted within samples of made ground for arsenic and lead, and arsenic in samples of topsoil. Single exceedances of benzo(a)pyrene and dibenzo(ah)anthracene were noted within TP-219. On the basis of the chemical testing undertaken to date is considered that the soils across the scheme have a generally low potential for contamination, however it is considered there is a risk of isolated areas of contaminated soils existing across the scheme.

9.11.41 The results of leachate analysis and groundwater sampling undertaken to date indicates a potential for the groundwater to be impacted by heavy metals. Leachable levels of PAHs above the MRVs were found during the Phase 1 investigations, however these exceedances were minimal. Some isolated TPH exceedances were recorded during the Phase 2 groundwater sampling.

9.11.42 On the basis of the chemical analysis undertaken throughout the scheme to date it is considered that in the absence of mitigation there is a risk to construction workers during the development from soil and groundwater contamination. It is considered that the most sensitive receptor would be a working age female construction worker, but that exposure would be over a short duration and on this basis the sensitivity of the receptor has been assessed as low. Adoption of the mitigation measures detailed in the **Outline CEMP** (Volume 6 Document Ref 6.4 ES Appendix 16.1) and MMP will provide sufficient mitigation to reduce the impact on the receptor an acceptable level. On this basis, the construction workers are considered to be a low sensitivity receptor assuming the adoption of mitigation measures such as PPE. However, the works would have negligible impact and therefore the significance of effect is considered to be **Neutral.**

Potential impact of unexpected contamination on construction workers

9.11.43 Considering the past mining history of the study area and scheme there is a potential risk of encountering areas of unexpected contamination (outside of that identified on the basis of the baseline results) during the construction works.

9.11.44 In relation to the assessment of impact of unexpected contamination on construction workers (human health) it is considered that the most sensitive receptor would be a working age female construction worker, but that exposure would be over a short duration and on this basis the sensitivity of the receptor has been assessed as medium. Adoption of an Action Plan described within Section 9.10, if and when unexpected contamination is encountered will provide sufficient mitigation to reduce the impact on the receptor an acceptable level. On this basis, the construction workers are considered to be a medium sensitivity receptor, however the works would have a negligible impact and therefore the impact significance is considered to be **Slight Adverse.**

Potential impact of existing contaminated land on groundwater and surface water quality

9.11.45 It is considered that the construction of the scheme will have the potential to disturb soils and potentially groundwater, which may increase the mobility of any contamination present within the site soils. Site works may introduce preferential pathways for contamination to migrate within the subsurface (e.g. service and drainage corridors, grouting of mine workings etc).

9.11.46 The potential receptors to this contamination are detailed in **Baseline conditions** (Volume 6 Document Ref 6.4 ES Appendix 9.4) and summarised below:

- Groundwater in the Secondary A Aquifer underlying the scheme.
- Surface water features near or passing beneath the scheme as detailed in **Baseline conditions** (Volume 6 Document Ref 6.4 ES Appendix 9.4).

9.11.47 The sensitivity of the groundwater is considered to be high since although it has been classified as a Secondary A two active source protection zones are present in the study site and under the scheme.

9.11.48 The sensitivity of the River Kenwyn is considered to be high given the WFD classification of Good.

9.11.49 The sensitivity of the Zelah Brook is considered to be high given the WFD classification of Good.

9.11.50 The sensitivity of the Upper River Allen is considered to medium given the WFD classification of moderate.

9.11.51 The review of baseline conditions has indicated the presence of leachable levels of heavy metals and PAHs across the scheme, and TPH in some isolated areas. However, in general limited contamination has been observed in the soil samples. Groundwater sampling and analysis during the Phase 2 investigations indicated elevated levels of metals across the site, and TPHs and PAHs in some isolated areas.

9.11.52 The construction activities have the potential to increase mobility of potential contamination by introducing additional pathways, and also introducing additional sources. However, the impact arising from construction activities is likely to be temporary, the anticipated level of contamination it is considered to be relatively low. In addition, the implementation of design mitigation and best practise during construction described within Section 9.10 means that the impact would likely be negligible on the both the groundwater and surface waters. On this basis, the significance of effect on the groundwater is **Slight Adverse** and the significance of impact on the surface waters is **Slight Adverse.**

Potential Impact of Unexpected Contamination on Controlled Waters

9.11.53 Similarly, to the risk to construction workers there is a risk that encountering unexpected contamination may impact on the underlying groundwater, surface water features, and possibly abstraction points.

9.11.54 The groundwater (and therefore groundwater abstraction points) is considered to be a high sensitivity receptor whilst the surface waters are high to medium sensitivity dependant on the WFD classification.

9.11.55 In order to mitigate the potential effects of encountering unexpected contamination an Action Plan has been formulated and included within the **Outline CEMP** (Volume 6 Document Ref 6.4 ES Appendix 16.1). With the implementation of these mitigation measures the magnitude of impact is considered to be at worst minor in relation to the risk to controlled waters receptors. The impact significance is therefore considered to be **Slight Adverse** for groundwater receptors, and **Slight Adverse** for surface water receptors.

9.12 Assessment of effects – operation

9.12.1 This section presents the assessment of potential effects resulting from operation of the scheme on the geology and geomorphology, soils and land contamination. The potential effects of construction works on agricultural soils has been considered as part of **People and communities** (Volume 6 Document Ref 6.2 ES Chapter 12) of this Environmental Statement. The assessment of the effects on water resources and flooding are considered in **Road drainage and water environment** (Volume 6 Document Ref 6.2 ES Chapter 13).

Geology and geomorphology

Assessment of potential impact of embankments during operation

9.12.2 The scheme alignment is underlain by a regionally important resource of interbedded sandstone and shale/slate. The operation of embankments would eliminate access to the deposits within the scheme footprint and in its direct vicinity. However, considering the limited extent of the impacted area, access to the vast majority of these resources will not be affected. Additionally, there are no Mineral Safeguarding Areas within the study area. This demonstrates that no mineral resource in the area will be sterilised by the scheme. As the impact is considered minor and the regionally important resource considered moderate sensitivity, the significance would be **Slight Adverse**.

9.12.3 During the operational phase, it is unlikely that the embankment would result in any further consolidation of the soils due to the applied load of the embankment materials. Therefore, there is unlikely to be a further significant reduction in the soils permeability and consequent localised changes to the groundwater movement. The sensitivity would be medium, however, the impact would likely have no change. Consequently, the effect of the construction of the earth embankments on the geology is considered to be **Neutral**.

9.12.4 During the operation phase the embankments may have an impact on water flow due to the presence of springs/seepages beneath embankments. Issues associated with drainage and flooding are considered in **Road drainage and water environment** (Volume 6 Document Ref 6.2 ES Chapter 13).

Assessment of potential impact of cuttings during operation

9.12.5 The operation of the cuttings could locally impact hydrological and hydrogeological regime within the scheme area.

9.12.6 Cuttings would result in the formation of new exposures of geological/ geomorphological interest. The new exposures would have a medium sensitivity and the magnitude of the impact would be minor, therefore the significance of effect of operation on the new geological/geomorphological features is considered to be **Slight Beneficial**.

9.12.7 The scheme areas where cuttings would be required would be equipped with drainage, the purpose of which would be to control groundwater level and collect groundwater issues from the slopes formed within the rock. This is likely to impact the groundwater flow direction and levels. An assessment of potential impact of proposed cuttings on the identified surface water features and groundwater abstraction is presented in **Road drainage and water environment** (Volume 6 Document Ref 6.2 ES Chapter 13). The potential hydrological and

hydrogeological impacts on the Newlyn Downs SAC and the Breney Common and Goss and Tregoss Moors SAC has been assessed within the **Statement to Inform the Appropriate Assessment** (Volume 6 Document Ref 6.5).

Assessment of potential impact of operation of structures

9.12.8 The operation of the structures such bridges, culverts and underpasses will have no additional impact on the underlying geology with a **Neutral** significance of effect.

Soils

9.12.9 The assessment of the soils adjacent to the scheme to be affected by spray or air borne pollutants has been assessed within **Air quality** (Volume 6 Document Ref 6.2 ES Chapter 5).

Land contamination

9.12.10 The operation of the scheme will introduce new receptors to potential contamination arising from the possible sources as identified in the Conceptual Site Model presented in **Baseline conditions** (Volume 6 Document Ref 6.4 ES Appendix 9.4).

9.12.11 The review of the identified potential sources, receptors, and pathways and the plausible pollution linkages, as detailed below, allows for the assessment of the likely impacts of land contamination on the existing baseline conditions during the operational phase.

9.12.12 In addition to those sources identified during the baseline assessment and detailed in **Baseline conditions** (Volume 6 Document Ref 6.4 ES Appendix 9.4) the following sources of contamination would be present as a result of operational activities:

Table 9-10 Operational phase potential sources of contamination.

Potential Source	Potential Contaminants
On site	
Imported or site won construction materials	Metals, hydrocarbons, asbestos, herbicides, ground gas

9.12.13 In addition to those receptors identified during the baseline assessment and detailed in **Baseline conditions** (Volume 6 Document Ref 6.4 ES Appendix 9.4) the following receptors would be introduced during the operational phase:

Table 9-11 Operational phase potential receptors.

Receptors	Discussion
Human:	
Maintenance workers on the scheme, retained A30, and other highways crossing the scheme and study area.	Regular and possible long term (albeit intermittent) exposure to the potential contamination sources identified in the previous section.
Users of the scheme, including motorists, cyclists, pedestrians, horse riders etc.	These receptors are considered to be at a low risk due to the transient nature of their likely

Receptors	Discussion
	exposure to the potential contamination sources.

9.12.14 In addition to the pathways outlined during the baseline assessment and as detailed in **Baseline conditions** (Volume 6 Document Ref 6.4 ES Appendix 9.4), the following additional pathways would be introduced during the operational phase.

Table 9-12 Operational phase potential pathways.

Pathway	Discussion
Human Health:	
Ingestion of soil and dust	Direct contact between maintenance workers and imported or site won construction materials. Inhalation of gasses confined in scheme infrastructure. Mobilisation of dust from soils on the scheme
Inhalation of soil dust	
Inhalation of gases and volatile organic contamination	
Dermal contact with soils and dust.	
Controlled Waters:	
Leaching of contaminants, vertical and horizontal migration.	Leaching of contamination introduced into the scheme during construction.

9.12.15 Review of the likely pathways operating during the operational phase indicates a change from the baseline scenario whereby nearby residents and workers, and recreational users of the study site may be impacted by dermal, inhalation and ingestion pathways via dust generated from operational maintenance works on the scheme. However, an assessment of this impact is covered in **Air quality** (Volume 6 Document Ref 6.2 ES Chapter 5) and as such no further assessment on this is provided in this Chapter.

9.12.16 With regards to the other baseline pathway scenarios identified for nearby residents and workers, and recreational users it is not considered that the operational phase significantly alters these. For the same reasons as provided in the baseline assessment (**Baseline conditions** (Volume 6 Document Ref 6.4 ES Appendix 9.4)) the pathways between potential sources and the receptors are not considered to be plausible and as such the source-pathway-receptor linkage is not present.

9.12.17 It is not considered that the operational phase will result in a change in the pollution linkage for the existing users of the A30, or other highways in the Study site. Similarly, it is not considered that the operational phase will result in a new pollution linkage for users of the scheme, for the same reasons as they were not considered to be at risk from the existing baseline conditions.

9.12.18 Review of the possible impact to maintenance workers working on the retained A30 and other nearby highways indicates little change from the baseline scenario as a result of the operational phase. A plausible pollutant linkage still exists between maintenance workers and potential sources in relation to existing highways. However, a new source-pathway-receptor linkage is introduced should the construction of the scheme introduce additional contamination from offsite

sources or re-use contaminated site won material then maintenance workers working on the operational scheme will be exposed during their works. It should be noted that it will be highly unlikely that imported or site won materials will be a source of contamination. This is on the basis of measures being taken to establish acceptable reuse criteria and procedures for the scheme to ensure that suitability of material for reuse can be demonstrated and verified. This approach is in line with the Specification for Highway Works, Series 600.

9.12.19 The operational phase will also introduce new sources and pathways in which Controlled waters may be impacted if contaminated site won or imported materials are used in the construction.

9.12.20 It is assumed that as part of the mitigation measures, site won, or imported materials will be managed by a verification system applied by a suitable earthworks specification. This would include chemical limits to determine whether materials would be acceptable for use as construction materials, meaning any contaminated materials are highly unlikely to be used in construction.

9.12.21 On the basis of the above discussion, Table 9-13 presents the plausible pollutant linkages present during the construction phase for the scheme.

Table 9-13 Operational source-pathway-receptor linkages.

Sources	Pathways	Receptors	Comments
On Site **Made ground:** Existing road infrastructure Made ground identified during previous ground investigations **Historic Mining and Quarries** Mine waste used to fill/level areas. Backfilled mine workings with mine wastes (possible surface workings along lodes) Back filled quarries – unknown backfill with potential contamination. **Current or historic activities** Possible contamination associated with operation of A30 and other highways crossing the scheme alignment. Land use – filling stations, electrical distribution network, agriculture. Previous pollution incidents (recorded and un-recorded). ***Operational Phase:*** *Site won or Imported construction materials* **Off Site** **Made ground:** Possible made ground associated with the existing road infrastructure crossing the scheme alignment. Possible made ground associated with private developments, farm land. **Historic Mining and Quarries** Mine waste used to fill/level areas.	**Human Health** Ingestion of soil and dust Inhalation of soil and dust Inhalation of gasses and volatile organic contamination Dermal contact with soils, dust.	**Human Health** Maintenance workers on highways or other land that crosses the scheme alignment. ***Operational Phase:*** *Maintenance workers on the scheme*	**Human Health** Made ground, mining waste or backfilled workings, and potential current contaminative processes are considered likely to be present in locations in the study site. Maintenance workers on existing highways may be directly exposed to potential contaminated made ground. *Maintenance workers on the scheme may come into direct contact with contaminated soils and made ground along the scheme that remains or from site won or imported materials used in the scheme construction.*
	Controlled Waters Leaching of contaminants, vertical and horizontal migration within the subsurface.	**Controlled Waters** Groundwater beneath the scheme alignment (Secondary A Aquifers) Surface water features Water Abstractions	**Controlled Waters** Migration of contaminants from spills or leaks or via leaching of soil based contamination is considered plausible. Surface water features are present within the scheme, direct discharge of contamination possible as is indirect migration of contamination. Source protection zones related to abstractions exist beneath the scheme. These are considered likely to be impacted by any contamination present.

Sources	Pathways	Receptors	Comments
Backfilled mine workings with mine wastes (possible surface workings along lodes) Back filled quarries – unknown backfill with potential contamination **Current or historic activities** Possible contamination associated with operation of A30 and other highways crossing the scheme alignment. Land use – filling stations, smithy's, electrical distribution network, horticulture, agriculture. Previous pollution incidents (recorded and un-recorded). Soakaway drainage as possible contamination pathways.			*Introduction of contaminated fill materials and potential leaching impact on underlying groundwater, nearby surface water features and abstraction points.*

Potential impact of existing contaminated land on maintenance workers

9.12.22 Table 9-13 indicates that in the operational phase there is a risk that maintenance workers on the scheme are likely to come into dermal contact with potentially contaminated site soils and possibly shallow groundwater. However, review of the baseline assessment indicated that the current investigations show generally low levels of soil contamination across the scheme. Using conservative screening criteria (residential with plant uptake) it was shown that the current conditions on site are unlikely to present a risk to human health in relation to current maintenance workers, and by extension to new maintenance workers involved in the scheme.

9.12.23 It is considered that the most sensitive receptor in terms of maintenance workers would be a working age female, involved in maintenance of the scheme for a working life. The sensitivity of the maintenance worker receptor would likely be high, however based the provision of appropriate health and safety management and on the investigation findings to date the impact would be classified as no change and thus the significance would be classified as ***Neutral*.**

Potential impact of construction materials on maintenance workers

9.12.24 A risk has been identified whereby contaminated site won materials may be used in the scheme, or that contaminated imported materials from offsite sources may be introduced into the scheme. This is highly unlikely as imported materials are required to comply with an earthworks specification, however, maintenance workers might be exposed to these materials during their works on the scheme and therefore in the absence of mitigation measures a source-pathway-receptor linkage may be present. However, for the reasons stated in paragraph 9.12.22 above, the existing soils across the scheme that may be re-used as fill are not considered to present a risk to human health in relation to Maintenance Workers on the basis of the chemical analysis undertaken to inform the baseline assessment. In addition, mitigation measures (as detailed in the **Outline CEMP** (Volume 6 Document Ref 6.4 ES Appendix 16.1)) will be implemented in line with the details presented in Section 9.10 in relation to encountering unexpected contamination (differing from the baseline) and also it is assumed that as part of the mitigation measures, site won, or imported materials will be managed by a verification system applied by a suitable earthworks specification. This would include chemical limits to determine whether materials would be acceptable for use as construction materials.

9.12.25 On this basis despite the maintenance worker representing a high sensitivity receptor, the impact of construction materials would be no change and as such the significance of this effect would be **Neutral.**

Potential Impact of Construction Materials on Controlled Waters

9.12.26 Review of the operational phase has indicated that in the absence of mitigation measures a risk to controlled waters may exist from re-use of contaminated site won materials or the import of contaminated materials curing the construction phase. Contaminants may leach from materials and migrate vertically and horizontally, impacting groundwater, surface waters and abstraction points.

9.12.27 However, it is assumed that as part of the mitigation measures, site won, or imported materials will be managed by a verification system applied by a suitable

earthworks specification. This would include chemical limits to determine whether materials would be acceptable for use as construction materials.

9.12.28 On this basis despite the groundwater being classified as a medium sensitivity receptor, and particular surface water features being classified as a high sensitivity receptor, the impact of construction materials would be no change and as such the significance of this effect would be **Neutral.**

9.13 Monitoring

9.13.1 This section provides a description of monitoring to inform the mitigation for any likely significant adverse residual effects.

9.13.2 The majority of the residual effects of the scheme on the geology and soils have all been assessed as **Slight Beneficial** to **Slight Adverse**, except for the effects associated with mining features. Therefore, for most of the potential effects this section of the assessment is not relevant and no monitoring has been proposed as mitigation.

9.13.3 The worst case residual effect of the scheme on potential shallow mine workings and entrances has been assessed as **Moderate** Adverse. This assessment is based on an assessment of the hazard informed by desk based information and non-intrusive surface geophysical surveys. Further ground investigation has been proposed to further inform the assessment and the design of any potential mitigation measures. This does not currently include any monitoring, however monitoring of possible remedial/stabilisation measures may be required if the further investigation confirms the presence of shallow mine workings and entrances beneath the scheme alignment.

9.13.4 Groundwater monitoring installations constructed as part of the Phase 1 and Phase 2 ground investigations will continue to be monitored until the construction phase. This will continue to provide accurate information on the groundwater levels.

9.13.5 Surface water level monitoring of the quarry pond at approximate Ch 12+750 will continue for the next 12 months and will provide information on the hydraulic connectivity to the adjacent proposed cutting groundwater levels. This will be supplemented by rainfall monitoring at the location of the quarry pond and at Tolgroggan Bridge.

9.14 Summary

9.14.1 A summary of the assessment of geology and soils is presented within Table 9-14 below.

Table 9-14 Summary of assessment of geology and soils

With scheme									
Item	**Description of potential impact**	**Embedded design, mitigation and enhancement measures**	**Sensitivity /value of receptor**	**Duration of impact**	**Magnitude of potential impact**	**Significance of potential impact**	**Additional mitigation**	**Residual magnitude of potential impact**	**Residual significance of potential impact**
Assessment of effects due to construction									
1	Consolidation of soils due to the applied load of embankment materials	Stage 0 to 3 design development	Very low	Long term	Negligible	**Neutral**	Earthworks construction mitigation, e.g. removal soft soils	Negligible	**Neutral**
2	Damage to geologically protected sites	None	Medium	Long term	No change	**Neutral**	None	N/A	**Neutral**
3	Instability of steeply sloping ground due to construction of embankments	Stage 0 to 3 design development	Very low	Long term	Negligible	**Neutral**	None	Negligible	**Neutral**
4a	Subsidence/collapse of shallow underground mine workings due to construction of Chiverton Embankment (Ch1+150 to 1+320)	Stage 0 to 3 design development	Medium	Short term initial impact, but could occur repeatedly over long term	Moderate	**Moderate adverse**	Consider refined mining hazard during geotechnical design. Further gravity surveys over features F1.8 and largest feature of F1.2, Possible intrusive ground investigation depending on the results gravity survey	Moderate	**Moderate adverse**
4b	Subsidence/collapse of shallow underground mine workings due to	Stage 0 to 3 design development	N/A	N/A	No change	**Neutral**	None	None	**Neutral**

With scheme									
Item	**Description of potential impact**	**Embedded design, mitigation and enhancement measures**	**Sensitivity /value of receptor**	**Duration of impact**	**Magnitude of potential impact**	**Significance of potential impact**	**Additional mitigation**	**Residual magnitude of potential impact**	**Residual significance of potential impact**
	construction of Chiverton Embankment (Ch1+820 to 1+890)								
4c	Subsidence/collapse of shallow underground mine workings due to construction of Journey's End Embankment (Ch12+030 to 12+160)	Stage 0 to 3 design development	Medium	Short term initial impact, but could occur repeatedly over long term	Moderate	**Moderate adverse**	Consider refined mining hazard during geotechnical design. Further intrusive investigation of F1.2, F1.3, F1,4a to F1.4d and F1.5.	Moderate	**Moderate adverse**
4d	Subsidence/collapse of shallow underground mine workings due to construction of Nanteague Cutting (Ch6+380 to 6+430)	Stage 0 to 3 design development	Medium	Short term initial impact, but could occur repeatedly over long term	Moderate	**Moderate adverse**	Consider refined mining hazard during geotechnical design. Further intrusive investigation of F1.2. Further gravity profile approximately 60m to the north to further delineate the gravity anomaly.	Moderate	**Moderate adverse**
4e	Subsidence/collapse of shallow underground mine workings due to construction of Tolgroggan cutting and side road (Ch8+150 to 8+250)	Stage 0 to 3 design development	Medium	Short term initial impact, but could occur repeatedly over long term	Moderate	**Moderate adverse**	Consider refined mining hazard during geotechnical design. Further gravity survey over feature F1.2.	Moderate	**Moderate adverse**
4f	Subsidence/collapse of shallow underground mine workings due to	Stage 0 to 3 design development	N/A	N/A	No change	**Neutral**	None	None	**Neutral**

With scheme									
Item	**Description of potential impact**	**Embedded design, mitigation and enhancement measures**	**Sensitivity /value of receptor**	**Duration of impact**	**Magnitude of potential impact**	**Significance of potential impact**	**Additional mitigation**	**Residual magnitude of potential impact**	**Residual significance of potential impact**
	construction of Quarry Retaining Wall (Ch12+650 to 12+780)								
4g	Subsidence/collapse of shallow underground mine workings due to construction of Carland Crossing Cutting (Ch13+950 to 14+120)	Stage 0 to 3 design development	Medium	Short term initial impact, but could occur repeatedly over long term	Moderate	**Moderate adverse**	Consider refined mining hazard during geotechnical design.	Moderate	**Moderate adverse**
5	Removal or limit access to resource within a Mining Safeguarding Area	None	High	Long term	No change	**Neutral**	None	N/A	**Neutral**
6	Removal or limit access to regionally important resource	None	Medium	Long term	Minor	**Slight adverse**	None	Minor	**Slight adverse**
7	Reduction in permeability of the ground	Stage 0 to 3 design development	Medium	Long term	Negligible	**Neutral**	None	Negligible	**Neutral**
8	Flow of springs, seepages and headwater stream	Assessed within **Road drainage and water environment** (Volume 6 Document Ref 6.2 ES Chapter 13)							
9	Lowering of groundwater level in proximity of cuttings	Assessed within **Road drainage and water environment** (Volume 6 Document Ref 6.2 ES Chapter 13)							
10	Excavation of cuttings into bedrock	Stage 0 to 3 design development	Low	Long term	Moderate	**Slight beneficial**	None	Moderate	**Slight beneficial**

With scheme									
Item	**Description of potential impact**	**Embedded design, mitigation and enhancement measures**	**Sensitivity /value of receptor**	**Duration of impact**	**Magnitude of potential impact**	**Significance of potential impact**	**Additional mitigation**	**Residual magnitude of potential impact**	**Residual significance of potential impact**
11	Excavations for attenuation ponds	Stage 0 to 3 design development	Medium	Long term	Negligible	**Neutral or slight adverse**	None	Negligible	**Neutral or slight adverse**
12	Excavations for shallow foundations	Stage 0 to 3 design development	Medium	Long term	Negligible	**Neutral or slight adverse**	None	Negligible	**Neutral or slight adverse**
13	Effects on agricultural soils	Assessed within **People and communities** (Volume 6 Document Ref 6.2 ES Chapter 12)							
14	Exposure of air borne pollutants to construction workers	Assessed within **Air quality** (Volume 6 Document Ref 6.2 ES Chapter 5)							
15	Exposure of existing contamination to construction workers	Stage 0 to 3 design development CEMP MMP	Medium	Short term	Negligible	**Neutral or slight adverse**	Nfione	Negligible	**Neutral or slight adverse**
16	Exposure of unexpected contamination to construction workers	Stage 0 to 3 design development CEMP MMP	Medium	Short term	Negligible	**Neutral or slight adverse**	None	Negligible	**Neutral or slight adverse**
17	Existing contamination affecting groundwater	Stage 0 to 3 design development CEMP MMP	Medium	Short term	Negligible	**Neutral or slight adverse**	None	Negligible	**Neutral or slight adverse**

With scheme									
Item	**Description of potential impact**	**Embedded design, mitigation and enhancement measures**	**Sensitivity /value of receptor**	**Duration of impact**	**Magnitude of potential impact**	**Significance of potential impact**	**Additional mitigation**	**Residual magnitude of potential impact**	**Residual significance of potential impact**
18	Existing contamination affecting surface waters	Stage 0 to 3 design development CEMP MMP	High	Short term	Negligible	**Slight adverse**	None	Negligible	**Slight adverse**
19	Unexpected contamination affecting groundwater	Stage 0 to 3 design development CEMP MMP	Medium	Short term	Negligible	**Neutral or slight adverse**	None	Negligible	**Neutral or slight adverse**
20	Unexpected contamination affecting surface waters	Stage 0 to 3 design development CEMP MMP	High	Short term	Negligible	**Slight adverse**	None	Negligible	**Slight adverse**
Assessment of effects due to operation									
21	Limit access to regionally important resource	Stage 0 to 3 design development	Medium	Long term	Minor	**Slight adverse**	None	Minor	**Slight adverse**
22	Limit access to resource within a Mining Safeguarding Area	Stage 0 to 3 design development	High	Long term	No change	**Neutral**	None	No change	**Neutral**
23	Flow of springs, seepages and headwater stream	Assessed within **Road drainage and water environment** (Volume 6 Document Ref 6.2 ES Chapter 13)							

With scheme									
Item	**Description of potential impact**	**Embedded design, mitigation and enhancement measures**	**Sensitivity /value of receptor**	**Duration of impact**	**Magnitude of potential impact**	**Significance of potential impact**	**Additional mitigation**	**Residual magnitude of potential impact**	**Residual significance of potential impact**
24	Lowering of groundwater level in proximity of cuttings	Assessed within **Road drainage and water environment** (Volume 6 Document Ref 6.2 ES Chapter 13)							
25	Soils adjacent to the scheme to be affected by spray or air borne pollutants	Assessed within **Air quality** (Volume 6 Document Ref 6.2 ES Chapter 5)							
26	Exposure of existing contamination to maintenance workers	Stage 0 to 3 design development CEMP MMP Appropriate PPE	High	Short term	No change	**Neutral**	None	No change	**Neutral**
27	Exposure of construction materials on maintenance workers	Stage 0 to 3 design development CEMP MMP Appropriate PPE	High	Short term	No change	**Neutral**	None	No change	**Neutral**
28	Exposure of construction materials on controlled waters	Stage 0 to 3 design development CEMP MMP	High	Short term	No change	**Neutral**	None	No change	**Neutral**

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