



The Sizewell C Project

6.7 Volume 6 Sizewell Link Road Chapter 11 Geology and Land Quality

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11 Geology and Land Quality

11.1 Introduction

11.1.1 This chapter of **Volume 6** of the **Environmental Statement (ES)** presents an assessment of the potential effects on geology and land quality arising from the construction and operation phases of the Sizewell link road (referred to throughout this volume as the ‘proposed development’). This includes an assessment of potential impacts, the significance of effects, the requirements for mitigation and the residual effects.

11.1.2 Detailed descriptions of the Sizewell link road site (referred to throughout this volume as the ‘site’), the proposed development and the different phases of development are provided in **Chapters 1** and **2** of this volume of the **ES**. A glossary of terms and list of abbreviations used in this chapter is provided as a separate document (Doc Ref. 1.1d).

11.1.3 The Government’s Good Practice Guide for Environmental Impact Assessment¹ (EIA) (Ref. 11.1) outlines the potential environmental effects that should be considered for geology and land quality e.g. physical effects of the development, effects on geology and effects on contamination. Further information on these potential environmental effects and those which have been scoped in to the Geology and Land Quality Assessment can be found in **Appendix 6N** of **Volume 1** of the **ES**.

11.1.4 This assessment has been informed by data from the following other assessments:

- **Chapter 10:** Soils and Agriculture.
- **Chapter 12:** Groundwater and Surface Water.

11.1.5 This assessment has also been informed by data presented in the following technical appendices:

- **Appendix 11A** of this volume: Sizewell Link Road and Theberton Bypass: Phase 1 Desk Study Report, 2020².
- **Appendix 11B:** Conceptual Site Models.

¹ It should be noted that this document has been withdrawn; however, it still constitutes good advice and should be referred to in the absence of alternative guidance documents.

² It is noted that the Phase 1 Desk Study Report was written prior to the finalisation of the development design when both the Sizewell link road and Theberton Bypass options were being considered and therefore references both schemes.

- **Appendix 11C:** Impact Assessment Tables.

11.2 Legislation, policy and guidance

11.2.1 **Appendix 6N** of **Volume 1** of the **ES** identifies and describes legislation, policy and guidance of relevance to the assessment of the potential geology and land quality impacts associated with the Sizewell C Project across all **ES** volumes.

11.2.2 This section provides an overview of the legislation, policy and guidance specific to the assessment of the proposed development.

a) International

11.2.3 International legislation or policy relevant to the Geology and Land Quality Assessment includes the Water Framework Directive (WFD) 2000/60/EC and the Waste Framework Directive 2008. The requirements of these, as relevant to the Geology and Land Quality Assessment, are described in **Volume 1, Appendix 6N**.

b) National

i. Legislation

11.2.4 National legislation relating to the Geology and Land Quality Assessment include:

- Part IIA of the Environmental Protection Act 1990.
- Water Resources Act 1991.
- The Control of Substances Hazardous to Human Health Regulations 2002.
- Construction (Design and Management) Regulations (CDM Regulations) 2015.
- Waste Management Regulations 2016.
- Landfill (England and Wales) Regulations 2005.
- Hazardous Waste (England and Wales) Regulations 2005.
- The Environmental Permitting (England and Wales) Regulations 2016.

11.2.5 The requirements of these, as relevant to the Geology and Land Quality Assessment, are set out in **Volume 1, Appendix 6N**.

ii. **Planning Policies**

11.2.6 National Policy Statements (NPS) set out national policy for energy infrastructure. The overarching NPS for Energy (NPS EN-1) (Ref. 11.2) and NPS for Nuclear Power Generation (NPS EN-6) (Ref. 11.3) provide the primary policy framework within which the proposed development will be considered. The requirements of these, as relevant to the Geology and Land Quality Assessment, are described in **Volume 1, Appendix 6N**.

11.2.7 Other national policies relevant to the Geology and Land Quality Assessment include the National Planning Policy Framework 2019 (Ref. 11.4), Planning Practice Guidance 2019 (Ref. 11.5) and the Government's 25 Year Environment Plan 2018 (Ref. 11.6). The requirements of these are described in **Volume 1, Appendix 6N**.

c) **Regional**

11.2.8 No regional policy is deemed relevant to the assessment of geology and land quality for this site.

d) **Local**

11.2.9 **Volume 1, Appendix 6N** summarises the requirements of the Suffolk Coastal District Council (SCDC) Local Plan Core Strategy and Development Management Policies (Ref. 11.7), and the SCDC Final Draft Local Plan (Ref. 11.8), as relevant to the Geology and Land Quality Assessment.

e) **Guidance**

11.2.10 Guidance relating to the Geology and Land Quality Assessment include:

- Department for Environment, Food and Rural Affairs. Environmental Protection Act: Part 2A Contaminated land Statutory Guidance. 2012 (Ref. 11.9).
- Contaminated Land Report (CLR) 11³ (Ref. 11.10).
- Guiding Principles for Land Contamination (GPLC) (Ref. 11.11).

³ It is noted that CLR11 is due to be withdrawn early 2020 and replaced by updated online guidance: Environment Agency Land contamination: Risk Management (LCRM).

- The Definition of Waste: Development Industry Code of Practice (DoWCoP) (Ref. 11.12).
- The Design Manual for Roads and Bridges (DMRB) (2008) Volume 11, Section 2, Part 5 Assessment and Management of Environmental Effects (Ref. 11.13).
- DMRB (1993) Volume 11, Section 3, Part 11 Geology and Soils (Ref. 11.14).
- Environment Agency, Department of the Environment (DoE) (1995) Industry Profiles for previously developed land (Ref. 11.15).
- Construction Industry Research and Information Association (CIRIA) C552 (2001) Contaminated Land Risk Assessment – A Guide to Good Practice (Ref. 11.16).
- National House-Building Council and Environment Agency (2008) Guidance on the Safe Development of Housing on Land Affected by Contamination (R&D66) (Ref. 11.17).
- CIRIA C665 (2007) Assessing Risks Posed by Hazardous Ground Gases to Buildings (Ref. 11.18).
- British Standards (2015) BS 8485 +A1:2019 – Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings (Ref. 11.19).
- CIRIA C681 (2009) Unexploded Ordnance (UXO) – A Guide for the Construction Industry (Ref. 11.20).
- CIRIA C733 (2014) Asbestos in Soil and Made Ground: A Guide to Understanding and Managing Risks (Ref. 11.21).
- CIRIA C682 (2009) The Volatile Organic Contaminants Handbook (Ref. 11.22).
- British Standards (2015) BS 5930 – Code of practice for ground investigations (Ref. 11.23).
- British Standards (2017) BS 10175:2011+A2:2017 – Code of Practice for Investigation of Potentially Contaminated Sites (Ref. 11.24).

11.2.11 Further detail on this guidance, as relevant to the Geology and Land Quality Assessment, is set out in **Volume 1, Appendix 6N**.

11.3 Methodology

a) Scope of the assessment

11.3.1 The generic EIA methodology is detailed in **Volume 1, Chapter 6** of the **ES**.

11.3.2 The full method of assessment for geology and land quality that has been applied for the Sizewell C Project is included in **Volume 1, Appendix 6N**.

11.3.3 This section provides specific details of the geology and land quality methodology applied to the assessment of the proposed development and a summary of the general approach to provide appropriate context for the assessment that follows. The scope of assessment considers the impacts of the construction and operation phases of the proposed development.

11.3.4 The scope of this assessment has been established through a formal EIA scoping process undertaken with the Planning Inspectorate (PINS). A request for an EIA scoping opinion was initially issued to the PINS in 2014, with an updated request issued in 2019, see **Volume 1, Appendix 6A**.

11.3.5 Comments raised in the EIA scoping opinion received in 2014 and 2019 have been taken into account in the development of the assessment methodology. These are detailed in **Volume 1, Appendices 6A to 6C**.

11.3.6 The Government's Good Practice Guide for EIA⁴ states that the following potential environmental effects should be considered for geology and land quality:

- physical effects of the development: such as changes in topography, soil compaction, soil erosion, ground stability, etc.;
- effects on geology as a valuable resource: such as mineral resource sterilisation, loss or damage to regionally important geological sites, geological sites of special scientific interest (SSSIs) etc.;
- effects on soil as a valuable resource: such as loss or damage to soil of good agricultural quality;
- effects associated with ground contamination that may already exist on-site: such as introducing or changing pathways and receptors;

⁴ It should be noted that this document has been withdrawn; however, it still constitutes good advice and should be referred to in the absence of alternative guidance documents.

- effects associated with the potential for polluting substances used (during the various phases) to cause new ground contamination issues on-site, such as introducing or changing the source of contamination and, or pathways; and
 - effects associated with re-use of soils and waste soils: such as re-use of site-sourced materials on-site or off-site, disposal of site-sourced materials off-site, importation of materials to the site etc.
- 11.3.7 The proposed development is considered unlikely to have an impact on important geological sites as no geological SSSIs or local geological sites have been identified within the study area, described below in **section 11.3c**. However, given the comments in the revised scoping opinion received in 2019 in relation to effects on geology as a valuable resource, an assessment of the effects on mineral resources has been included.
- 11.3.8 Physical effects in relation to changes in topography are discussed in **Chapter 6** of this volume. The effects on soil as a valuable resource are discussed in **Chapter 10** of this volume. Management of site-sourced waste materials, other than site soils (i.e. general waste materials from construction and operational phases) is summarised in **Chapter 2** of this volume, with further details provided in the **Waste Management Strategy**, in **Volume 2, Appendix 8A**.
- 11.3.9 Therefore, the following remaining environmental effects have been considered and form part of the assessment in this chapter:
- physical effects including soil erosion, soil compaction and ground stabilisation;
 - mineral resource loss, damage or sterilisation;
 - effects associated with existing ground contamination and potential new ground contamination issues; and
 - effects associated with the re-use or disposal of site sourced soils and waste soils.
- 11.3.10 Potential impacts from existing and new contamination sources on controlled waters have been considered as part of the Geology and Land Quality Assessment to determine and classify potential effects associated with ground contamination. Further description of the effects from contamination to groundwater and surface water is provided in **Chapter 12** of this volume.

11.3.11 This chapter provides an initial indication of chronic long-term risks to construction and maintenance workers. In accordance with the **Code of Construction Practice (CoCP)** (Doc Ref. 8.11), short-term acute risks should be assessed, managed and mitigated by the Contractor with appropriate risk assessments and methods statements, and subsequent control measures.

b) Consultation

11.3.12 The scope of the assessment has also been informed by ongoing project-wide consultation and engagement with statutory consultees throughout the design and assessment process as outlined in **Volume 1, Appendix 6N**.

c) Study area

11.3.13 To consider the physical effects of the proposed development and the effects associated with mineral resources, the re-use of soils and waste soils, the study area is defined as the area within the site boundary. The site boundary of the proposed development is presented in **Chapter 1, Figure 1.1** of this volume.

11.3.14 The study area for the consideration of effects on human receptors, controlled waters, ecological receptors and property receptors includes the site and land immediately beyond it to a distance of 500 metres (m). This takes into account the transport and final destination of potential contaminants of concern in the environment and the connectivity of these contaminants via pathways of migration or exposure to the receptors identified.

11.3.15 Based on the contaminated land desk study provided in **Appendix 11A** of this volume, this study area was considered sufficient for the assessment of the potential land contamination and associated potential contaminant linkages (PCL)⁵ risks as the land has previously undergone limited development and as such contamination, if present, is likely to be limited in extent or have a limited lateral mobility if present.

d) Assessment scenarios

11.3.16 The assessment of effects on geology and land quality includes assessment of the construction and operational phases of the proposed development, rather than specific assessment years.

⁵ Where a linkage exists or is considered likely to be present between a potential contamination hazard/source, pathway and receptor relevant to the site.

e) Assessment criteria

11.3.17 As described in **Volume 1, Chapter 6** of the **ES**, the EIA methodology considers whether impacts of the proposed development would have an effect on any resources or receptors. For physical effects, and effects associated with mineral resources, waste soils and soil re-use, the assessments broadly consider the magnitude of impacts and value or sensitivity of resources or receptors that could be affected in order to classify effects. For land contamination, the assessment considers the change in the level of contaminative risks to the relevant receptors.

11.3.18 A summary of the two assessment methods and assessment criteria used in the Geology and Land Quality Assessment is presented in the following sub-sections.

- i. **Physical effects, and effects associated with mineral resources, waste soils and soil re-use**

11.3.19 An impact assessment of the potential physical effects of the proposed development on geology and the effects associated with mineral resources, soils re-use and waste soils has been undertaken using a qualitative approach which considers the effects of the construction and operational phases of the proposed development.

Value/sensitivity

11.3.20 The value/sensitivity of a receptor is considered when determining the consequence of an effect in the impact assessment. Where the attribute falls within two value/sensitivity criteria, the worst case value/sensitivity is selected. The value/sensitivity of soil and geological receptors has been determined using the classifications given in **Table 11.1**.

Table 11.1: Criteria for classifying the value and/or sensitivity of environmental resources/receptors.

Value/Sensitivity.	Criteria	Description
High	Attribute possesses key characteristics which contribute significantly to the distinctiveness, rarity and character of the site/receptor. Attribute has a very low capacity to accommodate the proposed change.	Regionally important mineral resource. Within a Mineral Safeguarding Area. Major ground stability, soil compaction or erosion hazards currently present at the site. High potential for soils re-use.
Medium	Attribute possesses key	Moderately economically viable mineral

Value/Sensitivity.	Criteria	Description
	characteristics which contribute significantly to the distinctiveness, rarity and character of the site/receptor. Attribute has a low capacity to accommodate the proposed change.	resource. Adjacent to a Mineral Safeguarding Area. Moderate ground stability, soil compaction or erosion hazards currently present at the site. Moderate potential for soils re-use.
Low	Attribute only possesses characteristics which are locally significant. Attribute has some tolerance to accommodate the proposed change.	Low economically viable minerals. Low ground stability, soil compaction or erosion hazards currently present at the site. Limited opportunity for soils re-use.
Very Low	Attribute characteristics do not make a significant contribution to local character or distinctiveness. Attribute is generally tolerant and can accommodate the proposed change.	No economically viable minerals. No ground stability, soil compaction or erosion hazards currently present at the site. No opportunity for soils re-use.

Magnitude

11.3.21 Following determination of the value/sensitivity of the receptors, the magnitude of potential impacts are determined. The criteria for the assessment of impact magnitude for physical effects and effects associated with mineral resources, waste soils and soil re-use are defined in **Table 11.2**.

Table 11.2: Assessment of magnitude of impacts for physical effects and effects associated with waste soils and soil re-use.

Magnitude	Criteria
High	Total loss of major alterations to one or more of the key elements, features or characteristics of the baseline. The situation will be fundamentally different.
Medium	Partial loss or alteration to one or more of the key elements or characteristics of the baseline. The situation will be partially changed.
Low	Minor loss or alteration to one or more of the key elements, features or characteristics of the baseline. The change will be discernible but the underlying situation will remain similar to the baseline.
Very Low.	Very minor loss or alteration to one or more of the key elements, features or characteristics of the baseline, such that the change will be barely discernible, approximating to the 'no change' situation.

Effect definitions

- 11.3.22 The overall potential significance of physical effects and effects associated with mineral resources, waste soils and soil re-use is defined using the matrix presented in **Table 11.3** which describes the relationship between the value/sensitivity of the receptor as defined in **Table 11.1** and the magnitude (change) of the potential impact as defined in **Table 11.2**.
- 11.3.23 Following the classification of an effect, a clear statement is made in the assessment as to whether the effect is 'significant' or 'not significant'. As a general rule, major and moderate effects are considered to be significant, and minor and negligible effects are considered to be not significant. However, professional judgement is also applied where appropriate.

Table 11.3: Criteria for determining the significance of physical effects and effects associated with mineral resources, waste soils and soil re-use.

		Value/Sensitivity of Receptor.			
		Very Low.	Low	Medium	High
Magnitude	Very Low.	Negligible	Negligible	Minor	Minor
	Low	Negligible	Minor	Minor	Moderate
	Medium	Minor	Minor	Moderate	Major
	High	Minor	Moderate	Major	Major

- 11.3.24 Physical effects, and effects associated with mineral resources, waste soils and soil re-use are described as adverse/negative or beneficial/positive, considering the value of the receptor, area over which the impact may occur, whether the impact is direct or indirect, the duration of the impact (short-term: under three years, medium term: three to ten years or long-term: over ten years), and whether the impact is permanent or temporary.
- 11.3.25 The classifications of physical effects and effects associated with mineral resources, waste soils and soil re-use are described in **Table 11.4**.

Table 11.4: Classification of effects.

Classification	Effect
Major adverse.	Major sterilisation of mineral resources from either an active mining/quarrying site or Mineral Safeguarding Area. Major soil erosion, soil compaction or ground instability that is permanent in nature. The generation of major volumes of soils classified as hazardous waste

Classification	Effect
	requiring off-site disposal.
Moderate adverse.	Moderate sterilisation of a mineral resource or Mineral Safeguarding Area. Moderate soil erosion, soil compaction, or ground instability that is either permanent or long-term in nature. The generation of moderate volume of waste requiring off-site disposal.
Minor adverse.	Minor sterilisation of a mineral resource or Mineral Safeguarding Area. Limited medium-term soil erosion, soil compaction, or ground instability. The generation of a minor amount of waste soil requiring off-site disposal.
Negligible	No change to a mineral resource or Mineral Safeguarding Area. No measurable impact on soil erosion, soil compaction, waste volumes, or ground instability or impacts that are only temporary in nature (less than three years). No change in contamination risks.
Minor beneficial.	Minor improvement in access to a mineral resource potentially facilitating future mineral extraction. Limited medium-term reduction in existing soil erosion, soil compaction, or ground instability issues. A minor amount of materials re-use on-site, thereby reducing off-site disposal volumes.
Moderate beneficial.	Moderate improvement in access to a mineral resource facilitating future mineral extraction. Moderate permanent or long-term reduction in existing soil erosion, soil compaction, or ground instability issues. A moderate amount of materials reuse as part of the development, thereby reducing off-site disposal volumes by a significant extent.
Major beneficial.	Major improvement in access to a mineral resource facilitating future mineral extraction. Major permanent reduction in existing soil erosion, soil compaction or ground instability issues. Sustainable reuse of materials on-site with no, or only minimal, off-site disposal of waste soils.

ii. Land contamination

11.3.26 The generic EIA methodology as described in **Volume 1, Chapter 6** of the **ES** is not used to consider the effects on land contamination from the proposed development. Instead, the assessment considers the risks to various receptors from land contamination and the change in this risk profile during construction and operation. As such the magnitude of the impact is not determined, being replaced by the change in risk level to the various receptors, which is subsequently used to define the effect.

11.3.27 The assessment of the potential impacts of the proposed development on land contamination has been undertaken over two stages including:

- Stage 1 – Land Contamination Risk Assessment.
- Stage 2 – Land Contamination Impact Assessment.

Stage 1 – Risk assessment

11.3.28 A Phase 1 Desk Study Report, provided in **Appendix 11A**, was prepared for the site which sets out the baseline environmental characteristics for the proposed development and study area. The baseline assessment was undertaken using existing data, publicly available information and historical records. This Phase 1 Desk Study Report also defines the preliminary conceptual site model (PCSM).

11.3.29 Based on the PCSM qualitative risk assessments have been undertaken in accordance with relevant guidance, outlined in **section 11.2**, considering the potential sources, pathways and receptors present during the baseline and construction phases and is included in **Appendix 11B**.

11.3.30 To assist in the risk assessment process by helping to determine the consequence of contamination being present, discussed in **section 11.3**, a value/sensitivity has been assigned to each of the contaminated land receptors. The definition of each of these is given in **Table 11.5**.

Table 11.5: Assessment of the value or sensitivity of receptors associated with land contamination.

Value/Sensitivity.	Criteria	Description
High	<p>Attribute possesses key characteristics which contribute significantly to the distinctiveness, rarity and character of the site/receptor.</p> <p>Attribute has a very low capacity to accommodate the proposed change.</p>	<p>Principal aquifer providing potable water to a large population, within an inner or outer groundwater source protection zone (SPZ) (SPZ 1 or SPZ 2).</p> <p>WFD high status water body (surface water) providing potable water to a small population.</p> <p>Sensitive human health receptors, for example young children/other users of residential areas, schools and parks.</p> <p>Buildings, including services and foundations but of high historic value or other sensitivity for example statutory historic designations, schools, residential dwellings.</p> <p>Ecological statutory designations with high sensitivity or international designations e.g. Special Area of Conservation, Special</p>

NOT PROTECTIVELY MARKED

Value/Sensitivity.	Criteria	Description
		Protection Area, Ramsar sites etc. Crops and livestock with a high commercial / economic value.
Medium	Attribute possesses key characteristics which contribute significantly to the distinctiveness, rarity and character of the site/receptor. Attribute has a low capacity to accommodate the proposed change.	Principal aquifer beyond a SPZ, secondary aquifer providing single private potable water supplies, abstraction water for agricultural or industrial use. WFD good status water body (surface water). Moderate sensitivity human health receptors, for example. commercial / industrial users. Buildings and infrastructure of high regional value or high sensitivity e.g. schools, hospitals, residential dwellings. Ecological statutory designations with medium sensitivity or national designations e.g. SSSI, National Nature Reserve, Area of Outstanding Natural Beauty, Marine Conservation Zone, etc. Local Geological Site, or Regionally Important Geodiversity Sites. Crops and livestock with a medium commercial / economic value.
Low	Attribute only possesses characteristics which are locally significant. Attribute has some tolerance to accommodate the proposed change.	Secondary aquifer not currently used for groundwater abstraction. WFD moderate status (surface water). Less sensitive human health receptors, for example construction workers using mitigation measures. Buildings and infrastructure of local importance or low sensitivity (commercial / industrial buildings, main roads, railways). Ecological statutory designations with low sensitivity, or sites with local designations for example Local Nature Reserve. Crops and livestock with a low commercial / economic value.
Very Low.	Attribute characteristics do not make a significant contribution to local character or distinctiveness. Attribute is generally tolerant and can accommodate the proposed change.	Non-productive strata (groundwater). WFD poor status (surface water). No sensitive human receptors. Locally important infrastructure (local roads, bridges, footpaths). Land with low sensitivity and/or non-statutory designations. No crop or livestock receptors.

- 11.3.31 The risk assessment then applies the principles given in the National House Building Council, and Environment Agency report R&D66 and CIRIA C552, which provide guidance on the preparation and application of the consequence and probability matrix, as presented in **Table 11.6**, for Contaminated Land Risk Assessment.
- 11.3.32 The potential risk to a receptor is a function of the probability and the consequence of a PCL being realised. Probability (likelihood of an event occurring) takes into account both the presence of the hazard and the receptor and the integrity of the exposure pathway. Consequence takes into account both the potential severity of the hazard and the value/sensitivity of the receptor. Definitions of probability, consequence and the classified risks adopted for this assessment are detailed in **Volume 1, Appendix 6N**.

Table 11.6: Land quality estimation of the level of risk by comparison of consequence and probability.

		Consequence			
		Severe	Medium	Mild	Minor
Probability	High Likelihood.	Very High Risk.	High Risk.	Moderate Risk.	Moderate/Low Risk.
	Likely	High Risk.	Moderate Risk.	Moderate/Low Risk.	Low Risk.
	Low Likelihood.	Moderate Risk.	Moderate/Low Risk.	Low Risk.	Very Low Risk.
	Unlikely	Moderate/Low Risk.	Low Risk.	Very Low Risk.	Very Low Risk.

- 11.3.33 The descriptions of the classified risks and likely action required as given in R&D66 are detailed in **Volume 1, Appendix 6N**.

Stage 2 – Impact assessment

- 11.3.34 The impact assessment has been undertaken by comparing the baseline risk assessments with the construction and operation phase risk assessments. This approach enables changes in the contaminated land status during the various phases to be identified and recorded.

Effect definitions

11.3.35 The effects of the proposed development are described as adverse/negative or beneficial/positive and major, moderate, minor or negligible on the basis of **Table 11.7**.

Table 11.7: Classification of effects.

Classification	Effect
Major adverse.	An increase in contamination risk from the existing baseline conditions of four or five risk levels in the risk matrix, e.g. land that has a very low contamination risk in the baseline becomes a high or very high risk. Land that does not meet the statutory definition of contaminated land in the existing baseline becomes capable of being determined under Part IIA of the Environmental Protection Act 1990.
Moderate adverse.	An increase in contamination risk from the existing baseline conditions of two or three risk levels in the risk matrix, e.g. land that has a low contamination risk in the baseline becomes a moderate or high risk. Land that does not meet the statutory definition of contaminated land in the existing baseline becomes capable of being determined under Part IIA of the Environmental Protection Act 1990.
Minor adverse.	An increase in contamination risk from the existing baseline conditions of one risk level in the risk matrix, e.g. land that has a low contamination risk in the baseline becomes a moderate to low risk.
Negligible	No change in contamination risks.
Minor beneficial.	A reduction in contamination risk from the existing baseline conditions of one risk level in the risk matrix, e.g. land that has a moderate to low contamination risk in the baseline becomes a low risk.
Moderate beneficial.	A reduction in contamination risk from the existing baseline conditions of two or three risk levels in the risk matrix, e.g. land that has a high contamination risk in the baseline becomes a moderate to low or low risk. Land that meets the statutory definition of contaminated land in the existing baseline is no longer capable of being determined under Part IIA of the Environmental Protection Act 1990.
Major beneficial.	A reduction in contamination risk from the existing baseline conditions of four or five risk levels in the risk matrix, e.g. land that has a very high contamination risk in the baseline becomes a low or very low risk. Land that meets the statutory definition of contaminated land in the existing baseline is no longer capable of being determined under Part IIA of the Environmental Protection Act 1990.

11.3.36 Following the classification of an effect, a clear statement is made as to whether the effect is 'significant' or 'not significant'. Major and moderate

effects are considered to be significant, and minor and negligible effects are considered to be not significant.

11.3.37 It should be noted that, given the information known at the time of writing, professional judgement has been applied in certain circumstances where the introduction or removal of a receptor has automatically triggered a minor adverse or minor beneficial effect.

f) **Assessment methodology**

11.3.38 Detailed assessment methodologies for geology and land quality are presented in **Volume 1, Appendix 6N**. A summary is provided in the following sections.

i. **General approach**

11.3.39 The approach to the Geology and Land Quality Assessment comprises:

- establishing the baseline conditions for the study area with respect to geology, ground stability, hydrology, hydrogeology, contaminated land (including the potential for unexploded ordnance and ground gases) and historical uses;
- identification of potential impacts on identified resources and receptors from the construction and operation phases of the proposed development;
- assessment of the significance of likely effects from the proposed development including the consideration of mitigation measures; and
- identification of any residual effects and secondary mitigation where required.

ii. **Establishing the baseline**

11.3.40 The baseline assessment has relied on existing data, previous desk study and historical records. The following sources have been reviewed:

- historical mapping and additional environmental information including historical landfill information and contemporary trade directories provided in an Envirocheck report, which is appended to the Phase 1 Desk Study Report provided in **Appendix 11A** of this volume;

- publicly available information from the British Geological Survey (BGS) (Ref. 11.25) online mapping resource;
- Suffolk County Council (SCC) Minerals Local Plan (Ref. 11.26);
- Suffolk Biodiversity Information Service website (Ref. 11.27);
- publicly available information from the Department of Environment, Food and Rural Affairs (Defra) Multi-Agency Geographic Information for the Countryside website (Ref. 11.28);
- publicly available information from the Environment Agency (Ref. 11.29);
- the Yell website (Ref. 11.30); and
- Zetica online unexploded ordnance (UXO) risk maps (Ref. 11.31).

iii. Assessment of Effects

11.3.41 An assessment of the potential physical effects of the proposed development on geology and the effects associated with soils re-use and waste soils has been undertaken using a qualitative approach considering the effects on soil erosion, mineral resources, the potential for soil re-use and waste soil generation in accordance with the methodology.

11.3.42 The assessment of the potential effects of the construction and operation phases of the proposed development on land contamination has been undertaken in accordance with the methodology.

g) Assumptions and limitations

11.3.43 The following assumptions have been made in this assessment:

- all assessment considers development within the site parameters as set out in the description of development in **Chapter 2** of this volume of the **ES** and as illustrated in the **Works Plans** reproduced in **Appendix 2A** of this volume;
- stockpiling of materials during construction (where required) would remain within the site boundary;
- vegetation, topsoil and potentially subsoil would be stripped in accordance with the **Outline Soil Management Plan (SMP)** provided in **Volume 2, Appendix 17C**;

- the use of grid connections for electricity for the permanent lighting and the temporary contractor's compounds, rather than generators to reduce the potential for storage of fuels on-site;
- following construction of the link road, the temporary haul routes, temporary contractor compounds (including any in ground utilities and drainage), plant, equipment storage/laydown areas, etc. will be decommissioned and returned as far as practicable to agricultural use. As such, risks and effects of this work has been considered as part of the construction phase and appropriate mitigation incorporated; and
- for the operational phase assessment, it has been assumed that all primary, tertiary and secondary mitigation measures proposed for construction have been adopted / implemented.

11.3.44 The following limitations have been identified:

- ground investigation data is not available for the site and the baseline has been prepared using BGS mapping.

11.3.45 Further details can be found in **Appendix 11A**.

11.4 Baseline environment

11.4.1 This section presents a description of the baseline environmental characteristics within the study area. Further detail can be found in **Appendix 11A**.

a) Current baseline

i. Site visit

11.4.2 A site visit from public roads was undertaken during March 2019 to gain further information on the site setting and study area, to consider the context of the site, and to support the desk study mapping and aerial photographs. Additionally, it was an opportunity to identify potential visual or olfactory contamination present at the site at the time of the site visit.

11.4.3 The site predominantly comprises agricultural land. The site includes several local roads, existing watercourses and woods, and is also in close proximity to farms and residential properties. The East Suffolk line crosses the site in the west. Areas surrounding the site are predominantly agricultural land with isolated farms and residential properties nearby. No ground hazards or evidence of contamination were observed during the site

visit. Further details on observations made during the site visit including photographs can be found in the desk study provided in **Appendix 11A**.

ii. Site history

11.4.4 The following section summarises the key historical land use information for the study area. This has been compiled using historical maps between 1883 and 2018 at the 1:10,560 and 1: 10,000 scale, and between 1884 and 1999 at the 1: 2,500 scale obtained from the Envirocheck historical maps which covers the study area.

Table 11.8: Historical development on the site.

Map Date.	Key Contamination Sources On-Site.	Key Contamination Sources in Study Area.
1883 – 1885 (1:10,560).	The majority of the site is shown as agricultural land. The East Suffolk line, Main Road (A12), Leiston Road (B1122), B1125, Littlemoor Road, Fordley Road, Moat Road, Pretty Road and unnamed tracks are present in their current layout crossing the site. Several unnamed drains/watercourses are also present crossing the site.	The surrounding area comprises predominantly agricultural fields, farms, woodland and isolated residential properties. Theberton Village is present 450m to the east of the site. Littlemoor Spring was present 250m south of the site at Middleton. Sand pits are indicated to be present 250m south-east and 250m east of the site in 1884 around Theberton, and a gravel pit 250m north-east of the site near Fordley.
1884 (1:2,500).	No substantial changes.	Brown's Plantation is present adjacent to the east of the site in Theberton. St Peter's Cemetery is present 500m to the north-east of the site in Theberton.
1904 (1:2,500).	No substantial changes.	No substantial changes.
1905 (1:10,560).		
1927 (1:2,500).		
1928 (1:10,560).		
1938 - 1950 (1:10,560).		
1950 - 1951 (1:10,560).	No substantial changes.	An old kiln is present 50m north-east of the site around Theberton.
1957 (1:10,000).	No substantial changes.	The old kiln is no longer indicated to be present to the north-east of the site.

Map Date.	Key Contamination Sources On-Site.	Key Contamination Sources in Study Area.
1975 (1:10,000).	No substantial changes.	No substantial changes.
1977 (1:2,500).	No substantial changes.	A garage is present 300m east of the site in Theberton.
1984 (1:10,000).	No substantial changes.	No substantial changes.
1990 - 1991 (1:10,000).		
1999 (1:2,500).		
2000 (1:10,000).		
2006 (1:10,000).		
2018 (1:10,000).		

iii. Geology

- 11.4.5 Made Ground is not shown on the BGS online mapping. However, there is potential for Made Ground to be encountered in the areas adjacent to the railway line and existing roads. In addition, due to the nature of the site and surrounding area, there is the potential for fly tipping as well as the potential for farmers tips, the contents of which will be unknown.
- 11.4.6 BGS records indicate that the site is largely underlain by superficial diamicton deposits of the Lowestoft Formation, and sand and gravel deposits of the Lowestoft Formation, which comprise an extensive sheet of chalky till as well as outwash sands and gravels, silts and clays.
- 11.4.7 Head (windblown) deposits are shown on the map where the site crosses Fordley Road and Hawthorne Road. These deposits comprise clay, silt, sand and gravel. Head deposits, comprising gravel, sand and clay deposits are also present in two small areas in the north-east of the site.
- 11.4.8 According to the BGS website, bedrock geology beneath the site comprises sand of the Crag Group, which is described as shallow-water marine and estuarine sands, gravels, silts and clays.

11.4.9 Historical BGS borehole logs have been identified in three areas within the study area. A summary of the logs is provided below with the full logs provided in the Phase 1 Desk Study provided in **Appendix 11A**.

Red House Farm / Lodge Farm borehole logs

11.4.10 Three borehole logs were identified to the south-west of the site in the vicinity of Red House Farm (TM36NE8) and Lodge Farm (TM36NE9 and TM36NE10), approximately 300m south of the where the site joins with the A12. These logs show the underlying geology in this area to be:

- Boulder Clay from ground level to a maximum of 19.81m below ground level (m bgl) in borehole TM36NE9;
- Glacial sand, gravels and clays and crag ranging from 54.86m to 54.86m bgl in borehole TM36NE8;
- Crag Group with shell ranging from 37.19m in borehole BH TM36NE9 to 54.86m bgl in borehole TM36NE8; and
- Chalk ranging from 49.07m in borehole TM36NE9 to 85.34m bgl in borehole TM36NE8.

11.4.11 Groundwater was recorded at 30.48m bgl in the three boreholes.

Middleton Moore borehole logs

11.4.12 Two borehole logs (TM46NW3 and TM46NW7) were identified approximately 500m to the north of the site in the vicinity of Theberton Cottages. These logs show the underlying geology in this area to be:

- Boulder Clay: ground level to a maximum of 9.45m bgl in borehole TM46NW7;
- Glacial Drift: ranging from 6.10m bgl in borehole TM46NW3 to 15.24m bgl in borehole TM46NW3; and
- Crag Group: ranging from 9.45m bgl in borehole TM46NW7 to 34.44m bgl in borehole TM46NW3.

11.4.13 Groundwater was recorded at 17.37m bgl in borehole TM46NW3 and 13.84m bgl in borehole TM46NW7.

Theberton Grange and Theberton Cottages borehole logs

11.4.14 Seven borehole logs were identified 280m south-west of the site in the vicinity of Theberton Grange and Cottages. However, only borehole TM46NW6 recorded the underlying geology in the area which is as follows:

- Topsoil: 0.45m bgl;
- Clay: 9.14m bgl;
- Ballast: 9.45m bgl;
- Sand on Crag: 18.29m bgl;
- Crag: 34.14m bgl; and
- Loamy sand: 35.97m bgl.

11.4.15 Groundwater was recorded in borehole TM46NW6 at 9.45m bgl.

11.4.16 The borehole logs generally correspond with the BGS mapped geology. However, borehole TM46NW6 (completed in 1964) identified ‘ballast’ from 9.14m to 9.45m bgl. Historically, ballast was used as a term for natural course gravels and it is possible that these materials and the shallower materials were all natural.

11.4.17 The BGS website indicates that no ground stability hazards or geological faults have been recorded on or within the study area.

iv. Mineral extraction

11.4.18 The BGS website indicates that the site is in an area unlikely to be affected by mining for coal or other mineral resources.

11.4.19 The BGS website indicates no historical extractive activities on or within the study area. However, the historical map review identified former sand pits 250m south-east and 250m east of the site around Theberton and former gravel pits 250m north-east of the site near Fordley.

11.4.20 The SCC Minerals Local Plan indicates there are no planned areas of mineral extraction within the study area, and the site is not located within a Mineral Safeguarding Area.

v. Local geological sites

11.4.21 According to protected sites mapping on the Suffolk Biological Information Service website the study area is not located within a geological SSSI or Local Geological Site.

vi. Hydrogeology

11.4.22 According to the MAGIC website the Lowestoft Formation (diamicton) and Head deposits are classified by the Environment Agency as Secondary (Undifferentiated) Aquifers⁶. The Lowestoft Formation (sands and gravels) are classified as a Secondary A Aquifer⁷.

11.4.23 According to the MAGIC website the Crag Group bedrock is classified as a Principal Aquifer⁸. The site does not lie within a groundwater SPZ⁹. A SPZ3 is present approximately 400m south of the site at its closest point.

11.4.24 Further baseline hydrogeology information for the site is provided in **Chapter 12** of this volume.

vii. Hydrology

11.4.25 A total of 107 small ponds are visible on Ordnance Survey mapping within the study area. The site also crosses several small drains/watercourses including:

- Middleton Watercourse, a designated Main River flows parallel to Fordley Road where it passes through the site, underneath the B1122 and then through Middleton to where it joins the Minsmere River;
- Theberton Watercourse, a designated Main river flows in a north-easterly direction through the eastern section of the site towards its confluence with Minsmere Old River;
- an unnamed watercourse located to the north of site that currently flows underneath the B1122 between the villages of Yoxford and

⁶ A secondary (undifferentiated) aquifer is designated in cases where it has not been possible to attribute either category secondary A or secondary B to a rock type.

⁷ A secondary (undifferentiated) aquifer is designated in cases where it has not been possible to attribute either category secondary A or secondary B to a rock type.

⁸ Principal aquifers are layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, principal aquifers are aquifers previously designated as major aquifer.

⁹ Principal aquifers are layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, principal aquifers are aquifers previously designated as major aquifer.

Middleton Moor. The watercourse flows in the northerly direction to its confluence with the River Yox;

- an unnamed watercourse that passes through the site to the east of Fordley Road and flows north to its confluence with the Middleton Watercourse, immediately downstream of the B1122;
- an unnamed watercourse that flows through the site on two occasions between Hawthorn Road and Pretty Road. This watercourse flows in a north-easterly direction through the Walberswick Heaths and Marshes SSSI to its confluence with the Minsmere Old River; and a surface drain located to the south of the western end of the site. This drain flows south, parallel to the A12 to its confluence with the River Fromus.

11.4.26 Further consideration of the hydrology of the site is provided in **Chapter 12** of this volume.

viii. Flood risk

11.4.27 The Flood Map for Planning website indicates that the site is located in Flood Zone 1 and has a low risk of flooding from rivers or the sea without defences.

11.4.28 The majority of the site is also at very low risk of flooding from surface water. However, where the Middleton Watercourse crosses the site at Fordley Road, the site is indicated to fall within Flood Zone 3 with a high risk of surface water flooding¹⁰.

11.4.29 Further details on flood risk are provided in the **Sizewell Link Road Flood Risk Assessment** (Doc Ref. 5.6).

ix. Historic and environmentally sensitive sites

11.4.30 The Grade II listed Gate and Gate Piers at junction of Leiston Road and Onner's Lane (LB 1287303) are indicated to be located within the site. There is one Grade I (church of St Peter), one Grade II* (Theberton House), and approximately 30 Grade II listed buildings indicated to be present within the study area comprising buildings associated with Theberton Village, as well as farmhouses and associated buildings and cottages.

¹⁰ 'High' risk means that each year, this area has a chance of flooding of greater than 1 in 30 (3.3%).

11.4.31 There are no ecological statutory designations indicated to be present within the study area.

11.4.32 Further consideration of designated sites, both statutory and non-statutory is given in **Chapter 7** and **Chapter 9** of this volume.

x. [Waste management and other permitted sites](#)

11.4.33 Information from the Environment Agency indicates that there is a historic landfill site (Middleton Landfill) located 100m to the north-east of the site, at Vale Farm on Fordley Road. It was licensed from 1989. However, no further information is provided on the type of wastes deposited there or when the landfill was last in use.

xi. [Service stations](#)

11.4.34 A service station is present in Theberton, approximately 300m east of the site. There are no other service stations within the study area.

xii. [Industrial and other potentially contaminative land uses](#)

11.4.35 The service station/garage listed above has the potential to use contaminants of concern and is likely to be on the contemporary trade directory. It is also noted that the site is currently used for agricultural purposes, and there are several farms present within the study area which have the potential to use contaminants of concern.

xiii. [Potential for unexploded ordnance \(UXO\)](#)

11.4.36 A Zetica UXO map was obtained to assess the risk of encountering UXO at the site and is appended to the desk study provided in **Appendix 11A**. The map indicates that the site is within an area with a low risk of encountering UXO.

xiv. [Previous investigations](#)

11.4.37 There have been no previous ground investigations undertaken at the site.

b) [Future baseline](#)

11.4.38 There are three committed developments which have been identified within the study area as summarised in **Table 11.9**.

Table 11.9: Committed developments.

Planning Application Ref.	Site Address.	Description of Development.	Date of Approval.	Status	Distance (m)
DC/16/3947/OUT	Norwood House, Littlemoor Road, Middleton, Suffolk IP17 3JZ.	Erection of 14 sheltered/extra care dwellings, together with residents lounge/meeting room and parking area.	06/09/2017	Construction not commenced.	221
DC/16/0444/COU	Middleton, Village Hall, Mill Street, Middleton, Suffolk.	Change of use of part of Agricultural Field to provide overflow car parking.	30/03/2016	Construction not commenced.	453
DC/14/0329/OUT	Land Adjoining Green Garth, Mill Street, Middleton, Suffolk.	Use of land for the erection of six dwellings (of which two are to be affordable houses) together with car parking and construction of service approach drive utilising existing access point.	05/08/2014	Construction not commenced.	477
DC/19/4813/FUL	Pretty Road Theberton Suffolk	Conversion of an old council depot/storage building into a one bedroomed holiday let/ living accommodation. With two extra holiday lodges and a new driveway access into the site from Pretty Road.	Awaiting decision	Awaiting decision	162

11.4.39 The construction timeline for these committed developments is unconfirmed. However, planning permissions generally require construction to commence within three years of the grant of planning permission or reserved matters upon which the planning permission lapses. As such, given the nature and scale of the applications, it has been

assumed that the developments will have been constructed prior to 2022. These committed developments have therefore been considered as future receptors, and a potential future source of contamination as part of the baseline for the land contamination risk assessments, and within the assessment of physical effects and effects associated with mineral resources, soils re-use and waste soils.

c) Preliminary Conceptual Site Model (PCSM)

11.4.40 A PCSM identifies the potential or known sources of contamination, receptors, and pathways between the two. Where all three are present or are considered likely to be present (source-pathway-receptor linkage), they are called a PCL.

11.4.41 Three PCSMs (baseline, construction and operational) have been produced for the proposed development using the information summarised above. A summary of potential contamination sources is provided in **Table 11.10**, and a summary of potential pathways and receptors identified is provided in **Table 11.11**.

Table 11.10: Existing potential sources of contamination for the proposed development.

Potential Source of Contamination.	Potential Contamination.	Approximate Location.
Made Ground associated with the construction of the East Suffolk line crossing the site, and activities associated with its operation.	A range of inorganic and organic contaminants including the potential for asbestos, hydrocarbons, polychlorinated biphenyls (PCBs), polyaromatic hydrocarbons (PAHs), metals, solvents and creosote, and ash and fill used in the construction of the railway.	On-site
Made Ground associated with the construction of the roads crossing the site including A12 Road, Littlemoor Road, Fordley Road, Pretty Road, Moat Road, B1122 Road, and activities associated with their operation.	A range of inorganic and organic contaminants including PAHs, coal tars, asbestos and ground gases. Fuels and oils attributed to spills from vehicles on the roads included within the site boundary, plus exhaust particulates.	
Farmland within site boundaries. Potential for unmapped farmer's tips.	Contamination risk from herbicides, pesticides, silage, effluent, and fuel/engine oils. Risk of inorganic and organic contamination including metals and hydrocarbons, PCBs, asbestos, etc.	
Service station 300m east of the site in Theberton.	Metals and organic contaminants including petroleum, petrol additives, diesel, oils/lubricants.	Off-site

Potential Source of Contamination.	Potential Contamination.	Approximate Location.
Made Ground associated with the disused sand and gravel pits (250m south-east and 250m east of the site around Theberton and 250m north-east of the site near Fordley).	Ground gas and a range of inorganic and organic contaminants including the potential for asbestos.	
Made Ground associated with the Old Kiln 50m north-east of the site around Theberton.	A range of inorganic and organic contaminants including the potential for asbestos.	
St Peter’s Graveyard 500m north-east of the site in Theberton.	Metals, organic contaminants including biological contaminants.	
Farms around the site boundaries. Potential for unmapped farmers tips.	Contamination risk from herbicides, pesticides, silage effluent, and fuel oil. Risk of inorganic and organic contamination including metals and hydrocarbons, PCBs, asbestos, etc.	
Middleton Historical Landfill 100m north of the site.	Ground gas and a range of inorganic and organic contaminants including the potential for asbestos.	

Table 11.11: Potential receptors and contaminant exposure and migration pathways at baseline and resulting from the proposed development.

Receptor Group.	Receptor	Principal Contaminant Migration Pathways.
Human Health (on-site).	Construction and maintenance workers.	Dermal contact with and ingestion of contaminants in soils, soil-derived dusts and water. Inhalation of soil-derived dust, fibres, gas and vapours.
	Pedestrians and road users using existing roads and footpaths within the site.	
	Pedestrians and road users using new link road, crossings and footpaths.	
	Farmers and workers on agricultural land.	
Human Health (off-site).	Occupants of nearby residential and commercial properties/commuters.	Dermal contact with and ingestion of contaminants in soil-derived dusts and water that may have migrated off-site. Inhalation of soil-derived dust, fibres, gas and vapours which may have migrated off-site.
	Pedestrians accessing surrounding roads and footpaths.	
	Farmers and workers on agricultural land.	
Controlled Waters:	Groundwater in principal	Leaching of contaminants in soil to

Receptor Group.	Receptor	Principal Contaminant Migration Pathways.
Groundwater (on-site and off-site).	bedrock aquifer. Groundwater in secondary A and secondary undifferentiated superficial aquifers.	groundwater in underlying aquifers. Migration of contaminated water through preferential pathways, such as underground services, pipes and granular material to groundwater in underlying aquifers.
Controlled Waters: Surface waters (on-site and off-site).	Watercourses/surface drains crossing the sites. Ponds within the site and study area.	Lateral migration of contaminated groundwater with discharge to surface watercourses as base flow. Discharge of contaminants entrained in groundwater and, or surface water run-off followed by overland flow and discharge.
Property (on-site and off-site).	Existing on-site and off-site services and structures including listed buildings. Proposed on-site services and structures.	Direct contact of contaminants in soil and, or groundwater with existing and proposed structures and buried services. Migration of contaminated groundwater, ground gas and, or vapours along strata and preferential pathways such as service routes or differentially permeable strata.
	Crops and livestock (on-site and off-site).	Migration of contaminated waters/dust/fibres and subsequent uptake by crops, or ingestion/inhalation/dermal contact by livestock.

11.5 Environmental design and mitigation

11.5.1 As detailed in **Volume 1, Chapter 6** of the **ES**, a number of primary mitigation measures have been identified through the iterative EIA process, and have been incorporated into the design and construction planning of the proposed development. Tertiary mitigation measures are legal requirements, or are standard practices that would be implemented as part of the proposed development.

11.5.2 The assessment of likely significant effects of the proposed development assumes that primary and tertiary mitigation measures are in place. For geology and land quality, these measures are identified, with a summary provided on how the measures contribute to the mitigation and management of potentially significant environmental effects.

a) Primary mitigation

11.5.3 Primary mitigation is often referred to as ‘embedded mitigation’ and includes modifications to the location or design to mitigate impacts; these measures become an inherent part of the proposed development.

11.5.4 Primary mitigation for the proposed development would include:

- the design of the road and the selection of construction materials would be in accordance with the Design Manual for Roads and Bridges (DMRB), British Standards and best practice guidance at the time of the design. The design would be required to take into account the ground conditions including the potential for ground movement, compaction, ground gas and ground aggressivity;
- gas mitigation measures for relevant structures will be designed where required dependent on the risk profile and the nature/usage of the structure; and
- the use of appropriate drainage systems in accordance with the **Drainage Strategy**, provided in **Volume 2, Appendix 2A**, to reduce the potential for contamination to migrate and impact on the ground, groundwaters and surface waters. Water draining from the road infrastructure will pass through appropriate drainage, including the incorporation of SuDS (e.g. swales), and bypass separators for the removal of hydrocarbon contaminants as necessary. This will allow infiltration to the superficial aquifer as well as protect the ground and underlying groundwater from hydrocarbon contamination.

b) Tertiary mitigation

11.5.5 Tertiary mitigation will be required regardless of any EIA assessment, as it is imposed, for example, as a result of legislative requirements, and/or standard sectoral practices.

11.5.6 Tertiary mitigation measures to be incorporated into the proposed development during construction, as set out in the **CoCP** (Doc Ref. 8.11) include:

- prior to stockpiling or other groundworks, topsoil present would be removed and appropriately stored for potential re-use in landscaping areas, subject to demonstrating suitability for reuse criteria. This process would reduce the potential for buried topsoil to generate ground gas beneath the proposed development which may pose a risk to human health;
- development of health and safety risk assessments and method statements by the contractor including emergency response procedures, and provision of appropriate personal protective equipment (PPE) for the protection of construction workers;

- implementation of a contamination watching brief by suitably qualified and experienced personnel would be completed for the proposed development when excavating areas of potential contamination risk. If unidentified contamination is encountered, works will be temporarily suspended in the area and appropriate investigations and remediation will be discussed and agreed with stakeholders and completed in accordance with current best practice;
- implementation of appropriate dust suppression measures to reduce migration of contaminated dust, further details are provided in **Chapter 5 – Air Quality**;
- minimising the area and duration of soil exposure and timely reinstatement of vegetation or hardstanding, to reduce soil erosion and reduce temporary effects on soil compaction;
- stockpile management (such as water spraying and avoiding over stockpiling to reduce compaction of soil and loss of integrity) to reduce windblown dust and surface water run-off;
- clear segregation between stockpiled material including imported material, excavated material stockpiled for re-use and excavated waste material stockpiled for treatment and / or off-site disposal;
- stockpiles would be located a minimum of 10m from the nearest watercourse;
- implementation of working methods during construction to ensure that surface water run-off from the works, landscape bunds, stockpiles or working area is minimised and captured prior to entry into adjacent surface watercourses or leaching into underlying groundwater in accordance with best practice;
- implementation of appropriate pollution incident control e.g. plant drip trays and spill kits and suitable training and toolbox talks completed; and
- implementation of appropriate and safe storage of fuel, oils, chemicals and equipment during construction in accordance with Control of Substances Hazardous to Human Health regulations and oil storage regulations.

11.5.7 Additional tertiary mitigation that will be anticipated and referenced in the **COCP** includes:

- implementation of an appropriate **Materials Management Strategy** to document how the excavated materials will be dealt with via **Materials Management Plan(s)** and verification report(s) to record the excavation and placement of materials at the site. Further details are provided in the **Materials Management Strategy**, provided in **Volume 2, Appendix 3B**;
 - implementation of a Site Waste Management Plan in accordance with the Waste Management Strategy provided in **Volume 2, Appendix 8A**;
 - implementation of an Outline SMP provided in **Volume 2, Appendix 17C**; and
 - Piling Risk Assessment in accordance with Environment Agency guidance may be required to ensure that piling techniques deemed appropriate are implemented at the site by identifying and managing potential risks as a result of creating pathways to the aquifer.
- 11.5.8 For the operational phase, storage and disposal of wastes and hazardous substances where required will be managed in accordance with current guidance and legislative requirements.
- 11.6 **Assessment**
- a) **Introduction**
- 11.6.1 This section presents the findings of the Geology and Land Quality Assessment for the construction and operation phases of the proposed development.
- 11.6.2 This section identifies any likely significant effects that are predicted to occur, and **section 11.7** of this chapter highlights the secondary mitigation and monitoring measures that are proposed to minimise any adverse significant effects (if required).
- b) **Construction**
- i. **Physical effects**
- 11.6.3 A qualitative approach has been undertaken to assess the likely physical effects of the proposed development. The effects have then been categorised in accordance with the methodology described in **Volume 1, Appendix 6N** and summarised in **section 11.3**, and confirmed as either

temporary or permanent, adverse or beneficial and significant (moderate or major effects) or not significant (minor or negligible).

- 11.6.4 The construction phase of the proposed development may result in soil erosion, soil compaction and ground instability issues associated with stripping of topsoil, vegetation clearance, stockpiling, earthworks, movement of heavy plant, temporary works and construction of new infrastructure. These are discussed in more detail below.

Soil erosion

- 11.6.5 Earthworks, including areas for temporary works, would be required for the construction of the proposed development with embankments and cuttings proposed for the main road alignment and associated junctions, roundabouts, ghost islands, footpath diversions, with excavations also required for proposed bridge foundations, piling, lighting columns, utilities, signage, swales, infiltration basins, gullies, culverts fencing and planting. Temporary stockpiles and temporary haul roads would be required and are anticipated to be located within the site boundary to allow movement for earthworks across the length of the proposed new road. The temporary contractor compounds would also need reinstating after the road is constructed requiring further earthworks and excavations. Piling is also anticipated to be required for the overbridge associated with the East Suffolk line and Pretty Road footbridge. Therefore, there is the potential for soil erosion across the proposed development.
- 11.6.6 Earthworks would be managed in accordance with the **CoCP** to minimise soil exposure as far as practicable, and areas required for temporary works/temporary contractor compounds during the construction phase would be returned to agricultural use as soon as possible when they are no longer required.
- 11.6.7 Stockpiles would be managed in accordance within primary and tertiary measures set out in **section 11.5** and the **CoCP** to reduce soil erosion and dust generation by management practices which may include water spraying. The impact on soil erosion during the construction phase is therefore considered to be temporary, short-term (as less than 3 years) and direct.
- 11.6.8 Given the current mainly agricultural use of the site, the potential for soil erosion currently is likely to be low, the value/sensitivity is classed as low. With the primary and tertiary mitigation measures set out in **section 11.5** the magnitude of the impact is considered to be low. The overall effect is therefore considered to be minor adverse and classed as **not significant**.

Ground stability and soil compaction

- 11.6.9 No ground stability hazards or geological faults are recorded as present within the study area, and the site is also identified as having a low UXO risk. Ground conditions indicated sands, gravels and clay deposits to be present with the potential for limited areas of Made Ground associated with roads and the East Suffolk line, and the potential for farmers tips. The proposed development is not within an area of coal or non-coal mining, although some small scale quarrying of sands and gravels has taken place historically in the 1800s. The impact on ground stability during the construction phase is therefore considered to be temporary, short-term, and direct.
- 11.6.10 Soil compaction may arise through the earthworks and from heavy plant movements within the site. All new embankments would also need to be constructed in layers and compacted to the design requirements. Given the ground conditions identified from geological mapping, substantial soil compaction over and above that required in the design is anticipated to be minimal. The impact on soil compaction during the construction phase is therefore considered to be temporary, short-term, and direct.
- 11.6.11 Given this, the potential for substantial ground instability and ground compaction is considered to be low, the value/sensitivity is classed as low. With the implementation of primary and tertiary mitigations set out in **section 11.5**, the magnitude of the impact on soil compaction and ground instability is considered to be very low. The overall effect is therefore considered to be negligible and classed as **not significant**.

ii. Mineral resources

- 11.6.12 A qualitative approach has been undertaken to assess the likely effects of the proposed development on mineral resources in accordance with the methodology outlined in **Volume 1, Appendix 6N** and summarised in **section 11.3**.
- 11.6.13 The proposed development has the potential to impact mineral resources and associated Mineral Safeguarding Areas through the loss, damage or sterilisation of an important mineral resource.
- 11.6.14 The baseline assessment identified the presence of historical mineral extraction sites (sand and gravel) within the study area. However, the site and study area are not located within a coal mining area, an area of planned mineral extraction or a Minerals Safeguarding Area. In addition, the pits identified within the baseline assessment are indicated to be

historical, being first identified on the 1883 to 1884 maps with no current viable extraction taking place. Therefore, there would be a limited impact on the current regional mineral resources. The impacts on mineral resources during the construction phase are therefore considered to be temporary, short-term and direct.

- 11.6.15 Given that there are limited valuable/commercially viable mineral resources located within the study area, the value/sensitivity of the receptor is classed as very low. The magnitude of the impact is considered to be very low as there would be limited loss of regional mineral resources. The overall effect is negligible and classed as **not significant**.

iii. **Effects associated with ground contamination**

- 11.6.16 The construction PCSM and risk assessment are presented in **Appendix 11B** of this volume, and the impact assessment in **Appendix 11C** of this volume. The Construction Impact Assessment is undertaken by comparing the baseline land contamination risks to those predicted during construction, while considering any new sources and pollution pathways introduced by construction activities.

- 11.6.17 The construction phase would potentially introduce new sources of contamination, and disturb and mobilise existing sources of contamination. Construction activities, such as excavation and piling may introduce new pathways for migration of existing contamination and exposure of contaminated soil, remobilisation of contaminants through soil disturbance and the creation of preferential pathways for surface water run-off and ground gas migration. Potential changes to the baseline situation creating PCLs, which have been assessed within this chapter are:

- the potential for mobilising contaminants by excavation and stockpiling of material, increasing the risk to controlled water receptors through leaching and run-off. Earthworks could provide opportunities for run-off to contain suspended solids if not carried out in line with required management procedure;
- the potential for introducing new sources of contamination i.e. from spillages and leaks;
- the potential for exposure of human receptors by generation of potentially contaminated dust and vapours released by the construction works; and

- the potential for creation of new pathways to groundwater during groundworks, through opening up ground temporarily and construction activities, such as earthworks, installation of drainage and other below-ground services and foundations.

11.6.18 The impacts on land contamination during the construction phase are considered to be permanent and direct. Primary and tertiary mitigation measures would be incorporated into the construction process as outlined in **section 11.5**. These would include the adoption of working methods during construction to manage groundwater appropriately, implementation of appropriate pollution incident control and implementation of appropriate and safe storage of fuel, oils and equipment.

11.6.19 A summary of the construction phase PCSM and impact assessment is provided in **Table 11.12**, and includes the risks identified to the receptors. A more detailed assessment of construction risk and impact assessment is provided in **Appendices 11B** and **11C** of this volume.

11.6.20 It is considered that with the primary and tertiary mitigation measures adopted, the risks identified to human health, controlled waters and property receptors during construction would range between very low to moderate/low. Compared to the existing baseline, the level of risk to receptors has generally remained the same or slightly increased during the construction phase. An overall negligible to minor adverse effect has therefore been predicted, which is classed as **not significant**.

Table 11.12: Construction phase effects for the proposed development.

Receptor	Value/Sensitivity	Baseline Risk.	Construction Risk.	Classification of Effect.
Human (on-site).	High	Very low to low.	Very low.	Negligible (not significant).
Human (off-site).	High	Very low.	Very low.	Negligible (not significant).
Controlled waters: groundwater (on-site and off-site).	Medium	Low	Moderate/low	Minor adverse (not significant).
Controlled waters: surface water (on-site and off-site).	Medium	Very low.	Low	Minor adverse (not significant).
Property: existing and future structures and services (on-site and off-site).	Medium	Very low.	Very low.	Negligible (not significant).

Receptor	Value/Sensitivity	Baseline Risk.	Construction Risk.	Classification of Effect.
Property: crops and livestock (on-site and off-site).	Medium	Very low.	Very low.	Negligible (not significant).

iv. Effects associated with waste soils and soil re-use

- 11.6.21 Waste soils would be generated during construction through the proposed earthworks, excavations and the installation of drainage/services. There is the potential that waste soil generated from the earthworks, foundation construction (signage, lighting, barriers, bridge piers, etc.), culverts, utilities, and drainage (infiltration basins, gullies, swales) fencing and planting, would be classified as geotechnically, and/or chemically unsuitable for reuse on-site or hazardous, therefore requiring removal from site. Waste soils would be dealt with in accordance with the **Waste Management Strategy** presented in **Volume 2, Appendix 8A**.
- 11.6.22 A **Material Management Plan** would set out how material is managed on-site during construction and removal and reinstatement in accordance with appropriate guidance such as Contaminated Land: Applications in Real Environments Development Industry Code of Practice, to allow the sustainable re-use of suitable soils during the construction and removal and reinstatement of the proposed development. An **Outline SMP**, provided in **Volume 2, Appendix 17C**, would also be implemented to manage the reinstatement of agricultural land.
- 11.6.23 In line with the waste hierarchy, the design would seek, as far as reasonably practicable, to reduce the amount of soil/materials excavated and/or of a hazardous nature, to reuse and recycle waste soils/materials on-site where possible, and to manage soils/materials suitably including off-site disposal of waste, if required, in accordance with relevant legislation. Therefore, impacts associated with waste soils and soil re-use during the construction phase are considered to be temporary, short-term and direct.
- 11.6.24 Given the scale of the proposed development, the fact that the majority of the road goes through agricultural land which has remained undeveloped, and that Made Ground is only likely to be associated with the existing railway and roads crossing the proposed development, the value/sensitivity of the receptor is classed as medium. With the primary and tertiary mitigation measures, the magnitude of the impact is considered to be very low. The overall effect is therefore considered to be minor adverse and **not significant**.

v. Inter-relationship effects

- 11.6.25 This section provides a description of the identified inter-relationship effects that are anticipated to occur on geology and land quality receptors between the individual environmental effects arising from construction of the proposed development.
- 11.6.26 There are anticipated to be inter-relationship effects between geology and land quality, soils and agriculture, heritage and groundwater and surface water in relation to potential receptors which could be impacted by ground contamination during the construction of the proposed development.
- 11.6.27 Potential impacts would include the contamination of sensitive/high value receptors such as good quality or best and most versatile (BMV) agricultural land, listed buildings, principal aquifers, WFD rivers and groundwater SPZs during construction works. Construction activities may introduce new sources of contamination, new pathways for migration of contamination and disturb and mobilise existing sources of contamination.
- 11.6.28 However, given the primary and tertiary mitigation measures proposed in relation to these disciplines as outlined in **section 11.5**, it is not expected that the combined impact of these inter-relationship effects would be greater than those effects predicted for the Geology and Land Quality Assessment as presented within this chapter. Only minor adverse inter-relationship effects are anticipated, which are classified as **not significant**. Further details are provided in **Chapter 10** and **Chapter 12** of this volume.

c) Operation

i. Physical effects

- 11.6.29 Physical effects are considered to be mainly related to the construction phase. During operation, there would be limited physical effects through maintenance operations. Suitable design and subsequent maintenance works would also minimise physical effects, and the proposed development would be operated in accordance with the relevant regulations and best practicable measures.

ii. Soil erosion

- 11.6.30 Soil exposure during operation of the road is only likely to occur during maintenance operations through local excavations within the road, embankments, cuttings or associated infrastructure for maintenance. There may also be some limited exposure through failure of landscaping such as

grass, shrubs and trees dying to expose the soils. However, as maintenance operations are likely to be limited in lateral extent time and should not, generally, entail excessive earthworks, the likelihood of substantial soil exposure and subsequent soil erosion would be low. The impacts on soil erosion during the operational phase are therefore considered to be temporary, short-term, and direct.

- 11.6.31 Given the above, the value/sensitivity of the receptor is classed as low. With the primary and tertiary mitigation measures the magnitude of the impact is considered to be very low. Therefore, it is considered that soil erosion would remain as negligible and classed as **not significant** for soil erosion.

iii. Ground stability and soil compaction

- 11.6.32 As discussed in the construction phase, the potential for substantial ground instability and/or soil compaction is low. The impacts on ground stability and soil compaction during the operational phase are therefore considered to be temporary, short-term, and direct.

- 11.6.33 Given the likely limited disturbance of the proposed development through the operational phase the value/sensitivity is classed as low. With the implementation of primary and tertiary mitigations set out in **section 11.5**, the magnitude of the impact on soil compaction and ground instability is considered to be very low. The effect is therefore considered to be negligible and classed as **not significant**.

iv. Mineral resources

- 11.6.34 Effects in relation to mineral resources during the operation phase relate to the permanent sterilisation/loss of minerals, preventing future extraction. The impacts on mineral resources during the operational phase are therefore considered to be permanent and direct.

- 11.6.35 Given that there are no protected mineral resources and no previous mineral extraction located within the study area, the value/sensitivity of the receptor is classed as very low. The magnitude of the impact is considered to be very low as there would be limited loss of regional mineral resources. Effects in relation to loss, damage or sterilisation of mineral resources would stay as negligible and are classed as **not significant**.

v. Effects associated with ground contamination

- 11.6.36 The operational PCSM and risk assessment are presented in **Appendix 11B** and the impact assessment in **Appendix 11C** of this volume. The Operational Impact Assessment has been undertaken by comparing the baseline land contamination risks to those predicted during operation, while considering any new sources and pollution pathways introduced by operational activities.
- 11.6.37 The operation of the proposed development would potentially introduce new sources of contamination. Spillages and leaks may occur and below ground services could create additional potential pathways for the migration of potential contamination that were not present at baseline. The impacts on land contamination during the operational phase are considered to be permanent and direct.
- 11.6.38 A summary of the operational phase contamination effects is provided in **Table 11.13**. A more detailed assessment of construction risk and impact assessment is provided in **Appendices 11B** and **11C** of this volume. It is considered that with proposed mitigation, risks identified to human health, controlled waters and property receptors during operation are assessed as very low. Compared to the existing baseline, the level of risk to receptors has generally remained the same or slightly reduced. An overall negligible to minor beneficial effects are anticipated which are considered to be **not significant**.

Table 11.13: Operational phase effects for the proposed development.

Receptor	Sensitivity/Value	Baseline risk.	Operation Risk.	Classification of Effect.
Human (on-site).	High	Low	Very low	Minor beneficial (not significant)
Human (off-site).	High	Very low	Very low	Negligible (not significant)
Controlled waters: groundwater (on-site and off-site).	Medium	Low	Very low.	Minor beneficial (not significant)
Controlled waters: surface water (on-site and off-site).	Medium	Very low	Very low	Negligible (not significant)
Property: existing and future structures and services (on-site and off-site).	Medium	Very low	Very low	Negligible (not significant)
Property: crops and livestock (on-site and off-site).	Medium	Very low	Very low	Negligible (not significant)

vi. Effects associated with waste soils and soil re-use

- 11.6.39 The proposed development may also generate limited waste soils during operation due to maintenance requirements which may include excavations for landscaping and for repairs and maintenance of services. The proposed development would be operated in accordance with the relevant regulations and best practice pollution prevention guidance. Therefore, the impacts associated with waste soils and soils reuse during the operational phase are assessed to be temporary, short-term and indirect.
- 11.6.40 Given that there is less potential for soil reuse during the operational phase, the value/sensitivity of the receptor is classed as low. With the primary and tertiary mitigation measures, the magnitude of the impact is considered to be very low. The overall effect is therefore assessed to be negligible and considered to be **not significant**.

vii. Inter-relationship effects

- 11.6.41 This section provides a description of the identified inter-relationship effects that are anticipated to occur on geology and land quality receptors between the individual environmental effects arising from operation of the proposed development.
- 11.6.42 There are anticipated to be inter-relationship effects between geology and land quality, soils and agriculture, heritage and groundwater and surface water in relation to potential receptors which could be impacted by ground contamination during the operation of the proposed development.
- 11.6.43 Potential impacts would include the contamination of sensitive/high value receptors such as good quality or BMV agricultural land, listed buildings, principal aquifers, WFD rivers and groundwater SPZs during operation. Operation of the proposed development may introduce new sources of contamination and new pathways for migration of contamination.
- 11.6.44 However, given the primary and tertiary mitigation measures proposed in relation to these disciplines as outlined in **section 11.5** of this chapter, it is not expected that the combined impact of these inter-relationship effects would be greater than those effects predicted for the Geology and Land Quality Assessment as presented within this chapter. Only minor adverse inter-relationship effects are anticipated, which are classified as **not significant**. Further details are provided in **Chapter 10** and **Chapter 12** of this volume.

11.7 Mitigation and monitoring

a) Introduction

11.7.1 Primary and tertiary mitigation measures which have been accounted for as part of the assessment are summarised in **section 11.5**. Where further mitigation is required, this is referred to as secondary mitigation, and where reasonably practicable, secondary mitigation measures have been proposed.

11.7.2 This section describes the proposed secondary mitigation measures for geology and land quality, as well as describing any monitoring required of specific receptors/resources or for the effectiveness of a mitigation measure.

b) Mitigation

11.7.3 A ground investigation would be undertaken to inform the detailed design of the proposed development and confirm ground conditions, contamination status and other ground related risks. This would be completed prior to the commencement of construction works. Where the ground investigation and subsequent generic risk assessments identifies unacceptable levels of contamination and ground related risks, further detailed quantitative risk assessment followed by, where necessary, and the remediation of soil and groundwater contamination prior to construction may be required.

c) Monitoring

11.7.4 A programme of short-term gas and groundwater monitoring would be designed as part of the ground investigation, and would be required prior to construction works commencing. The results of this short-term monitoring would determine whether further long-term gas and groundwater monitoring is required during the construction and operational phases.

11.8 Residual effects

11.8.1 The following tables (**Tables 11.4** and **11.5**) present a summary of the Geology and Land Quality Assessment. They identify the receptor(s) likely to be impacted, the level of effect and, where the effect is deemed to be significant, the tables include the mitigation proposed and the resulting residual effect.

Table 11.14: Summary of effects for the construction phase.

Receptor	Impact	Primary or Tertiary Mitigation.	Assessment of effects.	Additional Secondary Mitigation.	Residual Effects.
Geology.	Soil erosion.	Health and safety risk assessments, method statements and appropriate personal protective equipment for the protection of construction workers. Implementation of measures in the COCP during construction works. Preparation of a piling risk assessment in accordance with Environment Agency guidance. Design and selection of construction materials in accordance with best practice.	Minor adverse.	Ground investigation and relevant risk assessments completed prior to detailed design and construction works. Remediation of soil and groundwater, if necessary. Longer term gas and groundwater monitoring if necessary.	Minor adverse (not significant).
	Soil compaction and ground stability.		Negligible		Negligible (not significant).
Mineral resources.	Loss, damage or sterilisation.		Negligible		Negligible (not significant).
Human health.	Contamination from on-site and off-site sources.		Negligible		Negligible (not significant).
Controlled waters (groundwater).	Contamination from on-site and off-site sources.		Minor adverse.		Minor beneficial (not significant).
Controlled waters (surface water).	Contamination from on-site and off-site sources.		Minor adverse.		Negligible (not significant).
Property (existing and future structures and services).	Contamination from on-site and off-site sources.		Negligible		Negligible (not significant).
Property (crops and livestock).	Contamination from on-site and off-site sources.		Negligible		Negligible (not significant).
Soils	Impacts from waste generated during construction works.	Minor adverse.	Minor adverse (not significant).		

Table 11.15: Summary of effects for the operational phase.

Receptor	Impact	Primary or Tertiary Mitigation.	Assessment of effects.	Additional Secondary Mitigation.	Residual Effects.
Geology	Soil erosion.	Use spill response kits and adequate staff training. Use of hardstanding to avoid spills and leaks. Incorporation of bypass separators within the drainage design where considered necessary. The use of appropriate SuDs schemes. The use of grid connections for electricity rather than generators. Appropriate storage and disposal of chemicals, oils, fuels, materials and wastes in accordance with current guidance.	Negligible	Longer term gas and groundwater monitoring if necessary.	Negligible (not significant).
	Soil compaction and ground stability.		Negligible		Negligible (not significant).
Mineral resources.	Loss, damage or sterilisation.		Negligible		Negligible (not significant).
Human health.	Contamination from on-site and off-site sources.		Negligible to minor beneficial.		Negligible to minor beneficial (not significant).
Controlled waters (groundwater).	Contamination from on-site and off-site sources.		Minor beneficial.		Minor beneficial (not significant).
Controlled waters (surface water).	Contamination from on-site sources and off-site.		Negligible		Negligible (not significant).
Property (existing and future structures and services).	Contamination from on-site and off-site sources.		Negligible		Negligible (not significant).
Property (crops and livestock).	Contamination from on-site and off-site sources.		Negligible		Negligible (not significant).
Soils	Impacts from waste generated during operation.	Negligible	Negligible	Negligible (not significant).	

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