



Tween Bridge Solar Farm

A Nationally Significant Infrastructure Project in the Energy Sector

Preliminary Environmental Information Report

Chapter 9 – Ground Conditions

March 2025



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9. Ground Conditions

9.1. Introduction

9.1.1. This chapter provides a description of the geology, soils, hydrogeology and contaminated land of the site area. It also provides an assessment of the predicted physical impacts of the proposed scheme during the construction, operational (including maintenance) and decommissioning phases. Where necessary, proposed mitigation measures are identified to eliminate or minimise potential impacts.

9.1.2. This chapter is supported by the following appendices:

- **Appendix 9.1- Phase 1 Ground Conditions Desk Study, Volume 1: Mai Report & Appendices A to G**
- **Appendix 9.2- Phase 1 Ground Condition Desk Study, Volume 2: Appendix H Groundsure Data Reports and Historical Maps**
- **Appendix 9.3- Phase 1 Ground Condition Desk Study, Volume 3: Tween Bridge Wind Farm Factual Site Investigation Report, Donaldson Associates 2009 & Headland Archaeology Report 2015**

9.2. Legislative Framework, Planning Policy and Guidance

9.2.1. The principal legislation designed to protect the physical environment, including land quality, waste management and water resources, and which may be relevant to construction, operation and decommissioning of the scheme, in addition to planning policy and guidance, is shown in **Table 9.1** overleaf.

Table 9.1 Key Relevant Legislation/ Policy	
Document	Summary
Part 2A of the Environmental Protection Act (EPA) 1990 (the Contaminated Land Regime)	Under Part 2A of the EPA 1990 sites are identified as 'contaminated land' if they are causing harm or if there is a significant possibility of significant harm or if the site is causing, or could cause, significant pollution of controlled waters. Part 2A mostly applies to the existing use of the site and its enforcement is the responsibility of the Local Planning Authority. As a minimum, newly developed sites should not be able to be classed as contaminated land as defined by Part 2A of the EPA 1990. The EPA 1990 endorses the principle of a 'suitable for use' approach for contaminated land, where remedial action is only required if there is an unacceptable risk to human health or risk of pollution of the environment, taking into account the use of the land and its environmental setting. Statutory contaminated land guidance describes a risk-based approach based on a 'source- pathway-receptor' model of the site. For the land to be determined as contaminated in a regulatory sense, and thereby require remediation, all three elements (a source of contamination, a receptor and a pathway by which the receptor could be exposed to the contamination) must be present.
The Water Act 2003	The Water Act 2003 amended the Water Resources Act 1991 and makes numerous provisions, including those related to contaminated land. The Water Act 2003 (and various commencement orders) brings into effect changes to the definition of contaminated land in the EPA 1990 so that, in relation to the pollution of controlled waters, for land to be determined as contaminated land it must cause significant pollution or there must be a significant possibility of such pollution of controlled waters.
The Water Resource Act 1991 (as amended)	The Water Resources Act 1991 (as amended) seeks to protect the quality of water by setting out the functions of the Environment Agency and describing offences relating to water and discharges to it.
The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017	Establishes a framework for action relating to water policy in England and Wales.
The Groundwater (Water Framework Directive) (England) Direction 2016	Sets out obligations to protect groundwater.

Table 9.1 Key Relevant Legislation/ Policy	
Document	Summary
The Environmental Damage (Prevention and Remediation) Regulations 2009	The Environmental Damage (Prevention and Remediation) Regulations 2009 implement the European Union Directive (2004/35) in respect of environmental liability and remedying environmental damage. They introduced obligations to ensure that the polluter pays for damage caused, supplementing existing legislation. Various enforcing authorities include the Environment Agency in relation to damage to water, Natural England in relation to biodiversity and LPAs in relation to land damage.
National Planning Policy	
Overarching National Policy Statement for Energy (NPS EN-1) (2023) designated in January 2024	Section 5.11 related to land use and includes details of planning policy relating to land contamination, soil and agricultural land.
The National Policy Statement for Renewable Energy Infrastructure (NPS EN-3) (2023) designated in January 2024	Section 2.10 considers issues relating to soil quality for solar development, including the consideration of land types on which schemes could be developed.
National Policy Statement for Electricity Network Infrastructure (NPS EM-5) (2023) designated in January 2024	Details issues relating to underground cables, in connection with soil and contamination, although predominantly dealing with overhead cables.
National Planning Policy Framework (NPPF) (Dec 2024)	Section 15 'Conserving and enhancing the natural environment'; para 196 to 197 requires planning policies to ensure that sites suitability for development is assessed with respect to ground contamination and natural / man-made hazards. Where risks are identified it is the responsibility of the developer and/or landowner to secure the site for safe development.
Local Planning Policy	
Doncaster Council Local Plan 2015-2035 (adopted 2021)	Includes: Policy 55 Contamination and Unstable Land (designed to ensure full and effective use of land in an environmentally acceptable manner); Policy 60 Protecting and Enhancing Doncaster's Soil and Water Resources (seeks to conserve, protect and enhance land quality, soil and water resources); Policy 61 Providing for and Safeguarding Mineral Resources (aims to plan for steady, adequate, efficiently and sustainably sourced minerals during the plan period, and supports non-

Table 9.1 Key Relevant Legislation/ Policy	
Document	Summary
	mineral development where it will not prevent economically viable mineral resource from being extracted in the future. Temporary development is an exemption from the Mineral Safeguarding Policy.
North Lincolnshire Council Local Development Framework 2010 Local Plan 2020–2038 (submission made in Nov 2022)	Includes policies and strategies to safeguard mineral resources and protect the environment. Temporary planning permission is an exception from their minerals safeguarding policy. Other Adopted Planning Policy documents include supplementary document Planning for Solar Photovoltaic (PV) Development, 2016 which provides policy considerations to manage impacts of construction and groundworks.
Guidance	
Land Contamination Risk Management (Environmental Agency, 2023)	
Ministry of Agriculture, Fisheries and Food (1988). Agricultural Land Classification for England and Wales: Revised Guidelines and Criteria for Grading the Quality of Agricultural Land	
Likelihood of Best and Most Versatile Agricultural Land Strategic scale maps (Natural England, 2017)	
Institute of Environmental Management and Assessment (IEMA) Guide: A New perspective on Land and Soil in Environmental Impact Assessment (2022)	
Technical Information Note TIN049: Agricultural Land Classification: protecting the best and most versatile agricultural land, 2nd edition (2012)	
Department for Food, Environment and Rural Affairs (Defra) Local Lands, Soils and Groundwater Management Technical Guidance (TG22)	
Design Manual for Roads and Bridges LA 113: Road Drainage and the Water Environment, Revision 1 (2020)	
Design Manual for Roads and Bridges LA 104: Environmental Assessment and Monitoring, Revision 1 (2020)	
A Green Future: Our 25 Year Plan to Improve the Environment	
The Environment Agency’s approach to groundwater protection, Version 1.2 (2018)	
The Environment Agency, protect groundwater and prevent groundwater pollution (August 2024 update)	

9.3. Consultation

- 9.3.1. Discussions were held with various Local Authority and other statutory consultees (e.g. Environment Agency, Canal & Rivers Trust, Mining Remediation Authority etc) during the EIA Scoping exercise. Subsequent revisions and amendments were made following feedback from these authorities.
- 9.3.2. A summary of consultation undertaken in relation to the geology, hydrogeology and contaminated land assessment is provided in **Table 9.2**. These updates were taken into account during the collation of this Final version of the PEIR.

Table 9.2 Summary of Consultation

Consultee	Summary of consultee response	How response has been addressed by applicant
North Lincolnshire Council	Contaminated Land Officer satisfied with baseline study to date and notes intrusive investigation to be undertaken at future stage. Requested clarity on which parts of study relate to differing Local Authorities. Queried gas risk from peat soils.	Phase 1 Desk Study (Appendix 9.1) updated: Local Authority areas clarified in text by colour highlighting in text and boundary used on all drawings as appropriate. Gas risk considered & assessed (Appendix 9.1. Section 3.3).
Environmental Agency	Sustainable Places team provided response in Scoping Opinion (13 th March 2023): Source Protection Zones and groundwater vulnerability to be considered, refer to Contaminated Land Special Site to southwest of site, need for land quality assessment where directional drilling proposed, historic landfill site potential for ground gas.	Phase 1 Desk Study (Appendix 9.1) updated: Aspects reviewed and updated once full environmental data reports obtained
Canal & River Trust	Provided response in Scoping Opinion. Noted proximity to Stainforth & Keadby Canal and risk to water pollution from unintentional run-off from exposed soils or dust	Phase 1 Desk Study (Appendix 9.1) updated: Aspects reviewed and updated.

Consultee	Summary of consultee response	How response has been addressed by applicant
City of Doncaster Council	<p>Provided response in Scoping Opinion. Noted southwestern section partially in a mineral safeguarding area and PEDL license area.</p> <p>Noted potential for some areas of concern regarding contaminated land and need for Phase II investigation and CEMP</p>	<p>Phase 1 Desk Study (Appendix 9.1) updated:</p> <p>Aspects reviewed and updated. Mineral Safeguard Area assessed for consented sites, areas of search and proposed sites allocations within period of Adopted Local Plan. (Appendix 9.1. Section 2.5.5 and drawings in Appendix E of that report).</p> <p>PEDL licenses clarified (Appendix 9.1. Section 2.5.6.2). Consultation with North Sea Transition Authority confirmed direct consultation with license holders is appropriate. Ongoing.</p> <p>Areas of potential contamination clarified.</p>
Coal Authority	No requirement to consider coal mining legacy	Summarised in Phase 1 Desk Study (Appendix 9.1)

9.4. Approach to the Assessment

Establishment of Baseline Environment

9.4.1. A preliminary risk assessment has been undertaken in order to develop an understanding of the physical environment and setting of the site. Baseline data was obtained from the following sources:

- Geological maps (bedrock and superficial geology)
- Hydrogeological and groundwater vulnerability maps
- Geological conservation review sites
- Historical mapping
- Site-specific environmental database report including Environment Agency, local authority and British Geological Survey data on the location of waste sites, pollution incidents and potentially contaminated sites, abstraction and discharge records relating to groundwater, plus aquifer designation and source protection zones.

9.4.2. The Groundsure reports are provided in Appendix 9.2- Volume 2: Groundsure data reports and Historical Maps.

Identification and Assessment of Impacts and Mitigation Measures

- 9.4.3. Potential impacts have been identified from data gathered during the desk study. This data has been assessed with the knowledge and experience of the impacts from similar projects, leading to the development of appropriate mitigation measures.
- 9.4.4. An assessment has been made of the significance of the potential effects on both the environment and the physical components of the scheme, taking into account the importance and sensitivity of the receptor, the magnitude of impact, the duration or persistence of the impact and the likelihood of the impact occurring.
- 9.4.5. Criteria adopted in the assessment are presented in **Tables 9.3, 9.4, 9.5 & 9.6.**

Table 9.3 Receptors value and sensitivity

Receptor	Receptor Sensitivity			
	High	Medium	Low	Negligible
End users, workers	Residential, allotments	Landscaping or open space, play areas	Commercial areas	'Hardcover' use e.g., roads or industrial areas
Surrounding land uses	Residential	Open space or commercial areas	Commercial areas	'Hardcover' use e.g., roads or industrial areas
Construction workers	Extensive earthworks, demolition	Limited earthworks	Minimal/ localised earthworks	No earthworks
Controlled waters	Principal aquifers, source protection zones, main rivers	Medium cultivation, ecological, mineral or scientific value/ sensitivity	Low cultivation, ecological, mineral or scientific value/ sensitivity	Absent/ no cultivation, ecological, mineral or scientific value/ sensitivity
Soils/ geology	High cultivation, ecological mineral, or scientific value/ sensitivity	Medium cultivation, ecological, mineral or scientific value/ sensitivity	Low cultivation, ecological, mineral or scientific value/ sensitivity	Absent/ no cultivation, ecological, mineral or scientific value/ sensitivity
Built Environment	Historic or other sensitive buildings	Buildings including services and foundations	Buildings including services and foundations	Not applicable

Table 9.4 Magnitude of Impact on Contamination Risk

Magnitude of Contamination Risk	Definition by example
High	<p>Significant contamination represents an unacceptable risk to identified receptors across much of the site.</p> <p>Site not suitable for current/proposed use without significant remediation.</p> <p>Enforcement action possible.</p> <p>Urgent action required.</p>
Medium	<p>Contaminants may represent an unacceptable risk to identified receptors across parts of the site.</p> <p>Site probably not suitable for current /proposed use without remediation.</p> <p>Action required in the medium term.</p>
Low	<p>Contaminants may be present but are unlikely to create unacceptable risk to identified receptors.</p> <p>Site probably suitable for current use, may require localised remediation for proposed use.</p> <p>Action unlikely to be needed whilst site remains in current use.</p>
Negligible	<p>If contamination sources are present they are considered Minor in nature & extent, and not likely to present a risk to identified receptors.</p> <p>Site suitable for current/proposed use.</p> <p>No further action required.</p>

Table 9.5 Magnitude of Impact on Geology and Soils

Magnitude of Impact on Soils, Geology and Groundwater	Definition by example
High	<p>Soils on a large proportion of the site will be removed (or improved) by the development.</p> <p>Important geological features or high quality agricultural soils will be destroyed.</p> <p>Important mineral resources will be sterilised or made inaccessible by the development.</p> <p>Groundwater resources will be subject to an identifiable change in groundwater flow regime, aquifer use or artesian flows.</p>
Medium	<p>Access to important geological features will be restricted (or improved) by the development.</p> <p>Localised damage (or improvement) to soils quality or geological features.</p> <p>Groundwater resources will be subject to an identifiable change in local groundwater flow regime or aquifer use.</p>
Low	<p>Access to some localised geological features may be restricted (or improved) by the development.</p> <p>Very localised damage (or improvement) to soils or geological features.</p> <p>Measurable change in groundwater levels, but no appreciable change in groundwater flow regime, status or potential use.</p>
Negligible	<p>No damage to important soil, mineral resources or geological features, and only Minor disturbance (or improvement) of soils. No or very limited impact on groundwater resources.</p>

Note: Impacts can be adverse or beneficial

- 9.4.6. The significance of effect for land and soil is based on the sensitivity of the receptor and the magnitude of impact (change), as outlined in **Table 9.6**.
- 9.4.7. The significance of an effect is reported as either 'significant' or 'not significant'. Any effects determined as 'minor to moderate' or above are considered to be significant. Any effects determined as 'minor' or below are considered not significant.

Table 9.6 Significant of Residual Effects

Magnitude	Sensitivity			Negligible
	High	Medium	Low	
High	Major	Major/ Moderate	Moderate	Minor
Medium	Major/ Moderate	Moderate	Minor	Negligible
Low	Minor/Moderate	Minor	Minor	Negligible
Negligible	Minor	Negligible	Negligible	Negligible

9.4.8. The Phase 1 Desk Study (Appendix 9.1) is being provided to the local authorities and Environment Agency for review and comment, as part of the consultation process. The scope and location of proposed specific targeted Phase II intrusive investigation and risk assessment will be agreed with these regulators in due course and undertaken after consent during the detailed design phase.

Limitations to the Assessment

9.4.9. The current chapter is based on the findings of the Phase 1 Desk Study and site reconnaissance, as given in Appendix 9.1. No intrusive investigation has been completed for the current proposals at this stage. The factual data used to complete the desk study includes the previous (2009) investigation findings for the Tween Bridge Wind Farm and borehole records provided as Open Government License data by the British Geological Survey.

9.4.10. It is noted that the site boundary has changed since the Phase 1 Desk study was completed and this report is yet to be updated. For areas that were not covered by the original Phase 1 report, the baseline data summarized within this chapter is based only on information from Groundsure environmental database reports. The Phase 1 Desk Study will be updated in due course to reflect the site’s boundary change.

9.5. Environmental Baseline

Site Description and Context

- 9.5.1. The Site lies east of Thorne and west of Crowle, bounded north by the Humberhead Peatlands National Nature Reserve and south by Hatfield Moors and the Isle of Axholme. It comprises approximately 2,527 hectares of agricultural land parcels (named as parcels A to F) within the lowland basin of the former Rivers Don and Idle. The land is typically at 1-4m OD with very low or Negligible gradients, drained by ditches and larger Drains, with the River Torne forming the southeast boundary. It is crossed by a network of roads, railway and canal

Baseline Survey Information

- 9.5.2. The Phase 1 Desk Study in Appendix 9.1 provides details of the sources used to derive the baseline survey information and have been summarised on **Table 9.7** overleaf.

Table 9.7 Site Geology			
Land Area	Strata	Description	Depth (m)
Area A –West (Formerly Area 9. Tween Bridge Moors) <i>(based on 2009 investigation for the Wind Farm)</i>	Topsoil	Topsoil	GL to 0.3–0.5
	Hemingbrough Glaciolacustrine Formation	Soft occasionally firm orange brown and grey sandy CLAY or occasionally loose clayey silty SAND	0.3–0.5 to 1.4–2.1
	Hemingbrough Glaciolacustrine Formation	Soft to firm or firm thinly laminated brown sandy CLAY or SILT	1.4–2.1 to 3.8–8.8
	Fluvioglacial sand & Gravel or Hemingbrough Formation	Medium dense red brown silty fine to medium SAND	3.8–8.8 to 10.0–11.0
	Sherwood Sandstone Group	Weak, occasionally very weak red brown medium to coarse grained SANDSTONE, becoming weak to medium strong. With occasional very weak to weak thinly laminated MUDSTONE.	Below 11.0–14.5 +
Area A – East (Formerly Area 9. Tween Bridge Wind Farm East) <i>(based on very sparse BGS boreholes in the extreme southern area)</i>	Topsoil/ Subsoil	Made Ground/ WARP? Soils (loamy and clayey)	GL to 1.0–1.25
	Reworked Peat/ Alluvium	Soft to firm organic very silty odorous Clay	1.0–1.25 to 3.4
	Flandrian Alluvium/ Hemingbrough Formation	Very soft or firm brown silty sandy Clay with organic fragments	3.4 to 4.5–5.2
	Hemingbrough/ Concealed Sand?	Loose rapidly medium dense brown Sand	4.5–5.2 to 6.8
	Concealed Sand and Gravel/ Weathered Bedrock	Dense red brown slightly silty sand with occasional gravel	6.8 to 9.6–10.0m+
Area B (Formerly	Topsoil/ Subsoil	Peaty, loamy and clayey	GL to 0.1–1.0
	Flandrian Alluvium and Peat	Very soft grey and brown organic alluvial Clay/ Silt	0.3–1.0 to 1.0–2.5
		Very soft or soft clayey Peat	0.3–1.0 to 1.5–9.5

Table 9.7 Site Geology			
Land Area	Strata	Description	Depth (m)
Area 1. Old River Don) <i>(based on sparse borehole information immediately South of Area 1 and the Canal)</i>		Soft organic alluvial Clay/ Silt or firm clayey sandy Silt	1.5-9.5 to 5.0-12.0
	Hemingbrough Formation	Loose becoming medium dense laminated clayey sandy Silt or firm Silt/ Clay, gravelly in parts	5.0-12.0 to 10.0-12.0
	Mercia Mudstone Group	Medium dense or dense red brown clayey SAND to very weak Sandstone/ Mudstone	10-12.0 +
Area C – West (formerly Area 8. Clay Bank) <i>(based on 4 relevant boreholes)</i>	Topsoil/ Subsoil	Sandy and loamy	GL to 0.3-0.9
	Alluvium	Soft to firm or firm brown and grey mottled and peaty sandy Clay	0.3-0.9 to 1.0-4.0
	Blown/ Sutton Sand Formation	Loose grey silty Sand	1.0-2.6 to 2.4-3.3
	Hemingbrough Formation	Soft to firm laminated brown Clay with silt partings and loose sand horizons	2.3-4.0 to 6.5-7.6
	Hemingbrough/ Concealed Sand and Gravel?	Mixed grey silty Clay and Sand with some gravel becoming Medium dense silty Sand	4.5-7.6 to 10.6-16.0
	Chester Formation	Red Marl and Sandstone	Below 10-16.0 +
Area C – East (Formerly Area 4. Bletchers Drain and new area "Area C East") <i>(based on borehole information)</i>	Topsoil/ Subsoil	Loamy and clayey	GL to 0.3-0.8
	Blown sand/ Sutton Sand Formation	Medium dense grey brown silty Sand (thin in south, thickening northwards)	0.3-0.8 to 0.5-4.0
	Hemingbrough Formation	Soft to firm brown laminated silty Clay with silt lenses	0.5 to 3.5
	Peat (in southeastern corner)	Very soft brown peat	0.5-1.6
	Concealed Sand and Gravel	Medium dense brown Sand and Gravel	3.5 to 6.5
	Chester Formation	Sandstone	Below 6.5

Table 9.7 Site Geology			
Land Area	Strata	Description	Depth (m)
Area D - Northeast (formerly Area 5. Elder Gates, High Levels and new Area D East) (based on existing borehole information)	Topsoil/ Subsoil	Loamy and clayey	GL to 0.3-0.6
	Peat	Soft dark brown clayey PEAT	0.3-1.2 to 1.0-2.5
	Flandrian Alluvium and Peat	Soft brown silty Clay or medium dense grey brown silty Sand with organic traces	0.5-2.5 to 1.8-3.7
	Hemingbrough Formation	Soft to firm or firm dark brown silty or silty Clay with silt laminations and fine sand lenses	1.8-3.7 to 6.0-12.0
	Concealed Sand and Gravel	Sand and fine Gravel	6.0-12.0 to 15 +
	Chester Formation	Red Sandstone	Below 15 +
Area D - Northwest (formerly Area 6. Hatfield Chase) (based on existing borehole information)	Topsoil/ Subsoil	Loamy and clayey	GL to 0.3-0.6
	Flandrian Alluvium	Medium dense brown silty Sand or firm sandy Clay, occasionally peaty	0.3-0.6 to 1.3-3.0
	Hemingbrough Formation	Soft or firm brown silty Clay with silt laminations and fine sand lenses	1.3-3.0 to 3.0-4.2
	Concealed Sand and Gravel	Loose becoming medium dense and dense Sand with some fine to coarse Gravel, clayey pockets and cobbles in parts	2.8-4.2 to 5.0-7.0
	Chester Formation	Red sandstone	Below 7.0 +
Area D -South (formerly Area 7. Ferne Carrs and new Area D East) (based on borehole information from the eastern area adjacent to the M180)	Topsoil/ Subsoil	Sandy and loamy with a little gravel	GL to 0.5
	Blown sand/ Sutton Sand Formation?/ Brighton Sand?	Loose or medium dense grey brown slightly silty fine and medium SAND	0.5 to 2.3
	Hemingbrough Formation	Soft or firm laminated brown very silty Clay to clayey Silt with some sand horizons, becoming gravelly below 4.3m	2.3 to 4.6
	Concealed Sand and Gravel	Dense to very dense Sand with some gravel	4.6 to 7.5
	Chester Formation	Red Sandstone	Below 7.5 +
	Topsoil/ Subsoil	Loamy and sandy with peat	GL to 0.3-0.6

Table 9.7 Site Geology			
Land Area	Strata	Description	Depth (m)
Area E East (formerly Area 2. North Engine Drain to River Torne new Area E West) <i>(based on existing boreholes and geological mapping)</i>	Peat	Very soft or soft clayey Peat in peripheries	0.3-0.6 to 1.0-1.5
	Blown sand/ Sutton Sand Formation	Medium dense yellow, brown or red brown slightly clayey or silty fine to medium SAND, soft and wet silty sand to sandy clay in parts	0.3-0.6 to 1.5-5.0
	Hemingbrough Formation	Soft to firm laminated red or red brown very silty slightly sandy CLAY, becoming firm to stiff with fine sand or sandy bands in parts	1.5-5.0 to 7.0-11.0
	Mercia Mudstone Group	Medium dense or dense brown clayey SAND to very weak SANDSTONE/ MUDSTONE	Below 7.0-11.0 +
Area E West (formerly Area 3. Plains Lane) <i>(based on sparse borehole information)</i>	Topsoil/ Subsoil	Loamy and clayed with peat	GL to 0.4-0.5
	Flandrian Alluvium	Soft grey brown peaty Clay or loose red brown Sand	0.4-0.5 to 2.0-5.0
	Flandrian Alluvium and Peat	Very soft or soft clayey Peat and Peat	2.0-5.0 to 2.0-7.0
	Flandrian Alluvium and Peat	Soft organic/ peaty alluvial Clay/ Silt	2.0-7.0 to 3.5-7.0
	Hemingbrough Formation	Medium dense laminated clayey Sand or firm Silt/ Clay, gravelly in parts	3.5-7.0 to 6.0-7.0+
Area F (new area not included in original Phase 1 report) <i>(based on 7 on-site boreholes)</i>	Topsoil/ Subsoil	Sandy and loamy	GL to 1.1
	Made Ground	Fill	0.0-1.5
	Blown/ Sutton Sand Formation	Loose grey/brown silty Sand	0.2-4.0 to 2.5-5.2
	Peat in the east	Soft brown clayey peat over fibrous peat	0.4-7.2
	Hemingbrough Formation	Soft to firm laminated brown Clay with silt and clayey silt	0.6-5.2 to 5.8-7.0
	Hemingbrough/ Concealed Sand and Gravel	Clayey fine Sand and rounded Gravel	7.0-12.1 to 8.0-13.0
	Mercia Mudstone Group	Red/grey Mudstone	6.7-16.7

- 9.5.3. Permeable alluvial superficial deposits typically form a Secondary A Aquifer, whilst the peat and laminated silt/clay deposits are Unproductive. Sherwood Sandstone at depth forms a Principal Bedrock Aquifer.
- 9.5.4. The local details of groundwater vulnerability are complex; however the Secondary Superficial Aquifers are typically of medium groundwater vulnerability in the central and western Site area. Parts of the eastern and northeastern areas, and of the southwest have high groundwater vulnerability in the Secondary Superficial Aquifer, mainly where sands occur.
- 9.5.5. Within 1.00-10.00m distance of drainage ditches, groundwater may be maintained at 1.00-2.00m below GL much of the year and 0.50-1.00m below GL in winter. More remote than 8.00-10.00m probably between 0.50-2.00m below GL most of year in most areas. In some areas groundwater will stand at less than 0.50m below GL in winter, or at field capacity i.e. at ground surface in worst periods.
- 9.5.6. Overall, groundwater flows west to east across the study area with rectilinear drainage pattern controls, and little or no flow locally.
- 9.5.7. The western and central site area is a Source Protection Zone 3 (Total Catchment) with an area of Source Protection Zone 2 (Outer Catchment) c. 250m west of the southwest Draft Order Limits extent.
- 9.5.8. Both these relate to an abstraction borehole at Sandtoft Road pumping station 600m west of southwest Draft Order Limits, which forms the center of a Source Protection Zone 1 (Inner Catchment).
- 9.5.9. Historic maps indicate a prolonged history of agricultural use, with drainage features of key importance. Historical Peat working was mainly beyond the Site boundaries, with a peat works at Medge Hall, and at Hatfield Peat Works to the south, just beyond the Draft Order Limits.
- 9.5.10. Small scale peat digging or sand and gravel workings are markedly limited on the mapping. Larger workings at Tudworth Hill are only shown on maps from the 1960's and appear to not be infilled, based on topographic evidence. Some evidence for Flood Warp channels and ponds is noted on the mapping. Area F was not covered in the original Phase 1 Desk study report but a review of historic maps shows tramways and sidings, an unspecified pit and an unspecified tank.
- 9.5.11. Relevant environmental permits and incidents detailed within the environmental database report (Appendix 9.2) of note, former landfills at Tudworth, and a waste transfer station facility at Brier Hills Farm lie adjacent beyond the Site boundaries.
- 9.5.12. Mineral Safeguarding Areas are identified by North Lincolnshire Council for Sand and Gravel and for Brick Clay, and by Doncaster Council for Sand and Gravel, within parts of the Draft Order Limits. Neither of the Councils respective consented extraction sites, areas of search, nor proposed sites allocations lie within the Draft Order Limits. Development which is deemed a Mineral Safeguarding Exception within the relevant Local Plan policies includes the Exemption Criteria of temporary

planning permissions, which (by definition) includes renewables schemes with time limited permission and an integral decommissioning phase.

- 9.5.13. A World War II airfield at Sandtoft included a bomb store area close to Woodcarr Small Drain, north of the M180. The location of an air crash west of Crowle has not been identified precisely in the soft ground. A Preliminary Unexploded Ordnance Risk Report for the complete Order Limits area will be obtained during autumn 2023, followed by Detailed UXO Risk Report(s) for the former airfield bomb store area and any other areas identified as of concern by the Preliminary Report, prior to final submission of the Environmental Statement
- 9.5.14. Thorne Colliery operated 1925–58 from two shafts approximately 875m north of the Site and not within influencing distance. The Coal Authority have confirmed there is no requirement to consider mining legacy within the EIA.
- 9.5.15. The Initial Conceptual Exposure Model in Section 4 of Appendix 9.1 identifies localised ground workings, the former airfield area, and two previous pollution incidents as the main on-site potential contaminant Sources (Section 4.2 of Appendix 9.1). The off-site Sources identified as requiring consideration are the Tudworth Hall Farm landfill adjacent northwest, the Brier Hills Farm waste management station adjacent south, and the Contaminated Land Determination at Green Tree Garage approximately 600m west.
- 9.5.16. The Conceptual Exposure Model Receptors identified are construction workers, future construction and maintenance staff, drainage ditches and water courses, groundwater within the Secondary Superficial Aquifer, and the solar Scheme infrastructure and plant. There are no residential receptors within 250m of the proposed substations and BESS areas.
- 9.5.17. The Conceptual Exposure Model Pathways identified by which contaminant sources could impact on these receptors are dermal exposure and inhalation, migration of ground gas, contact with unexploded ordnance, creation of new water migration pathways during construction, surface water run-off, and direct contact of construction materials with contaminated ground.
- 9.5.18. The potential Source–Pathway–Receptor linkages identified are summarised in **Table 9.8**.

Table 9.8: Potential Contamination Linkages

Source	Pathway	Receptor
Former Tudworth Sand/Gravel Workings if contaminated soils present	Dermal exposure Inhalation (if contamination exposed during groundworks)	On-site construction worker.
Former Airfield / bomb store Unexploded Ordnance or contaminated soils	UXO risk Dermal exposure Inhalation (if contamination exposed during groundworks)	On-site construction worker.
Brier Hills Waste Management Site on southern boundary	Dermal exposure Inhalation of particulates	On-site construction worker

Source	Pathway	Receptor
Area 7B (Area D) if airborne surface particulates spread beyond	(if surface disturbed significantly during construction)	
Former Tudworth Sand/Gravel Workings if contaminated soils within construction depth	Creation of new pathways for leaching or migration of liquid contaminants through the unsaturated zone by means of new man-made or natural pathways. Inverter stations only.	Surface Water Courses & Groundwater
Former Airfield / bomb store contaminated soils	Creation of new pathways for leaching or migration of liquid contaminants through the unsaturated zone by means of new man-made or natural pathways. Run-off from disturbed soils. Inverter stations only.	Surface Water Courses & Groundwater
Pollution Incident 2003 Oil/Fuel impact Area 2 (Area E) trackway	Creation of new pathways for leaching or migration of liquid contaminants through the unsaturated zone by means of new man-made or natural pathways. Run-off from disturbed soils.	Surface Water Courses & Groundwater
Clay/Silt laden Run-off (loamy and clayey soils)	Mobilisation due to intense machinery traffic during wet weather	Surface Water Courses
Former Tudworth Sand/Gravel Workings if contaminated soils within construction depth	Migration of abnormal ground gases Contact with soils	Array cables or pipework Inverter stations In-ground concrete
Tudworth Hall Farm Landfill if gas migration has occurred beyond boundaries	Migration of abnormal ground gases	Array cables or pipework
Former Airfield / bomb store contaminated soils	Contact with soils	Array cables or pipework In-ground concrete
Pollution Incident 2003 Oil/Fuel impact Area 2 (Area E) trackway	Contact with soils	Array cables or pipework In-ground concrete
Brier Hills Waste Management Site on southern boundary Area 7B (Area D) if airborne	Contact with airborne surface particulates	Array cables or pipework In-ground concrete

Source	Pathway	Receptor
surface particulates spread beyond		
Highly peaty Alluvium or Peat at shallow depth where Battery Energy Storage (BESS), Substations or Inverters located	Migration of combustible gases	BESS compound Substations Inverter Stations (and by connection human receptors)
Note: The Phase 1 Desk study did not include Area F or other additional land parcels in Areas C, D and E. Provisional additional contaminant linkages assessed based on review of the Groundsure reports are reported below. Table 9.8 will be finalized once the updated Phase 1 report has been completed.		
Provisional additional contaminant linkages for additional land parcels		
Potential contamination associated with made ground and historic land uses including tramways, sidings, unspecified pits and tanks	Contact with soils	Array cables or pipework In-ground concrete

- 9.5.19. At the time of writing the location of trenchless cable works requiring horizontal directional drilling at crossing points is unknown but likely required near Maud’s Bridge for the Stainforth and Keadby Canal and South Humberside Main Line Railway, at the M180 motorway at Hatfields Chase, and at High Level Bank Road (the A18). A number of Internal Drainage Board Managed Watercourses which may require trenchless cable works are being explored.
- 9.5.20. The qualitative risk assessment concludes that the shallow construction activity required for the solar arrays will not create an adverse or worsening impact on the contaminant exposure model. A Construction Environmental Management Plan will be required. Further consideration is needed for structures, confined spaces and sensitive plant, battery storage areas and substations.
- 9.5.21. It is considered that specific targeted contamination investigations at the critical historical land use or environmental features identified within the conceptual exposure model can be undertaken at detailed design stage following consent.
- 9.5.22. For geotechnical design purposes a range of array foundations are available, including both pin pile and concrete ballast types, dependent on the soil conditions in various parts of this very large Site. Piled foundations are the most likely option for substations and the battery energy storage system (BESS). Access roads and tracks are likely to require use of geogrid reinforcement to minimise pavement thickness and materials import, and cable trenching should be scheduled for drier periods.
- 9.5.23. Geotechnical investigation should develop the ground model, particularly where former river channels occur, by use of probing traverses to capture the range of ground conditions, with select control boreholes to aid interpretation. Additional boreholes are needed at directional drilling locations. Foundation trials for arrays could be used to optimise design and construction.

- 9.5.24. The ongoing assessments will be used to inform the scope of ground investigation (and any subsequent remediation) works. These include: detailed site reconnaissance walkover at specific locations identified in the Phase 1 Desk Study, further liaison with consultees on landfilling and waste management sites outside the Draft Order Limits, and approach to Minerals Safeguarding Areas, and Horizontal Directional Drilling assessment.

Future Baseline

- 9.5.25. In the absence of the Scheme, it is likely that the ground conditions within the Draft Order Limits would remain as existing

9.6. Predicted Impacts

Construction

- 9.6.1. Site levelling works are not typically envisaged at most locations within the prevalent very low slope angle topography in this area. For the arrays there will be no removal of soil, mineral resources or geological features, and only minor disturbance during construction. At substations, the battery area and compounds topsoil will be stripped and stockpiled for reuse during construction or restoration.
- 9.6.2. Construction of the Scheme is likely to involve installation of cable runs to between 0.5–1.5m below existing ground level and installation of arrays by driving steel pin piles to between 1.5 and 3m depth or adopting concrete ballast foundations. It may be necessary to adopt piled foundations for specific substations and the battery energy storage area (BESS), dependent on the anticipated loadings and ground conditions. This will reduce the need for large amounts of mass concrete or trench foundations.
- 9.6.3. New access roads will require stripping of topsoil and placement of aggregate, very likely with geogrid reinforcement to reduce the thickness of new construction required. At inverter stations, substations and the BESS area, along with temporary construction compounds and stores, it is likely that topsoil will be stripped, an aggregate blanket placed and reinforced concrete slabs constructed to support plant, or piled foundations installed. Topsoil would be appropriately stored to minimise damage and provide for initial and final site restoration.
- 9.6.4. The requirement to minimise disturbance of peat soils during construction and maintenance in order to minimise release of carbon dioxide and maximise the carbon balance savings of the Scheme is considered in Chapter 14 (Air Quality). Potential effects of disturbance on carbon dioxide release are most likely to occur during the construction period.
- 9.6.5. Given the current degraded ('wasted') soils at the shallow depths anticipated for construction of arrays across the majority of the peaty soils areas, and the current agricultural operations, it is considered that minimal additional disturbance will occur. Where peaty soils occur in areas for compounds, BESS or substations, micro siting to reduce potential carbon release will be considered at detailed design stage. Reuse of excavated soils and minimising waste will provide further mitigation.

- 9.6.6. At horizontal directional drilling crossing points, it is likely that multi-duct installations will be required, with launch and receive pits for the drilling equipment, drilling platforms and potentially a drilling mud storage pit or recycling area pit, along with conventional construction compounds, access and storage areas. A specialist contractors method statement and environmental management plan will be required for this aspect of the construction.
- 9.6.7. The determination of the unmitigated effects relating to soils and water resources and potential contamination during the construction phase is given in **Table 9.9** overleaf.

Table 9.9 Significance of effects during construction				
Feature / Receptor	Potential Effect	Magnitude of Effect	Receptor Sensitivity	Significance of Effect
Soils & Underlying Geology	Loss of Topsoil / Subsoil	<u>Arrays</u> : Negligible as no removal of important soil, mineral resources or geological features, and only slight disturbance of soils. <u>Substations, BESS, compounds</u> : Low as localised removal and reuse possible	Low or Medium due to current agricultural use and resilience to structural damage.	Minor or Minor to Moderate
Soils	Damage to soils by compaction, rutting and poaching	Low– Short term work at each area for array installation. Heavier trafficked routes and compounds more likely to be damaged if abnormal weather and wet soils	Medium due to current agricultural use, short term and recoverable	Minor to Moderate
Mineral Resource of Underlying Geology	Resource inaccessible	Low – access to local areas restricted only during lifetime of development. No depletion or damage to resource and development temporary.	<u>Safeguarded areas</u> : Medium value as no current consents or areas of search proposals within current Local Plans. <u>Remainder of Site area</u> : Negligible mineral value.	Minor to Moderate
Peat Stability	Unacceptable differential settlement beneath new loaded areas. Stability of excavations. Very localised damage or disruption of continuity possible.	Low – very localised damage or disruption	Medium – construction activities, structures or services	Minor to Moderate

<p>Groundwater Quality Source Protection Zone 3 on-site (Total Catchment)</p>	<p>Changes to pollutant pathways (Minor nature of most construction limits significant disturbance/ release of contaminants; penetrative foundations could increase potential changes). Short term changes to local groundwater flow regime for new crossing points.</p>	<p>Low – those very few areas of potential (low level) source contamination identified are in array areas only and so unlikely to be disturbed significantly. Any penetrative foundations (ie deeper piling) require further assessment. Groundwater level or flow changes short-lived.</p>	<p>Medium or High – Secondary Aquifer in Superficial Deposits, low to Medium permeability soils, Source Protection Zone 3, some areas of High Vulnerability, groundwater & surface water connectivity assumed</p>	<p>Minor or locally Moderate Adverse</p>
<p>Surface Water Quality Substations, BESS and compounds, new roads/tracks</p>	<p>Disturbance of contamination or run-off to water courses</p>	<p>Medium – due to degree of construction activities proposed, proximity of water courses, likely connectivity with shallow perched groundwater.</p>	<p>Medium – assume likely connectivity between shallow perched groundwater & surface water courses</p>	<p>Moderate – adverse</p>
<p>Surface Water Quality All areas near drainage or water courses where substations, BESS, compounds or new roads/tracks</p>	<p>Mobilisation of clay/silt fines due to machinery traffic during wet weather</p>	<p>Medium – due to degree of construction activities proposed, proximity of water courses</p>	<p>Medium – currently agricultural plant operating similarly across majority of area. Locally High sensitivity</p>	<p>Moderate – adverse</p>
<p>Surface Water Quality Horizontal Directional Drilling Sites</p>	<p>Disturbance of contamination, run-off to water courses, potential use of polluting materials and plant</p>	<p>Medium – proven construction techniques proposed with integral preventative measures</p>	<p>High – due to proximity of water courses and assumed likely connectivity between shallow groundwater & water courses</p>	<p>Major-adverse</p>

Ground Gas Regime Adjacent landfill and waste management sites (no on-site sources confirmed to date)	Linkage of receptors with ground gas	Low – predominantly outdoors usage, with shallow array installation only at these locations. Absence of confined spaces, very low potential for new pathway creation due to shallow installation	Low – no groundworkers in confined space working. Arrays only within influencing distance	Minor
Ground Gas Regime Naturally occurring peat /organic sources	Linkage of receptors with ground gas	Low – predominantly outdoors usage. Shallow array installation. Very low potential for new pathway creation due to shallow construction and ‘wasted peat’ regime. Confined spaces & sensitive infrastructure potential at substations and BESS	Medium – confined spaces & sensitive infrastructure potential at substations and BESS	Minor to Moderate
Surrounding Land Uses	Disturbance /release of contamination beyond Site boundaries	Negligible –no works beyond Site boundary.	Low – agricultural or open space. No residential properties within 250m of substations or BESS	Negligible
Construction Workers	Exposure to contaminants	Low – if contamination sources present they are considered Minor in nature and extent, & short term exposure	Medium – limited earthworks typically	Minor to Moderate
Construction Workers	Unexploded Ordnance (former airfield / bomb store)	High – UXO would represent an unacceptable risk	Medium – limited earthworks for arrays and inverter stations	Major – adverse

9.6.8. During the construction phase, risks to human health for groundworkers, site visitors and neighbours by exposure to any contaminants present will be controlled by the contractor as part of their obligations under the Construction (Design & Management) Regulations 2015 (CDM). by use of Personal Protective Equipment, dust suppression, vehicle sheeting and wheel

washing as necessary, prevention of entry to confined spaces without monitoring or equipment etc.

- 9.6.9. The processes are well practiced and the risks well understood, therefore the construction would have a remaining Minor adverse potential risk to human health once the risks are correctly controlled.
- 9.6.10. During the limited groundworks, there will be a low likelihood of exposure of workers to any contaminated soils (and potentially to abnormal ground gases in any confined spaces). The unexploded ordnance risk in the former airfield area remains unknown and Preliminary and Detailed UXO risk assessments from a specialist are to be obtained. This is considered a Major and Adverse effect, and therefore Significant. It requires mitigation by means of specialist risk assessment to identify the degree of risk. If that assessment concludes that UXO site supervision and watching brief during groundworks in this area is required, then it will be controlled by the contractor under their CDM obligations and secured by implementation of the Construction Environmental Management Plan (CEMP). The exposure would have a remaining Minor or Negligible adverse potential risk to human health once the risks are correctly controlled.
- 9.6.11. There is clearly potential, as with most construction sites, for oil/diesel or other contaminants to be accidentally spilled or to leak from plant and equipment during the works. In critical locations, this could potentially impact on the groundwater quality, or run-off to surface water courses. The significance of this potential effect in this site context is considered Moderate and Adverse and will therefore require mitigation by design and management identified within the CEMP.
- 9.6.12. There is a low potential for contaminants to be present in any shallow depth Made Ground and Negligible for natural soils. The limited amount of earthworks required for the majority of the area where solar arrays or inverters are proposed will limit disturbance to such soils. The actual degree of contamination present at the substation, BESS and compounds areas or where potentially contaminative features or areas have been identified, and where water courses are in close proximity, is considered a plausible Moderate and Adverse effect and therefore Significant. This will be clarified during further assessment walkover and research and confirmed during post-consent investigation to inform both detailed design and the Detailed CEMP.
- 9.6.13. There is not considered to be any short-term increased risk of dust generation from soils due to the limited nature of proposed earthworks and the predominantly cohesive soils. However, this requires control measures identified within the Construction Environmental Management Plan (CEMP).
- 9.6.14. There is a Moderate and Adverse potential for mobilisation of fines within run-off during abnormal or extreme wet weather combined with intense traffic movements of construction machinery. While there is currently frequent heavy agricultural plant using similar techniques, this aspect is considered Significant and requires mitigation. The CEMP must include control measures, requirements for use of protective systems such as track matting or membrane cover and protocols for work adaptation.

- 9.6.15. The directional drilling proposals, particularly where adjacent to water courses are considered a plausible Major and Adverse effect due to the type of construction activity in proximity to surface water and with potential to intersect the groundwater table.
- 9.6.16. A specialist directional drilling contractors method statement and environmental management plan will be required for this Significant aspect of the construction to mitigate the potential effects.
- 9.6.17. For Safeguarded Minerals Areas within the Draft Order Limits the temporary nature of the development and the fact that it would not deplete or damage the resource for the longer term indicates a Minor to Moderate effect.
- 9.6.18. Groundwater levels and flow pathways are unlikely to be altered by installation of array foundation pin piles or shallow cabling due to their typical size and length. In cohesive soils the driven installation forms a rapid 'seal' around the pin, thus precluding formation of new vertical pathways.
- 9.6.19. Where peaty soils are present, these are classed as 'wasted' due to prolonged drainage and agriculture. The limited degree of disturbance caused by array piles is unlikely to create any further enhanced drainage or wasting due to the installation. Groundwater within the deeper organic deposits beneath the pin piles would be unaffected.
- 9.6.20. Further assessment of the likely groundwater levels in very low elevation areas such as Tudworth and Hatfield Chase is being undertaken and will be included in the next iteration of this PEIR.

Operation

- 9.6.21. Following commissioning, maintenance engineers would visit on occasion as necessary. Grass pasture will be retained or upgraded between and beneath the arrays which will be available for small livestock grazing.
- 9.6.22. This land use will maintain or lower the probability of future ground contamination of soils and geology occurring. This is a low magnitude effect on a Medium sensitivity receptor and therefore will produce a Minor Neutral or Beneficial effect.
- 9.6.23. The end users and surrounding land uses are limited to maintenance staff during periodic visits and surrounding agriculture or open space sites. The site usage will maintain or lower the probability of exposure to any ground contaminants, by reducing agricultural intervention such as ploughing or digging. This is a low magnitude effect on Medium sensitivity receptors and therefore will produce a Minor Neutral or Beneficial effect.

Decommissioning

- 9.6.24. The decommissioning phase is considered to create potential similar effects to that during construction, or of lesser magnitude. All above ground plant and equipment, and all cabling above 1m below ground would be removed. Any cabling buried 1m+ below ground will not be removed at decommissioning.

- 9.6.25. Bunded topsoil from the initial stripped areas can be reused for site restoration. Where steel pin piles are adopted, these installations can be removed easily and economically.

9.7. Mitigation, Enhancement and Residual Effects

Embedded Mitigation

- 9.7.1. Environmental effects on ground conditions which are determined as Moderate or Major would be mitigated within the embedded design measures and secured through implementation of the CEMP for the Scheme. Additionally, effects considered above as Minor to Moderate will be mitigated by inclusion within embedded design considerations, the CEMP and good construction practice.
- 9.7.2. Those embedded measures will be secured by adoption of agreed Outline and Detailed Construction Environmental Management Plans. The measures are summarised in Table 9.9 and described further below.
- 9.7.3. Peat stability will be assessed during detailed design at any specific locations where existing geological data or intrusive investigation indicates a sufficient peat thickness would be intersected by the proposed construction, such as at new accesses, tracks or where structures are proposed. Critical areas will be identified and protocols for groundworks activities in these areas developed.
- 9.7.4. Selection of appropriate plant and best practice working methods would be adopted to control or reduce creation of new pathways during penetrative foundations ie piling.
- 9.7.5. Appropriate buffer or non-working zones would be integral to the construction layout alongside surface water courses to prevent fines run-off, or mobilisation of chemicals entering the water courses.
- 9.7.6. Appropriately located storage areas would be allocated for all construction products, in particular hydrocarbons or petrochemicals in accordance with Control of Substances Hazardous to Health (COSHH) Regulations 2002.
- 9.7.7. For crossing points requiring horizontal directional drilling, specific risk assessments, method statements and environmental management plans, based on location specific topography, ground and groundwater conditions, will be undertaken and agreed with consultees, stakeholders and regulators prior to commencement.
- 9.7.8. Assessment of shallow depth ground gas regime at sensitive infrastructure locations such as substations and BESS is required, with adoption of appropriate gas protection within ground slab design if appropriate. Location specific unexploded ordnance risk assessments would be undertaken by specialist consultancy at detailed design stage and their recommendations embedded in the Detailed CEMP. This may require on-site supervisory watching brief and in situ testing during works.
- 9.7.9. Environmental effects on ground conditions which are determined as Moderate or Major would be mitigated within the embedded design measures and secured through implementation of the

CEMP for the Scheme. Additionally, effects considered above as Minor to Moderate will be mitigated by inclusion within embedded design considerations, the CEMP and good construction practice.

- 9.7.10. Those embedded measures will be secured by adoption of agreed Outline and Detailed Construction Environmental Management Plans. The measures are summarised in Table 9.9 and described further below.
- 9.7.11. Peat stability will be assessed during detailed design at any specific locations where existing geological data or intrusive investigation indicates a sufficient peat thickness would be intersected by the proposed construction, such as at new accesses, tracks or where structures are proposed. Critical areas will be identified and protocols for groundworks activities in these areas developed.
- 9.7.12. Selection of appropriate plant and best practice working methods would be adopted to control or reduce creation of new pathways during penetrative foundations ie piling.
- 9.7.13. Appropriate buffer or non-working zones would be integral to the construction layout alongside surface water courses to prevent fines run-off, or mobilisation of chemicals entering the water courses.
- 9.7.14. Appropriately located storage areas would be allocated for all construction products, in particular hydrocarbons or petrochemicals in accordance with Control of Substances Hazardous to Health (COSHH) Regulations 2002 .
- 9.7.15. For crossing points requiring horizontal directional drilling, specific risk assessments, method statements and environmental management plans, based on location specific topography, ground and groundwater conditions, will be undertaken and agreed with consultees, stakeholders and regulators prior to commencement.
- 9.7.16. Assessment of shallow depth ground gas regime at sensitive infrastructure locations such as substations and BESS is required, with adoption of appropriate gas protection within ground slab design if appropriate. Location specific unexploded ordnance risk assessments would be undertaken by specialist consultancy at detailed design stage and their recommendations embedded in the Detailed CEMP. This may require on-site supervisory watching brief and in situ testing during works.

Additional Mitigation

- 9.7.17. No additional mitigation measures are currently envisaged as required prior to and during construction, since the potential effects detailed above are considered localised and temporary, or would be controlled by the embedded design and management measures secured by the CEMP, or controlled by contractors obligations under CDM Regulations.

During Operation

- 9.7.18. With the implementation of the embedded mitigation measures and those undertaken during the construction phase, the effects on Ground Conditions aspects during operation of the Scheme are considered Negligible.
- 9.7.19. Maintenance activities involving potentially contaminative products would be controlled under the Operations Environmental Management Plan (OEMP.) The site drainage strategy would be designed to preclude potentially contaminated run-off. Maintenance works involving in-ground working or excavations would require similar strategy and control to those adopted at construction stage, and again by specified within the OEMP.
- 9.7.20. No additional mitigation measures are envisaged therefore during operation for ground conditions aspects.

During Decommissioning

- 9.7.21. At the end of the Scheme operation, it is anticipated that decommissioning works would have similar effects on ground conditions aspects to those during the construction stage. Therefore, no additional mitigation measures are envisaged as likely during decommissioning.

Table 9.10 Mitigation Measures by Design or During Construction

Ref	Measure to avoid, reduce or manage any adverse effects and/or to deliver beneficial effects	How measure would be secured		
		By Design	By S.106	By CEMP Requirements
1	Peat stability assessment	X		
2	Prevent changes to pollutant pathways or prevent new pathways creation	X		X
3	Prevent disturbance of contamination or run off to water courses	X		X
4	Horizontal Directional Drilling Method Statement and CEMP	X		X
5	Gas Risk Assessment	X		
6	Unexploded Ordnance Risk Assessment and potentially on-site supervision / watching brief and in situ testing	X		X

7	Geotechnical & Geoenvironmental Investigation	X		
8	Contractors watching brief for unforeseen contamination			X

Residual Effects

- 9.7.22. Residual impacts are only considered in the assessment assuming implementation of the mitigation measures described above.
- 9.7.23. It is therefore considered that if the mitigation measures are implemented and adhered to then there should be no Significant residual Adverse effects to the soils, geology, hydrogeology, contaminated land, ground gas regime during the construction, operation and decommissioning phases of the Scheme.

Cumulative and In-Combination Effects

- 9.7.24. It is considered that the majority of effects of this Scheme on ground conditions would occur only within a localised area where soils, geology or hydrogeology are linked or have connectivity. This is considered to be no greater than 2 km beyond the Order Limits.
- 9.7.25. Other developments will be required to comply with the planning process which requires the land to be suitable for its intended use and not cause harm to potential receptors. The mitigation measures identified above for the current Scheme would prevent, reduce or offset environmental effects relating to Ground Conditions aspects. Those other developments would also need to demonstrate compliance with these principles.
- 9.7.26. Therefore, the cumulative residual effects are likely to be Not Significant for ground conditions aspects.

9.8. Summary

Introduction

- 9.8.1. This chapter of the PEIR assesses the likely significant effects of the Scheme on Ground Conditions, including soils, geology, groundwater and contaminated land.
- 9.8.2. The chapter is supported by the findings of a Phase 1 Desk Study (Appendix 9.1) and Scheme design information available at the time of writing and will be updated as further assessments and consultation responses become available

Baseline Conditions

- 9.8.3. This very large Site is predominantly large agricultural fields with isolated farmsteads, crossed by a network of roads, railway and canal. It forms part of the lowland basin of the former Rivers Don and Idle, being low-lying at typically 1–4mOD, with very low to Negligible natural gradients. The fields are typically bounded by a grid of numerous drainage ditches and larger water courses.
- 9.8.4. The area is underlain by thick sequences of complex superficial deposits including former lake laminated silt/clay deposits, sands and gravels and infill sediments to deep glacial period channels. Thick alluvial clay and silt blankets these and overlap marginal peat deposits. The old rivers have been historically diverted and artificial alluvium (floodwarp) deposited to provide better draining agricultural soils.
- 9.8.5. Surface soils are loamy or clayey, slowly to moderately permeable, or relatively impermeable and seasonally wet with impeded drainage. This helps maintain a naturally high groundwater table. There are no bog peat soils mapped.
- 9.8.6. There is no requirement to consider coal mining legacy within the Draft Order Limits. Peat soils were formerly more extensive, but peat cutting, drainage, ploughing and flood warping has lowered and compacted the relatively thin surface peats, such that they are classed as 'wasted' within the Draft Order Limits area. Parts of the western and eastern areas are included in Minerals Safeguarding Areas for sands and gravels, although these do not include any operational extraction sites, consented, proposed or search areas within the current Local Plans.
- 9.8.7. The Scheme area lies beyond the Hatfield Moors gasfield and two Petroleum Exploration and Development Licence areas cover parts of the western Draft Order Limits. The area has a prolonged agricultural history with isolated farmsteads. Peat working is not specifically mapped but has likely occurred historically, with peat works beyond the boundaries. A World War II airfield and bomb stores in the extreme southeast has been returned to agriculture.
- 9.8.8. Permeable alluvial superficial deposits typically form a Secondary A Aquifer, whilst the peat and laminated silt/clay deposits are Unproductive. Sherwood Sandstone at depth forms a Principal Bedrock Aquifer. Groundwater levels are maintained below ground level for much of the year by drainage and there is likely hydraulic continuity between groundwater and water courses. The overall level and flow will also be controlled by local factors such as former drainage courses or historical features. The western and central zones are in Source Protection Zone (SPZ) 3, due to a

SPZ 1 at a pumping station 600m west of the Draft Order Limits, and SPZ 2, 250m West. Groundwater vulnerability to pollution is typically Medium, with parts being High where sands of the Secondary Superficial Aquifer occur.

- 9.8.9. Former landfills at Tudworth and a waste transfer station at Brier Hills lie adjacent to the western and southern boundaries respectively. Two past pollution incidents within the Draft Order Limits are considered as plausible contaminant sources and a Contaminated Land Determination 600m west has been considered within the conceptual modelling.
- 9.8.10. Potential Source–Pathway–Receptor linkages identified for assessment can be summarised as: dermal and inhalation exposure and UXO risk to construction workers at the former sand workings, adjacent waste site and airfield; leaching or migration of liquid or mobile contamination to surface water or groundwater; fines laden run-off to water courses if heavy machine working in adverse weather conditions; migration of abnormal ground gases to sensitive structures; direct contact of construction materials with contaminated soils; directional drilling at crossing points adjacent water courses.
- 9.8.11. Assessment concludes that the shallow construction for solar arrays will not create an adverse or worsening effect. A Construction Environmental Management Plan (CEMP) will be required.
- 9.8.12. Further consideration is required for structures, confined spaces and sensitive plant. Specific targeted contamination investigation at critical locations during detailed design stage is proposed, in combination with geotechnical investigation for foundation design and directional drilling.

Likely Significant Effects

- 9.8.13. The assessment indicates that during construction the majority of effects can be controlled by CDM Regulations and the CEMP as they are well understood and practiced. The limited and shallow groundworks create low likelihoods of exposure.
- 9.8.14. Those potential effects deemed Moderate or Major and Adverse comprise: UXO risk at the former airfield/bomb stores; potentially polluting construction plant and materials working near water courses; disturbance of any contaminated soils where deeper or larger scale construction proposed for substations and BESS area; fines run-off to water courses if heavy machinery working during adverse weather; and directional drilling at surface water crossing points.

Mitigation and Enhancement

- 9.8.15. Environmental effects determined as Moderate or Major would be mitigated within the design measures of the Scheme to prevent, reduce and offset those effects. Those embedded mitigation measures will be secured by adoption of agreed Outline and Detailed CEMP's.
- 9.8.16. With the adoption and implementation of the agreed embedded mitigation measures, the effects identified for construction, operation and decommissioning of the Scheme are Negligible. There is no requirement for additional mitigation measures.

Conclusion

- 9.8.17. The short duration construction period and shallow depth intrusive construction method for the majority of the Scheme are determined as creating only localised and temporary environmental effects. Those elements determined as potentially giving rise to Moderate or Major effects would be mitigated by implementation of a well understood and practiced CEMP and controlled under CDM Regulations, secured under the DCO. The residual effects are therefore Negligible and Not Significant.
- 9.8.18. **Table 9.11** overleaf provides a summary of effects, mitigation and residual effects.

PRELIMINARY ENVIRONMENTAL INFORMATION REPORT

Ground Conditions

Table 9.11: Summary of Effects, Mitigation and Residual Effects								
Receptor / Receiving Environment	Description of Effect	Nature of Effect	Sensitivity Value	Magnitude of Effect	Geographical Importance	Significance of Effects	Mitigation Enhancement Measures	Residual Effects
Construction								
Soils & Underlying Geology	Loss of Topsoil / Subsoil	Temporary Direct	Medium	Low	Local	Minor or Minor to Moderate Adverse	None required	Negligible (Not Significant)
Soils	Damage by compaction or rutting	Temporary Direct	Medium	Low	Local	Minor to Moderate Adverse	None required	Negligible (Not Significant)
Mineral Resource of Underlying Geology	Resource inaccessible	Temporary Direct	Medium	Low	Borough / District	Minor to Moderate Adverse	None required	Negligible (Not Significant)
Peat Stability	Settlement, stability, damage, disruption	Permanent Direct	Medium	Low	Local	Minor to Moderate Adverse	None required	Negligible (Not Significant)

TWEEN BRIDGE SOLAR FARM

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Ground Conditions

Aquifers, Groundwater Quality, Source Protection Zones	Change to pathway, flow Change in quality	Temporary Direct	Medium or High	Low	Borough / District	Moderate Adverse	Design and CEMP	Negligible (Not Significant)
Surface Water Quality	Disturbance of contamination Mobilisation of Fines	Temporary Direct	Medium	Medium	Borough / District	Moderate Adverse	Design and CEMP	Negligible (Not Significant)
Surface Water Quality Directional Drilling Sites	Disturbance of contamination, run-off, polluting materials / plant	Temporary Direct	High	Medium	Borough / District	Major Adverse	Risk Assessment, Design and CEMP	Negligible (Not Significant)
Ground Gas Regime	Linkage of receptors with ground gas	Permanent Direct	Low	Low	Local	Minor Adverse	Design and CEMP	Negligible (Not Significant)
Natural Ground Gas (Peat)	Linkage of receptors with ground gas	Permanent Direct	Medium	Low	Local	Minor to Moderate Adverse	Design and CEMP	Negligible (Not Significant)

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PRELIMINARY ENVIRONMENTAL INFORMATION REPORT

Ground Conditions

Surrounding Land Uses	Release of contaminants beyond boundaries	Temporary Indirect	Low	Negligible	Local	Negligible	CEMP	Negligible (Not Significant)
Construction Workers	Exposure to contaminants	Temporary Direct	Medium	Low	Local	Minor to Moderate Adverse	CDM CEMP	Negligible (Not Significant)
Construction Workers	Unexploded Ordnance	Temporary Direct	Medium	High	Local	Major Adverse	UXO Assessment CDM CEMP	Negligible (Not Significant)
Operation								
Soils	Future ground contamination	Temporary Direct	Low	Low	Local	Minor Neutral or Beneficial	Not required	Negligible (Not Significant)
End Users and Surrounding Uses	Future contamination exposures	Temporary Indirect	Medium	Low	Local	Minor Neutral or Beneficial	Not required	Negligible (Not Significant)

TWEEN BRIDGE SOLAR FARM

PEIR VOLUME 1 – CHAPTER 9 GROUND CONDITIONS

MARCH 2025

PRELIMINARY ENVIRONMENTAL INFORMATION REPORT

Ground Conditions

Decommissioning								
Similar to Construction Phase								
Cumulative and In-Combination								
Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable

