



Hornsea Project Four: Environmental Statement (ES)

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Volume A3, Chapter 1 : Geology and Ground Conditions

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Table of Contents

1.1	Introduction	7
1.2	Purpose	7
1.3	Planning and Policy Context	8
1.4	Consultation.....	12
1.5	Study Area	18
1.6	Methodology to inform baseline.....	19
1.7	Baseline environment	21
1.8	Project basis for assessment	41
1.9	Maximum Design Scenarios	48
1.10	Assessment methodology	52
1.11	Impact assessment.....	56
1.12	Cumulative effect assessment (CEA).....	60
1.13	Transboundary effects	67
1.14	Inter-related effects.....	67
1.15	Conclusion and summary.....	69
1.16	References	71

List of Tables

Table 1.1: Summary of NPS EN-1 provisions relevant to geology and ground conditions.	8
Table 1.2: Summary of NPS EN-1 policy on decision making relevant to geology and ground conditions.....	9
Table 1.3: National Planning Policy Framework Guidance Relevant to Ground Conditions and Contamination.	10
Table 1.4: Consultation Responses.	12
Table 1.5: Key Sources of Geology and Ground Conditions Data.....	19
Table 1.6: Geological sequence for the Hornsea Four 1 km geology and conditions study area.	21
Table 1.7: Geology and ground conditions impact register - Impacts not considered in detail in the ES.....	41
Table 1.8: Relevant Geology and Ground Conditions Commitments.....	45
Table 1.9: Maximum design scenario for impacts on geology and ground conditions.....	49
Table 1.10: Definition of Terms Relating to Receptor Sensitivity.....	52
Table 1.11: Definition of Terms Relating to Magnitude of an Impact.	54
Table 1.12: Matrix used for the assessment of the significance of the effect.	56
Table 1.13: Potential Cumulative Effects.	61

Table 1.14: Project Screening for CEA for Geology and Ground Conditions.	63
Table 1.15: Inter-related effects assessment for geology and ground conditions.	67
Table 1.16: Summary of potential impacts assessed for geology and ground conditions.	70

List of Figures

Figure 1.1: Geology and Ground Conditions Study Area.....	20
Figure 1.2: Potential Sources of Contamination (Sheet 1 of 7).	25
Figure 1.3: Potential Sources of Contamination (Sheet 2 of 7).	26
Figure 1.4: Potential Sources of Contamination (Sheet 3 of 7).	27
Figure 1.5: Potential Sources of Contamination (Sheet 4 of 7).	28
Figure 1.6: Potential Sources of Contamination (Sheet 5 of 7).	29
Figure 1.7: Potential Sources of Contamination (Sheet 6 of 7).	30
Figure 1.8: Potential Sources of Contamination (Sheet 7 of 7).	31
Figure 1.9: Mineral Safeguarding Areas (Landfall) (Sheet 1 of 5).....	34
Figure 1.10: Mineral Safeguarding Areas (Onshore ECC #1) (Sheet 2 of 5).....	35
Figure 1.11: Mineral Safeguarding Areas (Onshore ECC #2) (Sheet 3 of 5).....	36
Figure 1.12: Mineral Safeguarding Areas (Onshore ECC #3) (Sheet 4 of 5).....	37
Figure 1.13: Mineral Safeguarding Areas (OnSS) (Sheet 5 of 5).	38

Annexes

Annex Number	Heading
1.1	Land Quality Preliminary Risk Assessment
1.2	Envirocheck Report (Part One - Part Eight)

Glossary

Term	Definition
Area of Search	Areas of search relating to mineral extraction areas where knowledge of mineral resources may be less certain but within an area where planning permission for extraction may be granted.
Code of Construction Practice (CoCP)	A document detailing the overarching principles of construction, contractor protocols, construction-related environmental management measures, pollution prevention measures, the selection of appropriate construction techniques and monitoring processes.
Commitment	<p>A term used interchangeably with mitigation and enhancement measures. The purpose of Commitments is to reduce and/or eliminate Likely Significant Effects (LSEs), in EIA terms.</p> <p>Primary (Design) or Tertiary (Inherent) are both embedded within the assessment at the relevant point in the EIA (e.g. at Scoping, Preliminary Environmental Information Report (PEIR) or ES).</p> <p>Secondary commitments are incorporated to reduce LSE to environmentally acceptable levels following initial assessment i.e. so that residual effects are acceptable.</p>
Cumulative effects	The combined effect of Hornsea Four in combination with the effects from a number of different projects, on the same single receptor/resource. Cumulative impacts are those that result from changes caused by other past, present or reasonably foreseeable actions together with Hornsea Project Four.
Design Envelope	A description of the range of possible elements that make up the Hornsea Four design options under consideration, as set out in detail in the project description. This envelope is used to define Hornsea Four for Environmental Impact Assessment (EIA) purposes when the exact engineering parameters are not yet known. This is also often referred to as the "Rochdale Envelope" approach.
Development Consent Order (DCO)	An order made under the Planning Act 2008 granting development consent for one or more Nationally Significant Infrastructure Projects (NSIP).
Effect	Term used to express the consequence of an impact. The significance of an effect is determined by correlating the magnitude of the impact with the importance, or sensitivity, of the receptor or resource in accordance with defined significance criteria.
EIA Regulations	Infrastructure Planning (Environmental Impact Assessment) Regulations 2017.
Energy balancing infrastructure (EBI)	The onshore substation includes energy balancing Infrastructure. These provide valuable services to the electrical grid, such as storing energy to meet periods of peak demand and improving overall reliability.
Environmental Impact Assessment (EIA)	A statutory process by which certain planned projects must be assessed before a formal decision to proceed can be made. It involves the collection and consideration of environmental information, which fulfils the assessment requirements of the EIA Directive and EIA Regulations, including the publication of an Environmental Statement (ES).
Environmental Statement (ES)	A document reporting the findings of the EIA and produced in accordance with the EIA Directive as transposed into UK law by the EIA Regulations.

Term	Definition
Export cable corridor (ECC)	The specific corridor of seabed (seaward of Mean High Water Springs (MHWS)) and land (landward of MHWS) from the Hornsea Four array area to the Creyke Beck National Grid substation, within which the export cables will be located.
High Voltage Alternating Current (HVAC)	High voltage alternating current is the bulk transmission of electricity by alternating current (AC), whereby the flow of electric charge periodically reverses direction.
High Voltage Direct Current (HVDC)	High voltage direct current is the bulk transmission of electricity by direct current (DC), whereby the flow of electric charge is in one direction.
Hornsea Project Four Offshore Wind Farm	The term covers all elements of the project (i.e. both the offshore and onshore). Hornsea Four infrastructure will include offshore generating stations (wind turbines), electrical export cables to landfall, and connection to the electricity transmission network. Hereafter referred to as Hornsea Four.
Landfall	The generic term applied to the entire landfall area between Mean Low Water Spring (MLWS) tide and the Transition Joint Bay (TJB) inclusive of all construction works, including the offshore and onshore ECC, intertidal working area and landfall compound. Where the offshore cables come ashore east of Fraisthorpe.
Made Ground	Land where natural and undisturbed soils have largely been replaced by man-made or artificial materials
Maintain	Includes inspect, upkeep, repair, adjust, and alter and further includes remove, reconstruct and replace, to the extent assessed in the environmental statement; and "maintenance" must be construed accordingly.
Maximum Design Scenario (MDS)	The maximum design parameters of each Hornsea Four asset (both on and offshore) considered to be a worst case for any given assessment.
Mineral Safeguarding Area	Mineral Safeguarding Areas are areas that contain known mineral resources that warrant protection due to their economic value. Mineral safeguarding is a process to prevent non-mineral development unnecessarily sterilising mineral resources deemed as being of local and national importance.
National Grid Electricity Transmission (NGET) substation	The grid connection location for Hornsea Four at Creyke Beck.
Onshore substation (OnSS)	Comprises a compound containing the electrical components for transforming the power supplied from Hornsea Project Four to 400 kV and to adjust the power quality and power factor, as required to meet the UK Grid Code for supply to the National Grid. If a HVDC system is used the OnSS will also house equipment to convert the power from HVDC to HVAC.
Order Limits	The limits within which Hornsea Four (the 'authorised project') may be carried out.
Orsted Hornsea Project Four Ltd.	The Applicant for the proposed Hornsea Project Four Offshore Wind Farm Development Consent Order (DCO).
Planning Inspectorate (PINS)	The agency responsible for operating the planning process for Nationally Significant Infrastructure Projects (NSIPs).
Preferred Search Area	Preferred areas contain known mineral resources where planning permission for mineral extraction may reasonably be anticipated.
Trenchless Techniques	Also referred to as trenchless crossing techniques or trenchless methods. These techniques include Horizontal Directional Drilling (HDD), thrust boring, auger boring,

Term	Definition
	and pipe ramming, which allow ducts to be installed under an obstruction without breaking open the ground and digging a trench.

Acronyms

Acronym	Definition
ACM	Asbestos Containing Material
Bgl	Below ground level
BGS	British Geological Survey
CEA	Cumulative Effects Assessment
CoCP	Code of Construction Practice
CSM	Conceptual Site Model
DCO	Development Consent Order
DEFRA	Department for Environment Food and Rural Affairs
DMRB	Design Manual for Roads and Bridges
DWS	Drinking Water Standard
EBI	Energy Balancing Infrastructure
ECC	Export Cable Corridor
EEA	European Economic Area
EIA	Environmental Impact Assessment
EPA	Environmental Protection Act
EQS	Environmental Quality Standard
ES	Environmental Statement
HDD	Horizontal Directional Drilling
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IDB	Internal Drainage Boards
JB	Joint Bay
LB	Link Box
LSE	Likely Significant Effect
MHWS	Mean High Water Springs
NPPF	National Planning Policy Framework
NPS	National Policy Statement
NSIP	Nationally Significant Infrastructure Project
O and M	Operation and Maintenance
OnSS	Onshore Substation
OS	Ordnance Survey
PCB	Polychlorinated biphenyls
PCoC	Potential Contaminants of Concern
PEIR	Preliminary Environmental Information Report
PINS	Planning Inspectorate
PPE	Personal Protective Equipment

Acronym	Definition
PRA	Preliminary Risk Assessment
PRoW	Public Right of Way
SPA	Special Protection Area
SPZ	Source Protection Zone
SSSI	Site of Special Scientific Interest
SVOC	Semi-Volatile Organic Compounds
UK	United Kingdom
VOC	Volatile Organic Compounds
WFD	Water Framework Directive

Units

Unit	Definition
km	kilometre
kV	kilovolt
m	metre

1.1 Introduction

- 1.1.1.1 Orsted Hornsea Project Four Limited (the 'Applicant') is proposing to develop Hornsea Project Four Offshore Wind Farm (hereafter 'Hornsea Four'). Hornsea Four will be located approximately 69 km offshore the East Riding of Yorkshire in the Southern North Sea and will be the fourth project to be developed in the former Hornsea Zone. Hornsea Four will include both offshore and onshore infrastructure including an offshore generating station (wind farm), export cables to landfall, and on to an onshore substation (OnSS) with energy balancing infrastructure (EBI), and connection to the electricity transmission network.
- 1.1.1.2 This chapter of the Environmental Statement (ES) presents the results of the Environmental Impact Assessment (EIA) for the potential impacts of Hornsea Four on geology and ground conditions. Specifically, this chapter considers the potential impact of Hornsea Four landward of Mean High-Water Springs (MHWS) during its construction, operation and maintenance, and decommissioning phases. Details of impacts below MHWS on geology are included within [Volume A2, Chapter 1: Marine Geology, Oceanography and Physical Processes](#).
- 1.1.1.3 This chapter summarises information contained within two technical reports, which are included at [Volume A6, Annex 1.1: Land Quality Preliminary Risk Assessment](#), and [Volume A6, Annex 1.2: Envirocheck Report](#) (Part 1 to Part 8).

1.2 Purpose

- 1.2.1.1 The primary purpose of the ES is to support the Development Consent Order (DCO) application for Hornsea Four under the Planning Act 2008 (the 2008 Act). This ES constitutes the environmental information for Hornsea Four and sets out the findings of the EIA.
- 1.2.1.2 The ES has been finalised with due consideration of pre-application consultation to date (see [Volume B1, Chapter 1: Consultation Report](#) and [Table 1.4: Consultation Responses](#).) and the ES will accompany the application to the Planning Inspectorate (PINS) for Development Consent.
- 1.2.1.3 This ES chapter:
- Presents the existing environmental baseline established from desk studies, and consultation;
 - Presents the potential environmental effects on geology and ground conditions arising from Hornsea Four, based on the information gathered and the analysis and assessments undertaken;
 - Identifies any assumptions and limitations encountered in compiling the environmental information; and
 - Highlights any necessary monitoring and/or mitigation measures which could prevent, minimise, reduce or offset the possible environmental effects identified in the EIA process.

1.3 Planning and Policy Context

- 1.3.1.1 Planning policy on offshore renewable energy Nationally Significant Infrastructure Projects (NSIPs), specifically in relation to geology and ground conditions, is contained in the Overarching National Policy Statement (NPS) for Energy (EN-1; DECC 2011).
- 1.3.1.2 NPS EN-1 includes guidance on what matters are to be considered in the assessment. These are summarised in [Table 1.1](#).
- 1.3.1.3 The UK planning and policy context for Hornsea Four is set out in [Volume A1, Chapter 2: Planning and Policy Context](#). The potential effects in relation to geological conservation importance are considered within this chapter. Note that potential effects on sites of importance for nature conservation are considered separately in [Chapter 3: Ecology and Nature Conservation](#).

Table 1.1: Summary of NPS EN-1 provisions relevant to geology and ground conditions.

Summary of NPS EN-1	How and where considered in the ES
<p><i>"Where the development is subject to EIA [Environmental Impact Assessment] the applicant should ensure that the ES [Environmental Statement] clearly sets out any effects on internationally, nationally and locally designated sites of ecological or geological conservation importance, on protected species and on habitats and other species identified as being of principal importance for the conservation of biodiversity. The applicant should provide environmental information proportionate to the infrastructure where EIA is not required to help the IPC [hereafter the Secretary of State (SoS)] consider thoroughly the potential effects of a proposed project'.</i></p> <p><i>The applicant should show how the project has taken advantage of opportunities to conserve and enhance biodiversity and geological conservation interests"</i> (EN-1, paragraph 5.3.3 and 5.3.4).</p>	<p>Designated sites (including geological) have been considered as part of the route planning and site selection process, as outlined in Volume A1, Chapter 3: Site Selection and Consideration of Alternatives.</p> <p>This ES chapter presents the potential impacts and effects of Hornsea Four, including those that may be related to sites of national and local importance (see Sections 1.11 and Section 1.12).</p> <p>Volume A6, Annex 1.1: Land Quality Preliminary Risk Assessment informs this ES chapter and includes a review of the available information with regards to internationally, nationally and locally designated sites of geological importance. Designated sites (including geological sites) where possible have been routed around to conserve areas of geological conservation interest (see Co2, Volume A4, Annex 5.2: Commitments Register).</p> <p>Details and potential effects on international, nationally and locally designated sites of ecological conservation importance are addressed in Chapter 3: Ecology and Nature Conservation.</p>

- 1.3.1.4 NPS EN-1 also highlights several factors relating to the determination of an application and in relation to mitigation. These are summarised in [Table 1.2](#).

Table 1.2: Summary of NPS EN-1 policy on decision making relevant to geology and ground conditions.

Summary of NPS EN-1 provisions	How and where considered in the ES
<p><i>"In having regard to the aim of the Government's biodiversity strategy the SoS should take account of the context of the challenge of climate change: failure to address this challenge will result in significant adverse impacts to biodiversity. The policy set out in the following sections recognises the need to protect the most important biodiversity and geological conservation interests. The benefits of nationally significant low carbon energy infrastructure development may include benefits may outweigh harm to these interests. The SoS may take account of any such net benefit in cases where it can be demonstrated."</i> (EN-1, paragraph 5.3.6).</p>	<p>Designated sites (including geological) have been considered, and where possible routed around as part of the route planning and site selection process, as outlined in Volume A1, Chapter 3: Site Selection and Consideration of Alternatives and by Co2 (Volume A4, Annex 5.2). Full account has therefore been taken of reasonable alternatives and reported in Volume A1, Chapter 3.</p>
<p><i>"[The] development should aim to avoid significant harm to biodiversity and geological conservation interests, including through mitigation and consideration of reasonable alternatives; where significant harm cannot be avoided, then appropriate compensation measures should be sought"</i> (EN-1, paragraph 5.3.7).</p>	<p>Volume A6, Annex 1.1: Land Quality Preliminary Risk Assessment informs this ES chapter and includes a review of the available information with regards to internationally, nationally and locally designated sites of geological importance.</p>
<p><i>"In taking decisions, the SoS should ensure that appropriate weight is attached to designated sites of international, national and local importance; protected species; habitats and other species of principal importance for the conservation of biodiversity; and to biodiversity and geological interests within the wider environment."</i> (EN-1, paragraph 5.3.8).</p>	<p>This ES chapter considers the potential impacts of the proposed Hornsea Four project upon geological sites (Sections 1.11 and 1.12). The minerals resources (specifically, Mineral Safeguarding Areas) have been identified as part of the baseline (see Section 1.7). No likely significant effects to mineral resources have been identified. Further detail on this impact (GGC-O-3) can be found in Table 1.7 and Volume A4, Annex 5.1: Impacts Register.</p>
<p><i>"Applicants should safeguard any mineral resources on the proposed site as far as possible, taking into account the long-term potential of the land use after any future decommissioning has taken place"</i> (EN-1, paragraph 5.10.9).</p>	<p>Details and potential effects on international, nationally and locally designated sites of ecological conservation importance are addressed in Chapter 3: Ecology and Nature Conservation.</p>

1.3.2 National Planning Policy Framework Guidance

1.3.2.1 The National Planning Policy Framework (NPPF) (Ministry of Housing, Communities and Local Government, updated 2019) and associated guidance provides guidance to planning authorities on how to assess planning applications. Sections relevant to this aspect of the ES are summarised below in [Table 1.3](#).

Table 1.3: National Planning Policy Framework Guidance Relevant to Ground Conditions and Contamination.

NPPF Reference	NPPF Requirement	ES Reference
NPPF15-170	<p><i>"The planning system should contribute to and enhance the natural and local environment by:</i></p> <ul style="list-style-type: none"> <i>• Protecting and enhancing valued landscapes, sites of biodiversity or geological value and soils (in a manner commensurate with their statutory status or identified quality in the development plan);</i> <i>• Preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans; and</i> <i>• Remediating and mitigating despoiled, degraded, derelict, contaminated and unstable land, where appropriate."</i> 	<p>Commitments made by the Applicant with regards to protecting sites of geological value and the prevention of unacceptable risks are outlined in Table 1.8 (Co2 and Co127).</p> <p>Potential effects as a result of Hornsea Four and subsequent mitigation measures are set out in Section 1.11 and Table 1.8.</p> <p>Commitments made by the Applicant regarding remediating and mitigating the unacceptable risks posed by contaminated land are outlined in Table 1.8 (Co64 and Co77).</p>
NPPF15-179	<p><i>"Where a site is affected by contamination or land stability issues, responsibility for securing a safe development rests with the developer and/or landowner.</i></p>	<p>The existing environment in relation to any sources of contaminated land is discussed in Section 1.7.1.</p> <p>Figure 1.2 to Figure 1.8 illustrate areas of potential contamination.</p> <p>An assessment of any potential effects as a result of Hornsea Four which might affect the natural environment, along with proposed mitigation is given Section 1.11.</p>
NPPF15-178	<p><i>"Planning policies and decisions should ensure that:</i></p> <ul style="list-style-type: none"> <i>• A site is suitable for its proposed use taking account of ground conditions and any risks arising from land instability and contamination. This includes risks arising from natural hazards or former activities such as mining, and any proposals for mitigation including land remediation (as well as potential impacts on the natural environment arising from that remediation);</i> 	<p>The existing environment for ground conditions, contamination, and land stability including risks from land remediation is discussed in Section 1.7, supported by the information contained in Volume A6, Annex 1.1: Land Quality Preliminary Risk Assessment.</p>

NPPF Reference	NPPF Requirement	ES Reference
	<ul style="list-style-type: none"> • <i>After remediation, as a minimum, land should not be capable of being determined as contaminated land under Part IIA of the Environmental Protection Act 1990; and</i> • <i>Adequate site investigation information, prepared by a competent person, is available to inform these assessments."</i> 	<p>Potential linkages and impacts arising from any remediation is also discussed in Volume A6, Annex 1.1: Land Quality Preliminary Risk Assessment, and summarised in Section 1.7. An assessment of any potential effects from Hornsea Four, along with proposed mitigation, including consideration of site investigations is given Section 1.11.</p>
NPPF15-183	<p><i>"The focus of planning policies and decisions should be on whether proposed development is an acceptable use of land, rather than the control of processes or emissions (where these are subject to separate pollution control regimes). Planning decisions should assume that these regimes will operate effectively. Equally, where a planning decision has been made on a particular development, the planning issues should not be revisited through the permitting regimes operated by pollution control authorities."</i></p>	<p>The design parameters for the construction, operation and decommissioning of Hornsea Four are set out in full in Volume A1, Chapter 4: Project Description. The Maximum Design Scenario (MDS) used to inform any assessments is set out and justified in Section 1.9 and Table 1.9. The existing environment and baseline in relation to the Hornsea Four geology and ground conditions study areas is addressed in Section 1.7.</p> <p>An assessment of any potential effects from Hornsea Four, along with proposed mitigation is given in Section 1.11.</p>

1.4 Consultation

1.4.1.1 Consultation is a key part of the DCO application process. Consultation regarding geology and ground conditions has been conducted through the EIA scoping process (Orsted 2018) and formal consultation on the Preliminary Environmental Information Report (PEIR) (Orsted 2019) under section 42 of the 2008 Act. An overview of the project consultation process is presented within **Volume A1, Chapter 6: Consultation**. Agreements made with consultees within the Evidence Plan process are set out in the topic specific Evidence Plan Logs which are appendices to the Hornsea Four Evidence Plan (**Volume B1, Annex 1.1: Evidence Plan**), an annex of the Hornsea Four Consultation Report (**Volume B1, Chapter 1: Consultation Report**). All agreements within the Evidence Plan Logs have unique identifier codes which have been used throughout this document to signpost to the specific agreements made (e.g. ON-HYD-1.1).

1.4.1.2 A summary of the key issues raised during consultation specific to geology and ground conditions is outlined below in **Table 1.4**, together with how these issues have been considered in the production of this ES.

Table 1.4: Consultation Responses.

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
PINS	23 November 2018, Scoping Opinion	<i>“Commitment no. 2 states that the “permanent project footprint will avoid SSSIs where practical”. Table 7.4 states that two SSSIs have been identified and Figure 7.2 shows that they are both located within the landfall search area. Other SSSIs are shown on this figure; however, these are not identified as designated for their geological interest. Given the further refinements that will be made to the Proposed Development, it is not certain that these sites will be avoided by both the construction works and subsequently the Proposed Development. In addition, it is not apparent that indirect impacts have been considered. In light of the above, the Inspectorate considers impacts to geological SSSIs should be assessed where significant effects are likely to occur.”</i>	A desk-based review of the existing environment in relation to the presence of geological SSSIs to inform this ES has been provided in Section 1.7 . No assessment has been undertaken as no geological SSSIs are present within the Hornsea Four geology and ground conditions study area.
Natural England	23 November 2018, Scoping Opinion	<i>“Natural England notes that only SSSIs with geological features have been considered in the context of ‘geology and ground conditions’. Natural England advises that</i>	A desk-based review of the existing environment in relation to the presence of geological SSSIs

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
		<p><i>impacts on designated sites with a biological interest that is linked to or dependent on the underlying geology and ground conditions (e.g. rivers) should also be considered. Consequently, Natural England does not agree that this section provides robust consideration of the impacts on designated sites."</i></p>	<p>to inform this ES has been provided in Section 1.7.</p> <p>No geological SSSIs fall within the 1 km Hornsea Four geology and ground conditions study area and therefore any potential impacts have been scoped out from further assessment.</p> <p>Consideration of impacts on designated sites with a biological interest linked to the underlying geology and ground conditions has been provided in Chapter 3: Ecology and Nature Conservation, with cross-reference to Chapter 2: Hydrology and Flood Risk.</p>
		<p><i>"Natural England does not consider it sufficient to rely on commitment no. 2 and the undertaking to 'where practical' avoid sensitive sites within the permanent footprint to scope out this impact at this stage.</i></p> <p><i>Firstly, whilst they are likely outside of the proposed cable corridor and working area, the sites continue to fall within the 'red-line boundary'. Consequently, direct impacts cannot be fully excluded until the project plans are more detailed and have been subject to further refinement.</i></p> <p><i>Secondly, only the 'permanent project footprint' is referred to in this statement.</i></p> <p><i>This does not account for the fact that temporary works could lead to permanent or longer-term impacts on the site. All impacts on designated sites need to be considered, irrespective of their duration.</i></p> <p><i>Thirdly, only direct impacts on the geological sites are considered within the table and indirect impacts have been omitted from consideration completely. All</i></p>	<p>A desk-based review of the existing environment has been undertaken to identify potential direct and/or indirect impacts to designated geological SSSIs. The findings of which is provided in Section 1.7. No geological SSSIs fall within the 1 km Hornsea Four geology and ground conditions study area which includes both the temporary and permanent areas of the project footprint. Therefore, any potential direct and/or indirect impacts have been scoped out from further assessment.</p>

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
		<i>impacts on designated sites need to be considered, both direct and indirect."</i>	
PINS	23 November 2018, Scoping Opinion	<i>"In the absence of the further information regarding contaminated land identified as required, uncertainty remains that the mitigation proposed will entirely remove the pathway for effect, as stated in the Scoping Report. The Inspectorate is therefore concerned that there is a risk of significant effects and therefore this matter cannot be scoped out the ES."</i>	<p>A desk-based review in relation to potentially contaminated land and the identification of potential pathways and linkages has been assessed in Volume A6, Annex 1.1: Land Quality Preliminary Risk Assessment and summarised in Section 1.7. Potential sources and pathways for contamination are discussed in Section 1.7.1.</p> <p>Figure 1.2 to Figure 1.8 illustrate areas of potential contamination. Human health is discussed within paragraphs 1.7.1.20 and paragraph 1.7.1.21.</p> <p>Related impact assessments and proposed mitigation are provided in Section 1.11 with impacts to construction workers discussed in paragraphs 1.11.1.3 to 1.11.1.12.</p>
PINS	23 November 2018, Scoping Opinion	<i>"The Scoping Report proposes that accidental spills during construction and operation will be controlled through implementation of an outline Code of Construction Practice (CoCP) secured in the DCO. The Inspectorate is content that a suitably detailed and drafted CoCP is capable of avoiding likely significant effects in this regard. The Inspectorate agrees that a specific assessment in the ES is not necessary but requests that the ES includes appropriate cross reference to the specific measures relied upon in the CoCP (or equivalent)."</i>	<p>The outline CoCP (Co124) (Volume F2, Chapter 2) provides further measures and mitigation in relation to controlling accidental spills during construction and operation. This is a live document and will continue to be developed in consultation with the relevant stakeholders after DCO application, including ERYC, Natural England and the Environment Agency.</p>
PINS	23 November 2018, Scoping Opinion	<i>"The Scoping Report proposes to include assessment of the effects of construction of the substation in the ES. Given that decommissioning impacts are expected to be broadly similar and potentially less than</i>	<p>The effects of decommissioning will be less than or equal to those associated with construction, where no likely significant effects</p>

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
		<p><i>outlined for the construction phase, the Inspectorate considers that effects in relation to the decommissioning of the substation should be assessed and presented in the ES where they have the potential to be significant. "</i></p>	<p>have been identified (see Section 1.11).</p> <p>At the Hornsea Four OnSS all electrical infrastructure will be removed, and any waste will be disposed of in accordance with the relevant regulations. A decommissioning plan will also be produced in line with the latest relevant guidance and to include details relevant to pollution prevention and avoidance of ground disturbance (Co127, Table 1.8).</p> <p>Further information on decommissioning is included in Section 1.11.3.</p>
<p>East Riding of Yorkshire Council (ERYC)</p>	<p>22 January 2019, Late Scoping Consultation Response</p>	<p><i>"At 7.1.7.4 (Construction workers exposure to contamination resulting in health risks) the potential for construction workers to be exposed to unknown sources of contamination is acknowledged, but the report proposes this can be scoped out of the assessment as embedded mitigation measures, including PPE, will create a necessary barrier and result in negligible impact. A variety of potential sources of contamination have been identified within the Hornsea Four PEIR boundary and it will not always be the case that visual and / or olfactory indicators of the presence of contamination will be apparent. Analysis of samples of soil, water and / or ground gas may be required to assess the contamination at individual sites. Buried organic matter will be of particular concern as it has the potential to generate methane and carbon dioxide, meaning sites located in the vicinity of refuse tips may be at risk from ground gases. Similarly, free fibres of asbestos cannot be seen, so the absence of</i></p>	<p>A desk-based review in relation to potentially contaminated land and the identification of potential pathways and linkages has been assessed in Volume A6, Annex 1.1: Land Quality Preliminary Risk Assessment and summarised in Section 1.7. Potential sources and pathways for contamination are discussed in Section 1.7.1.</p> <p>Figure 1.2 to Figure 1.8 illustrate areas of potential contamination. Human health is discussed within paragraphs 1.7.1.20 and paragraph 1.7.1.21, and related impacts assessments and proposed mitigation are provided in Section 1.11 with impacts to construction workers discussed in paragraphs 1.11.1.3 to 1.11.1.12.</p> <p>In addition, contaminated land and groundwater scheme (Co77)</p>

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
		<p><i>visible asbestos containing material (ACM) does not necessarily mean that asbestos is not present in the soil. Sampling for asbestos is required, on all sites where a potential pollutant linkage has been identified, to ensure that it is not dispersed in the soil. If asbestos is identified it must be quantified.</i></p> <p><i>Sufficient information will be required in order to assess any risks to controlled waters. As part of the site investigation the observed levels of contaminants should be compared to water quality standards, for example environmental quality standards (EQS) or drinking water standards (DWS), and further risk assessment using the Environment Agency's Remedial Targets Methodology and / or remediation may be required.</i></p> <p><i>I would recommend, therefore, that rather than being scoped out of the Environmental Statement (ES), all aspects of investigations into possible land contamination should follow the guidelines within CLR11 Model Procedures for the Management of Land Contamination (Environment Agency, 2004), in line with current best practice. "</i></p>	<p>will be prepared to identify any contamination and any remedial measures which may be required. The guidance for this will be set out in Volume F2, Chapter 2: Outline Code of Construction Practice.</p>
ERYC	22 January 2019, Late Scoping Consultation Response	<p><i>"At 7.1.3.11 the scoping report acknowledges the potential areas of contamination within the study area and proposes that these will be further assessed during the PEIR upon review of environmental information. Later, at 7.1.8.1 (Proposed approach to the PEIR and ES), the report proposes a desk-based review of available environmental information followed with a site walkover of those areas where the desk-based study indicate this is necessary. No detailed assessment, such as intrusive ground investigation(s), is proposed; a Conceptual Site Model (CSM) is</i></p>	<p>A desk-based review of environmental information and a CSM has been provided in detail in Volume A6, Annex 1.1: Land Quality Preliminary Risk Assessment and summarised in Section 1.7. Potential sources and pathways for contamination are discussed in Section 1.7.1. Figure 1.2 to Figure 1.8 illustrate areas of potential contamination.</p> <p>A contaminated land and groundwater scheme will be</p>

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
		<i>to be established to compare with the baseline environment and with the identified activities during construction, operation and decommissioning phases."</i>	prepared to identify contamination and any remedial measures (Co77, Table 1.8). The approach to intrusive ground investigations has been proposed in Section 1.11 .
Environment Agency	18 April 2019, Late Scoping Consultation Response	<i>"Groundwater Source Protection Zones (SPZs) have not been mentioned in the report and it would appear from the maps that the cable route may pass within the SPZ2 and / or SPZ3 near Beverley. This will need to be taken into account within the Environmental Statement as it increases the sensitivity of groundwater resources. "</i>	The locations of SPZs in relation to the Hornsea Four 1 km geology and ground conditions study area are illustrated in detail in Volume A6, Annex 1.1: Land Quality Preliminary Risk Assessment and within paragraph 1.7.1.10 of this chapter. Additional consideration of groundwater in relation to potential abstraction and dewatering is included within Chapter 2: Hydrology and Flood Risk , and Volume A6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment .
Natural England	Section 42 consultation response	<i>"Where there is a risk to the quality and/or function of the SSSI, the sensitivity should be considered very high (most only state high)."</i>	The (geological) assessment of the River Hull SSSI has been updated to reflect a very high sensitivity rating within Section 1.11 of this Chapter. Consideration of SSSI's from an ecological perspective is detailed within Chapter 3: Ecology and Nature Conservation .

1.5 Study Area

- 1.5.1.1 Details of the location of Hornsea Four and the onshore elements of the project are set out within [Volume A1, Chapter 4: Project Description](#) and consist of the following:
- **Landfall:** This includes the landfall transition joint bay and cabling laydown and access track. These components are located to the east of Fraisthorpe;
 - **Onshore ECC:** This is where the permanent onshore electrical cable infrastructure will be located. The onshore ECC will be approximately 39 km in length and travels from the landfall location to the OnSS; and
 - **OnSS (including EBI):** This permanent infrastructure will allow electricity to be connected to the National Grid via the Creyke Beck substation.
- 1.5.1.2 The Hornsea Four geology and ground conditions study area is defined by the distance over which impacts on geology and ground conditions from all the onshore Hornsea Four project elements (i.e. landfall, onshore ECC and OnSS) may occur and by the location of any receptors that may be affected by those potential impacts. This has been established using professional judgement and supported by [Volume A6, Annex 1.1: Land Quality Preliminary Risk Assessment](#) (PRA) and is shown in [Figure 1.1](#).
- 1.5.1.3 Following ongoing route planning and site selection refinement, as detailed in [Volume A1, Chapter 3: Site Selection and Consideration of Alternatives](#), the PRA ([Volume A6, Annex 1.1: Land Quality Preliminary Risk Assessment](#)) has been updated to incorporate all changes to the Hornsea Four Order Limits, and accordingly the Hornsea Four geology and grounds conditions study area as described below, in order to support this ES chapter.
- 1.5.1.4 The Hornsea Four geology and ground conditions study area includes the Hornsea Four Order Limits, plus a 250 m buffer (hereafter referred to as the 250 m Hornsea Four geology and ground conditions study area) for direct impacts, and a 1 km buffer (hereafter referred to as the 1 km Hornsea Four geology and ground conditions study area) for indirect impacts related to Hornsea Four.
- 1.5.1.5 Sources of contamination are considered in detail within the 250 m Hornsea Four geology and ground conditions study area in the PRA ([Volume A6, Annex 1.1: Land Quality Preliminary Risk Assessment](#)). The risks associated with contamination sources at distances greater than 250 m are not considered as part of the PRA ([Volume A6, Annex 1.1: Land Quality Preliminary Risk Assessment](#)) as it is anticipated that at greater distances than this, the risk from potential sources of contamination to the Hornsea Four study area diminishes due to factors such as an absence of viable pathways.
- 1.5.1.6 Within the PRA ([Volume A6, Annex 1.1: Land Quality Preliminary Risk Assessment](#)), both surface water and groundwater abstraction points have been considered within the 1 km Hornsea Four geology and ground conditions study area as these are considered to be sensitive receptors that may be indirectly impacted by the development within the Hornsea Four Order Limits due to factors such as the potential for contaminants to travel greater distances via surface water and groundwater.

1.6 Methodology to inform baseline

1.6.1 Desktop Study

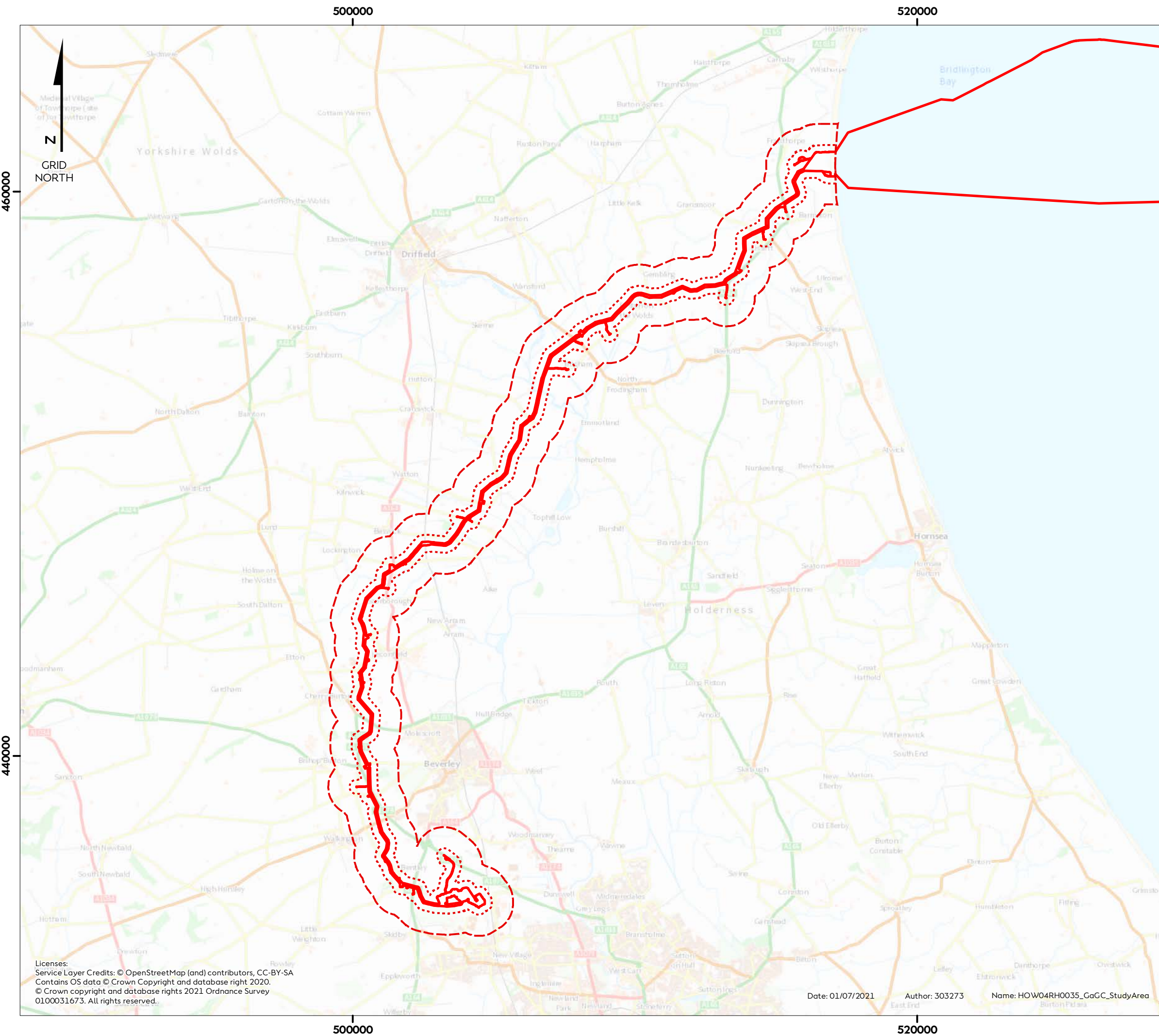
1.6.1.1 A desk-based study, in the form of a PRA (**Volume A6, Annex 1.1: Land Quality Preliminary Risk Assessment**), was undertaken to obtain and review information on geology and ground conditions within the Hornsea Four geology and ground conditions study areas. The PRA (**Volume A6, Annex 1.1: Land Quality Preliminary Risk Assessment**) provides an assessment of ground conditions for Hornsea Four and has followed a phased risk-based approach including consideration of potential sources, pathways and receptors to identify potential pollutant linkages that may result in unacceptable risks to receptors from ground contamination. For a risk to exist, all three of the elements defined below must be present:

- **Source:** A potentially polluting activity or existing ground contamination;
- **Pathway:** A route or means by which a receptor could be exposed to or affected by contamination; and
- **Receptor:** Something that could be adversely affected by contamination.

1.6.1.2 The sources of information presented in **Table 1.5** were consulted to inform the desk-based review. Considering the delayed submission of the Hornsea Four DCO to September 2021, a review of the validity of all baseline data underpinning the ES has been undertaken to ensure that it remains a robust and valid baseline used to inform and support a rigorous EIA. For geology and ground conditions, the review concluded that there would be no concerns in relation to data validity. The baseline validity position paper was issued to ERYC as the relevant stakeholder.

Table 1.5: Key Sources of Geology and Ground Conditions Data.




Data Source	Summary	Coverage of Hornsea Four 1 km Geology and Ground Conditions Study Area
BCS	BCS onshore GeoIndex map (http://mapapps2.bgs.ac.uk/geoindex/home.html)	All the data sources used provide full coverage of the 1 km Hornsea Four geology and ground conditions study area.
Department for Environment Food and Rural Affairs (DEFRA)	MAGIC map (www.magic.defra.gov.uk)	
Coal Authority	Interactive online viewer (http://mapapps2.bgs.ac.uk/coalauthority/home.html)	
Public Health England	UK Radon Website (https://www.ukradon.org/information/ukmaps)	
Google Earth	Publicly available aerial imagery	
Envirocheck Report (Ref 201127462_1_1; 201127557_1_1; 201127555_1_1; 201127465_1_1; and 201127560_1_1.)	Historical maps, environmental sensitivity data and regulatory records. These can be found in Volume A6, Annex 1.2: Envirocheck Report (Part One to Eight).	

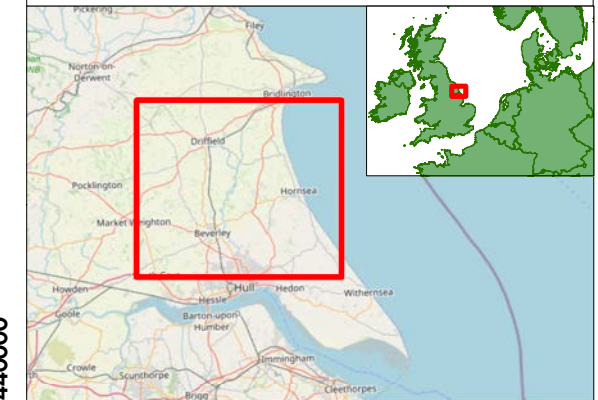


Hornsea Four

Figure 1.1

Geology and Ground Conditions Study Area

-  Order Limits
-  250 m Study Area
-  1 km Study Area



Coordinate system: British National Grid
 Scale@A3: 1:130,000

0 1.5 3 6 Kilometres

0 1 2 4 Miles

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1.7 Baseline environment

1.7.1 Existing baseline

1.7.1.1 This section describes the existing environment in relation to the geology and ground conditions associated with the Hornsea Four geology and ground conditions study areas. It has been informed by a review of the sources listed in [Table 1.5](#) and the PRA ([Volume A6, Annex 1.1: Land Quality Preliminary Risk Assessment](#)).

Geology

1.7.1.2 Information on the geological conditions within the Hornsea Four 1 km geology and conditions study area has been collated from British Geological Survey (BGS) datasets including 1:50,000 scale geological mapping. The geological sequence within the 1 km Hornsea Four geology and ground conditions study area, as shown on the BGS online viewer, is outlined in [Table 1.6](#) and illustrated in Figures 2 to 6 of the PRA ([Volume A6, Annex 1.1: Land Quality Preliminary Risk Assessment](#)).

Table 1.6: Geological sequence for the Hornsea Four 1 km geology and conditions study area.

Stratum	Unit	Description
Superficial Deposits	Till (Landfall, Onshore ECC and OnSS).	No description given.
	Glaciofluvial Deposits (Landfall, Onshore ECC and OnSS).	Sand and gravel.
	Alluvium (Landfall, Onshore ECC and OnSS).	Normally soft to firm consolidated, compressible silty clay, but can contain layers of silt, sand, peat and basal gravel. A stronger desiccated surface zone may be present.
Bedrock	Rowe Chalk Formation (Landfall and Onshore ECC).	White, flint-bearing chalk with sporadic marl bands.
	Flamborough Chalk Formation (Landfall, Onshore ECC and OnSS).	White, well-bedded, flint free chalk with common marl seams (typically about one per metre). Common stylolitic surfaces and pyrite nodules.
	Burnham Chalk Formation (Onshore ECC and OnSS).	White, thinly bedded chalk with common tabular and discontinuous flint bands; sporadic marl seams. Formal subdivision: none as defined here (BGS Lexicon), but there are many named marl and flint bands throughout the succession that are used to divide the formation. They are all of bed status.

1.7.1.3 Within the Hornsea Four Order Limits, pockets of Made Ground may be present. There are no designated geological sites within the 1 km Hornsea Four geology and ground conditions study area.

Hydrogeology

- 1.7.1.4 The baseline presented in the PRA ([Volume A6, Annex 1.1: Land Quality Preliminary Risk Assessment](#)) indicates that the superficial Alluvium and Glaciofluvial Deposits within the Hornsea Four 1 km geology and ground conditions study area are classified as Secondary A Aquifers, with some areas designated as Secondary B Aquifers (Figure 2 to Figure 6; [Volume A6, Annex 1.1: Land Quality Preliminary Risk Assessment](#)).
- 1.7.1.5 Secondary A Aquifers are composed of permeable strata capable of supporting water supplies at a local rather than strategic scale and in some cases forming an important source of base flow to rivers. A Secondary B Aquifer comprises predominantly lower permeability strata which may in part have the ability to store and yield limited amounts of groundwater by virtue of localised features such as fissures, thin permeable horizons and weathering.
- 1.7.1.6 The superficial Till Deposits within the Hornsea Four 1 km geology and ground conditions study area are classified as a Secondary Undifferentiated Aquifer, aquifers are given this classification when it has not been possible to attribute either category A or B to a rock type.
- 1.7.1.7 The Rowe Chalk Formation, Flamborough Chalk Formation and Burnham Chalk Formation within the Hornsea Four 1 km geology and ground conditions study area are classified as Principal Aquifers. Aquifers within this classification are composed of geology that exhibits high permeability and/or provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale.
- 1.7.1.8 The PRA ([Volume A6, Annex 1.1: Land Quality Preliminary Risk Assessment](#)) indicates that the area within the Hornsea Four 1 km geology and ground conditions study area has been assigned, by the Environment Agency, a medium to high groundwater vulnerability risk for the Superficial Aquifers and a low to high vulnerability for the Principal Aquifers. A high groundwater vulnerability designation indicates that the soil is easily able to transmit pollution to groundwater, which is characterised by high leaching potential in soils and the absence of low permeability superficial deposits.
- 1.7.1.9 There is one record of a groundwater abstraction within the Hornsea Four Order Limits (related to general farming and domestic use), and an additional 109 groundwater abstractions within the 1 km Hornsea Four geology and ground conditions study area (see Figures 2 to 6; [Volume A6, Annex 1.1: Land Quality Preliminary Risk Assessment](#)). Within the 1 km Hornsea Four geology and ground conditions study area, two records relate to potable water abstraction by Yorkshire Water Services Limited.
- 1.7.1.10 Part of the onshore ECC and the OnSS are located within Source Protection Zones (SPZs) 1, 2 and 3 (see Figures 2 to 6 of [Volume A6, Annex 1.1: Land Quality Preliminary Risk Assessment](#)). There are three SPZs located between Beverley and Cottingham, to the west of Leconfield and to the west of Hutton Cranswick. The OnSS is located to the north east of Bentley within the Inner Protection Zone (Zone 1). Approximately 5 km of the onshore

ECC passes through the Outer Protection Zone (Zone 2), with approximately 7 km passing through the Total Catchment (Zone 3). These zones are associated with groundwater and abstraction for public water supply, and therefore suggest that groundwater in this area is likely to be sensitive to change.

- 1.7.1.11 Regionally, the principal groundwater body underlying the Hornsea Four 1 km geology and ground conditions study area is the Hull and East Riding Chalk groundwater body (see Figure 2; [Volume A6, Annex 2.3: Water Framework Directive Compliance Assessment](#)), as defined by the Environment Agency under the Water Framework Directive (WFD) (water body ID: GB40401G700700). WFD classification data (Environment Agency 2020) states that the groundwater status is poor both for quantitative and chemical quality elements. This is attributed by the Environment Agency to pressures from diffuse source pollution from agriculture and rural land management sources, and continuous point source sewage discharges from the water industry. In addition, there have been cases of saline intrusion as a result of industrial practices.

Hydrology and Surface Drainage

- 1.7.1.12 Information provided within the PRA ([Volume A6, Annex 1.1: Land Quality Preliminary Risk Assessment](#)) indicates that the area within the Hornsea Four 1 km geology and ground conditions study area is located within the River Hull surface water catchment area. A total of 53 records of water bodies have been identified within the Hornsea Four Order Limits. Of these, 50 are rivers present at the ground surface and three are underground rivers. The inland rivers identified are comprised of both small streams and drainage ditches as well as larger water bodies over 1 km in length. Within the 250 m Hornsea Four geology and ground conditions study area, 359 additional waterbodies have been identified.
- 1.7.1.13 The Environment Agency's WFD water quality data for all surface waters in the Hornsea Four Order Limits, as presented on the Catchment Data Explorer (last updated January 2019) demonstrates that the water quality does not generally meet the required standards under the WFD and is under pressure from point source pollution from sewage and industrial discharges, and diffuse pollution from agriculture. As a result, concentrations of nutrients such as phosphate and ammonia, and contaminants such as metals are elevated within a large portion of the Hornsea Four Order Limits.
- 1.7.1.14 No surface water abstraction licences have been identified within the Hornsea Four Order Limits, however there are 86 surface water abstractions within the Hornsea Four 1 km geology and ground conditions study area (exclusive of the Hornsea Four Order Limits, see Figures 2 to 6; [Volume A6, Annex 1.1: Land Quality Preliminary Risk Assessment](#)), two of which are associated with water bottling from Blue Keld spring.
- 1.7.1.15 Further information with regards to hydrology is located within [Chapter 2: Hydrology and Flood Risk](#).

Potential Sources of Contamination

1.7.1.16 The research undertaken to inform the PRA (**Volume A6, Annex 1.1: Land Quality Preliminary Risk Assessment**) indicates that the area within the Hornsea Four Order Limits is located predominantly in areas that have historically been utilised for (and continue to operate as) agricultural land.

1.7.1.17 A review of historical Ordnance Survey (OS) maps has also confirmed the presence of a range of features within the Hornsea Four Order Limits (see **Figure 1.2** to **Figure 1.8**) that may give rise to potential sources of contamination, as summarised below:

- Agricultural land use – from the earliest available maps (1850s), land within the Hornsea Four Order Limits has predominantly been used as agricultural land, resulting in the potential for both diffuse and point sources of pollution to be present;
- Railway and sidings – the York, Markey Weighton and Beverley railway were recorded as bisecting the onshore ECC on the 1891 – 1892 map, before being recorded as being dismantled by 1970. The Hull and Scarborough railway is recorded as being located adjacent to the OnSS from 1854 (see **Figure 1.5** to **Figure 1.8**);
- Electricity substations are recorded as being within the OnSS site from the 1970 map (see **Figure 1.2** to **Figure 1.8**);
- Electricity pylons are recorded as being within the OnSS site from the 1952 map;
- A sewage works (Beverley Corporation) was recorded adjacent to the eastern boundary of the Onshore ECC from the 1954 – 1969 maps until 1993 (**Figure 1.6** and **Figure 1.7**); and
- Numerous former gravel, sand and chalk pits or ditches that may have been backfilled with unknown materials.

1.7.1.18 These isolated potential sources of contamination within the Hornsea Four Order Limits may be associated with a wide range of contaminants including, but not limited to, herbicides, hydrocarbons, metals, polychlorinated biphenyl (PCBs), asbestos, volatile organic contaminants (VOCs) and semi-volatile organic contaminants (SVOCs).

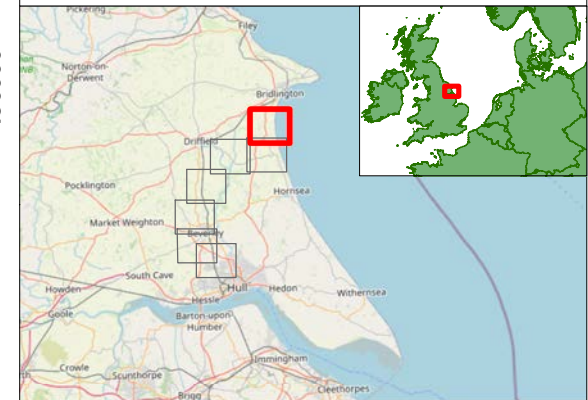
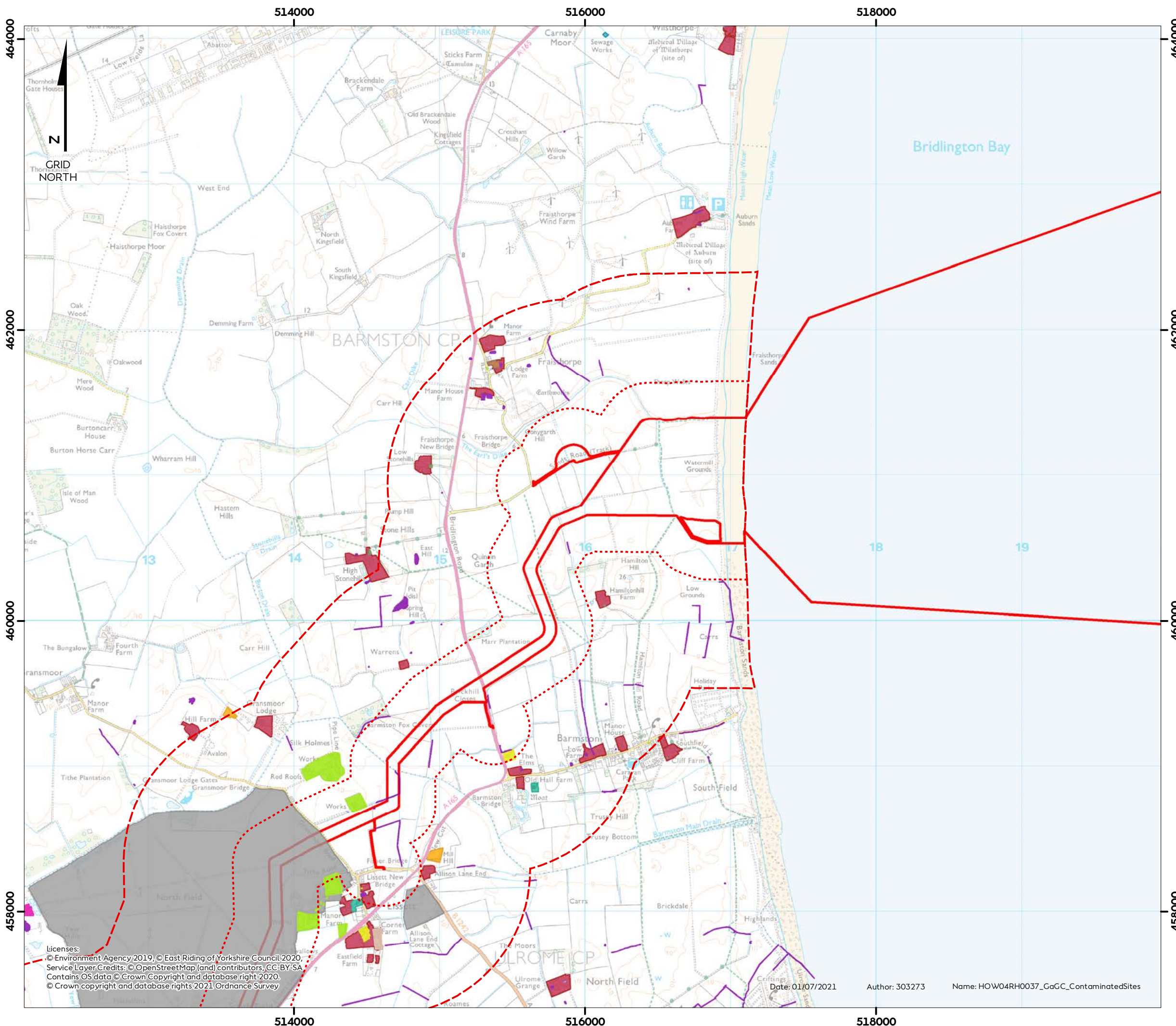
1.7.1.19 **Figure 1.2** to **Figure 1.8** illustrates potential sources of contamination that have been identified as being within the 1 km Hornsea Four geology and ground conditions study area (including the Hornsea Four Order Limits and 250 m Hornsea Four geology and ground conditions study area).

Hornsea Four

Figure 1.2

Potential Sources of Contamination
- Sheet 1 of 7

- Order Limits
 - 250 m Study Area
 - 1 km Study Area
 - Authorised Landfill Site
- Potentially Contaminated Land**
- Cemetery
 - Depot
 - Electricity Sub Station
 - Farm - Out Buildings
 - General Works
 - Historic Landfill Site
 - MoD Land
 - Part B Installation
 - Petroleum
 - Possible Landfill
 - Sewage
 - Sheep Dips
 - Tank
 - Timber Saw Mills



Coordinate system: British National Grid
Scale@A3: 1:25,000

0 0.25 0.5 1 Kilometres

0 250 500 1,000 Yards

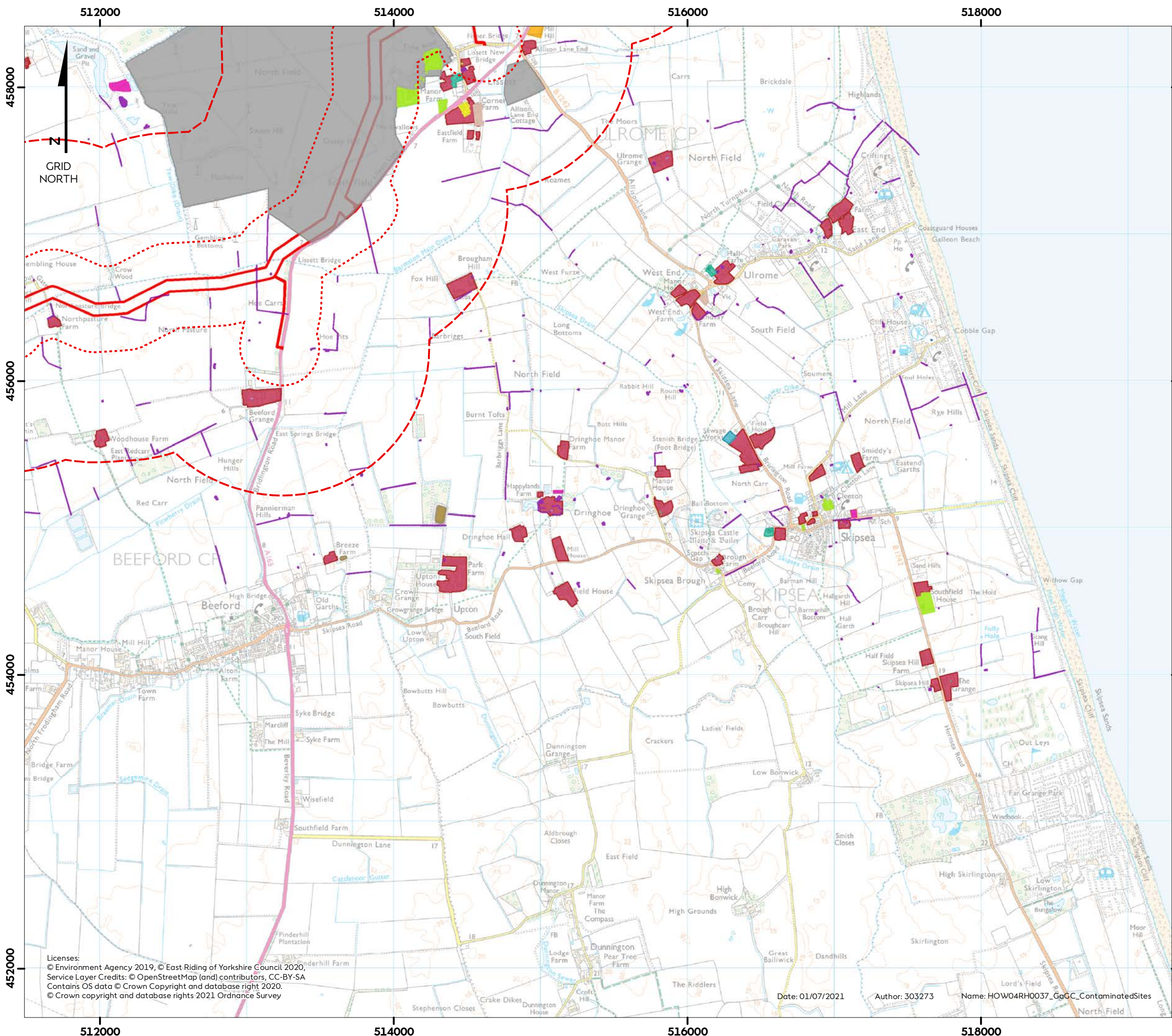
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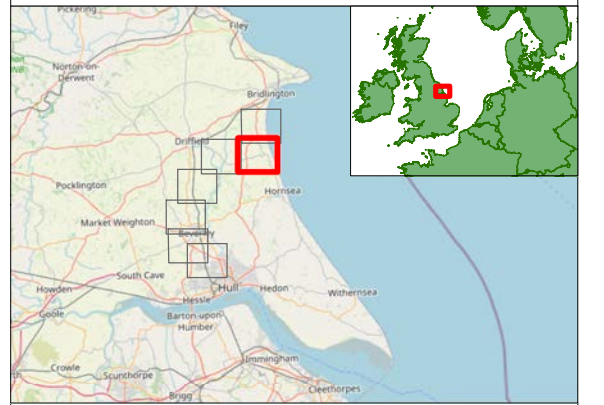
Hornsea Four

Figure 1.3

Potential Sources of Contamination

- Sheet 2 of 7

- Order Limits
 - 250 m Study Area
 - 1 km Study Area
 - Authorised Landfill Site
- Potentially Contaminated Land**
- | | |
|-------------------------|---------------------|
| Cemetery | Part B Installation |
| Chemical Works | Petroleum |
| Depot | Possible Landfill |
| Electricity Sub Station | Sewage |
| Farm - Out Buildings | Sheep Dips |
| General Works | Slurry Ponds |
| Historic Landfill Site | Tank |
| MoD Land | Timber Saw Mills |



Coordinate system: British National Grid
 Scale@A3: 1:25,000

0 0.25 0.5 1 Kilometres

0 250 500 1,000 Yards

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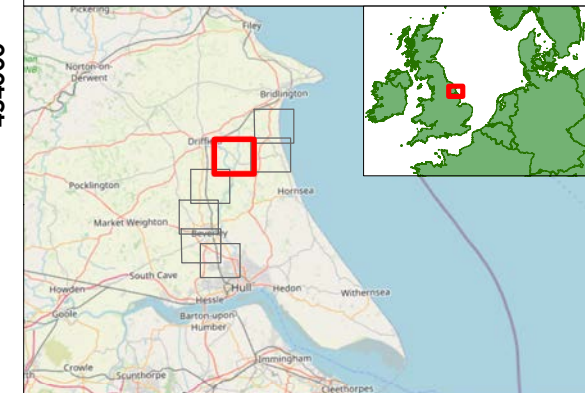
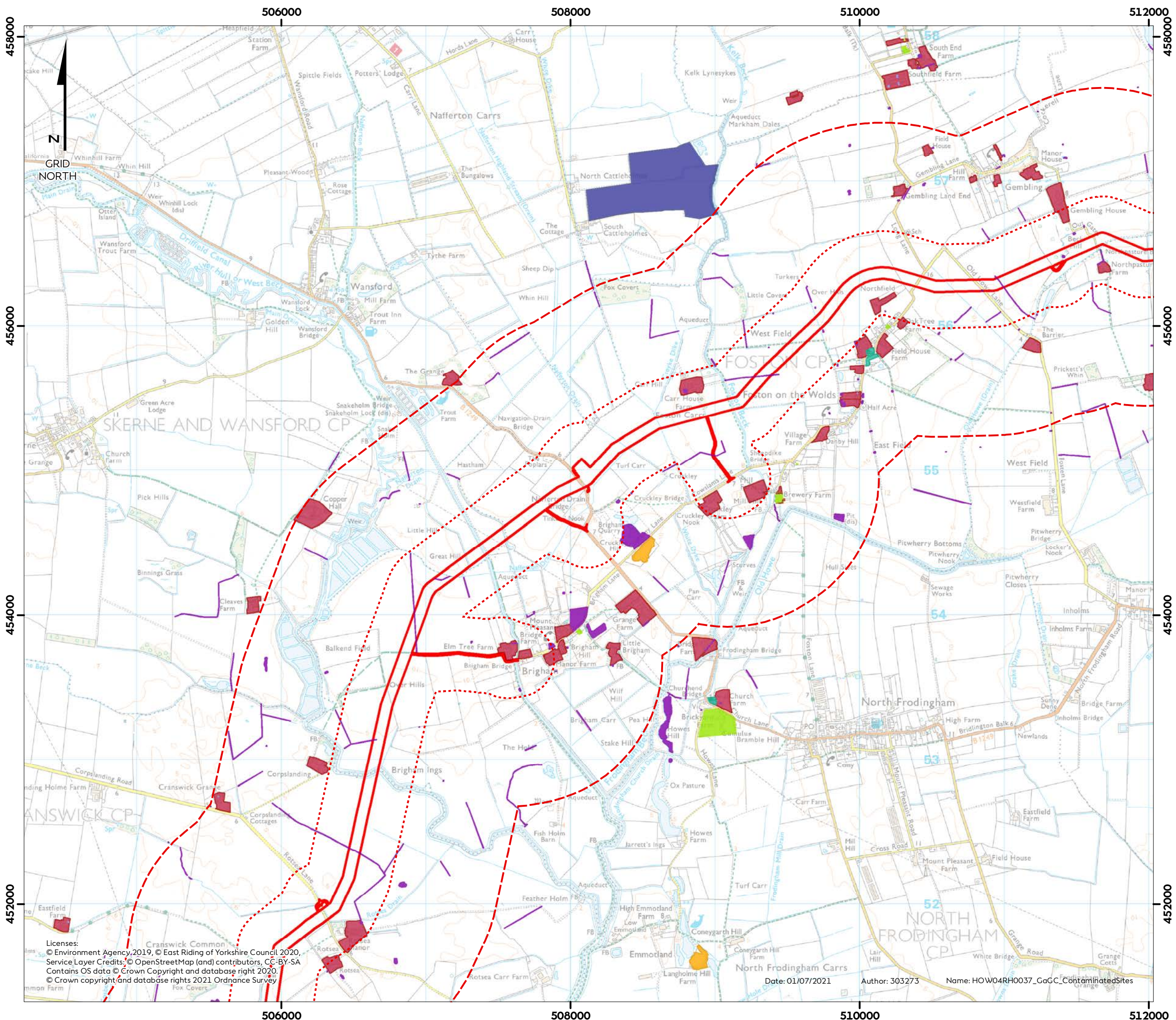
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Hornsea Four

Figure 1.4
Potential Sources of Contamination
- Sheet 3 of 7

-  Order Limits
 -  250 m Study Area
 -  1 km Study Area
 -  Authorised Landfill Site
- Potentially Contaminated Land**
-  Cemetery
 -  Possible Landfill
 -  Farm - Out Buildings
 -  Sewage Sludge Disposal
 -  General Works
 -  Tank
 -  Historic Landfill Site
 -  Tannery



Coordinate system: British National Grid
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0 0.25 0.5 1 Kilometres

0 250 500 1,000 Yards

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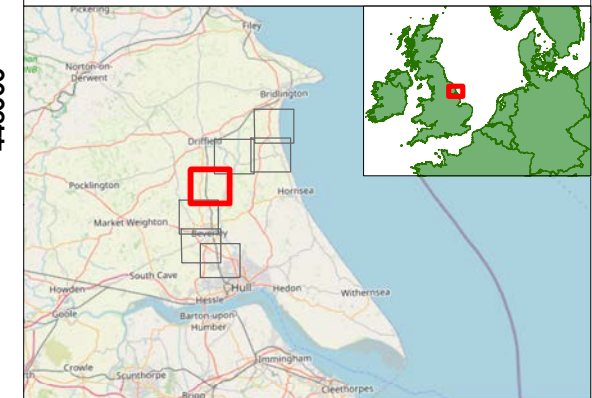
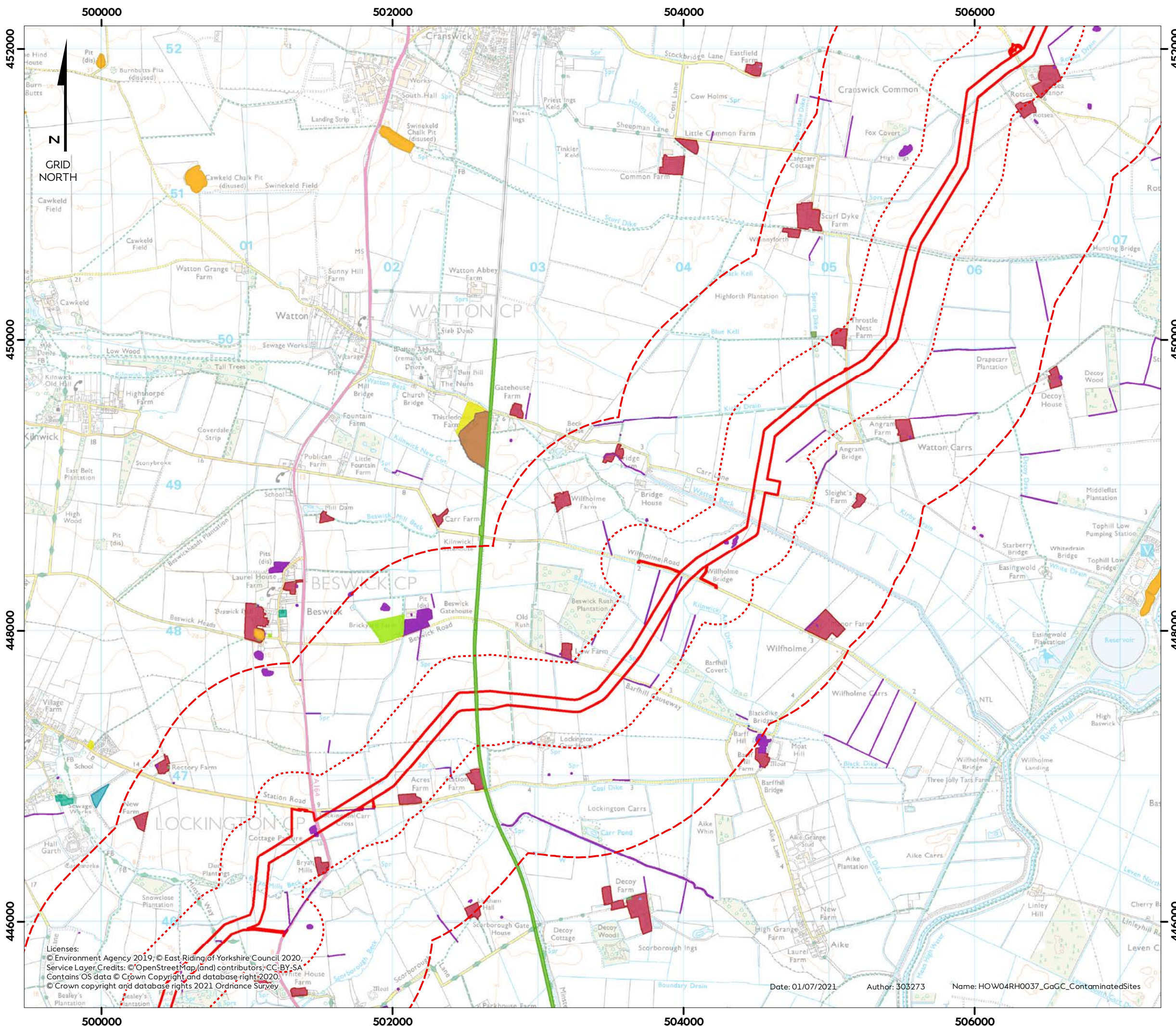
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Hornsea Four

Figure 1.5
Potential Sources of Contamination
- Sheet 4 of 7

- Order Limits
 - 250 m Study Area
 - 1 km Study Area
 - Authorised Landfill Site
- Potentially Contaminated Land**
- Cemetery
 - Depot
 - Electricity Sub Station
 - Existing Railway
 - Farm - Out Buildings
 - General Works
 - Historic Landfill Site
 - Petroleum
 - Possible Landfill
 - Sewage
 - Sheep Dips
 - Slurry Ponds
 - Tank



Coordinate system: British National Grid
Scale@A3: 1:25,000

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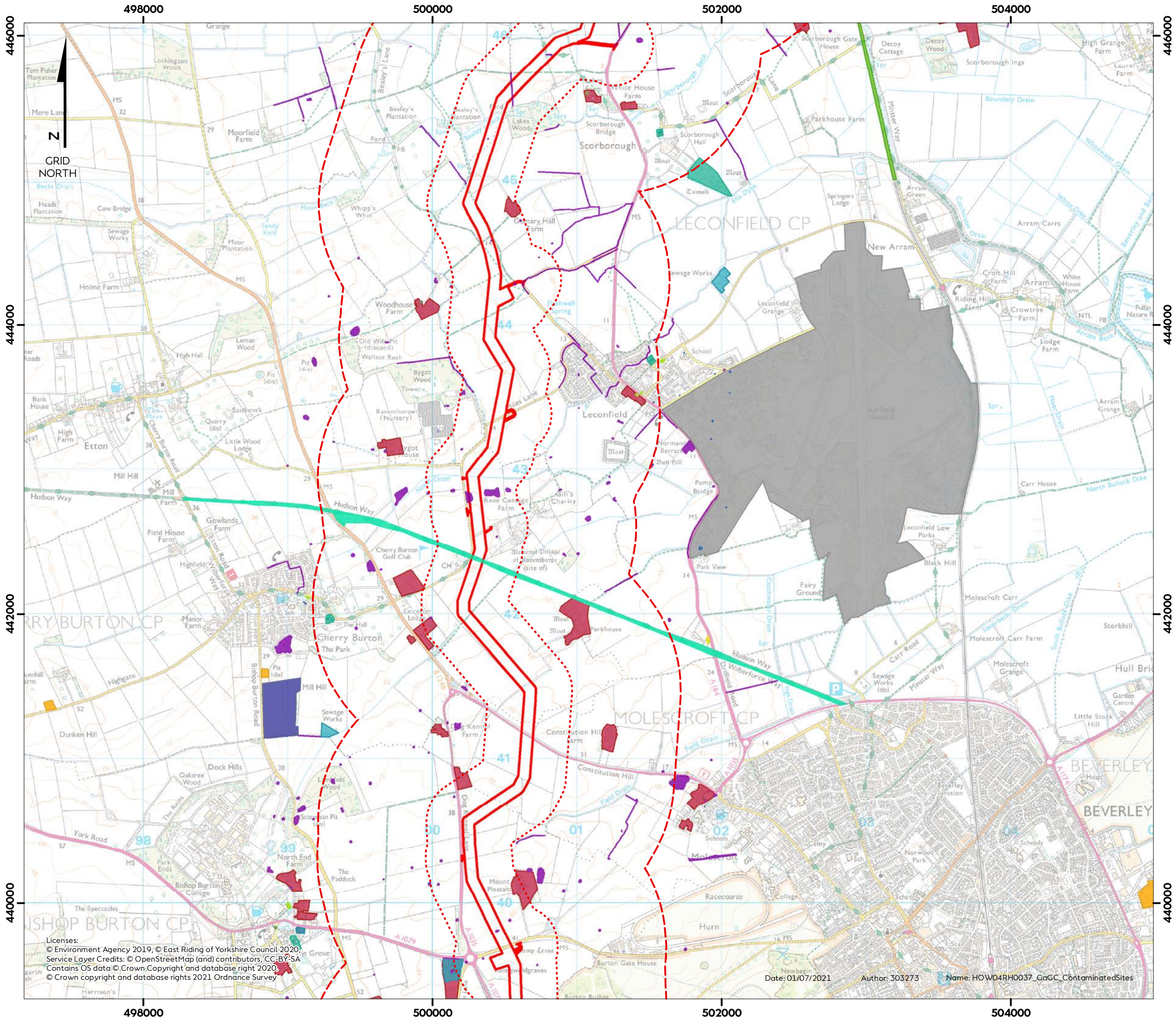
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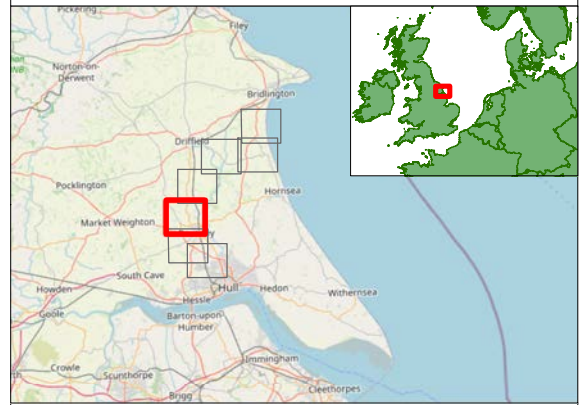
Hornsea Four

Figure 1.6

Potential Sources of Contamination

- Sheet 5 of 7

- Order Limits
 - 250 m Study Area
 - 1 km Study Area
 - Authorised Landfill Site
- Potentially Contaminated Land**
- | | |
|---|--|
| Cemetery | Old/Disused Railways |
| Depot | Petroleum |
| Electricity Sub Station | Possible Landfill |
| Existing Railway | Sewage |
| Farm - Out Buildings | Sewage Sludge Disposal |
| General Works | Sheep Dips |
| Hospital | Slurry Ponds |
| Historic Landfill Site | Tank |
| MoD Land | |



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Hornsea Four

Figure 1.7

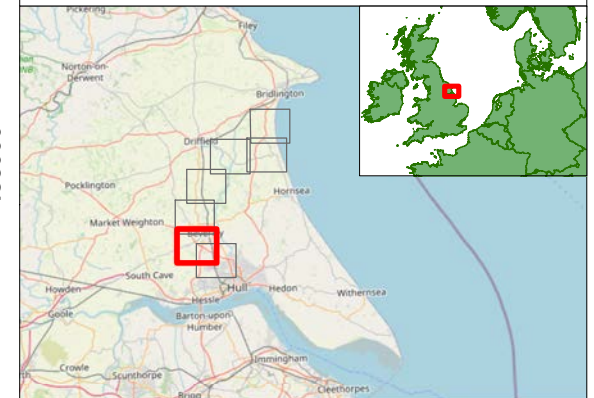
Potential Sources of Contamination
- Sheet 6 of 7

Order Limits

- Order Limits (Red solid line)
- 250 m Study Area (Red dashed line)
- 1 km Study Area (Red dotted line)
- Authorised Landfill Site (Pink solid area)

Potentially Contaminated Land

Cemetry	MoD Land
Depot	Old/Disused Railways
Electricity Sub Station	Part B Installation
Existing Railway	Petroleum
Farm - Out Buildings	Possible Landfill
Gas Works	Sewage
General Works	Sheep Dips
Hospital	Tank
Industrial Estate	Timber Saw Mills
Historic Landfill Site	



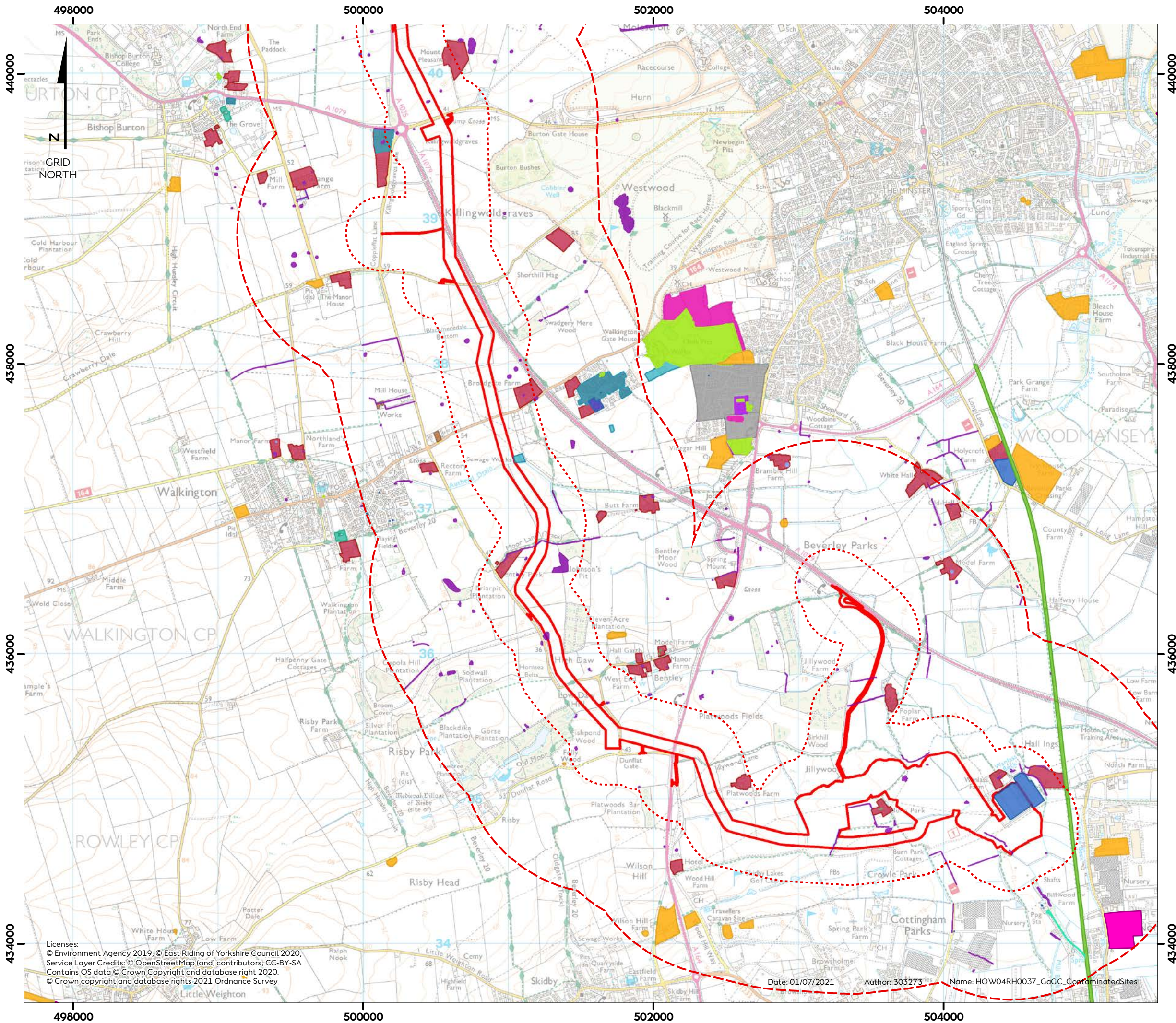
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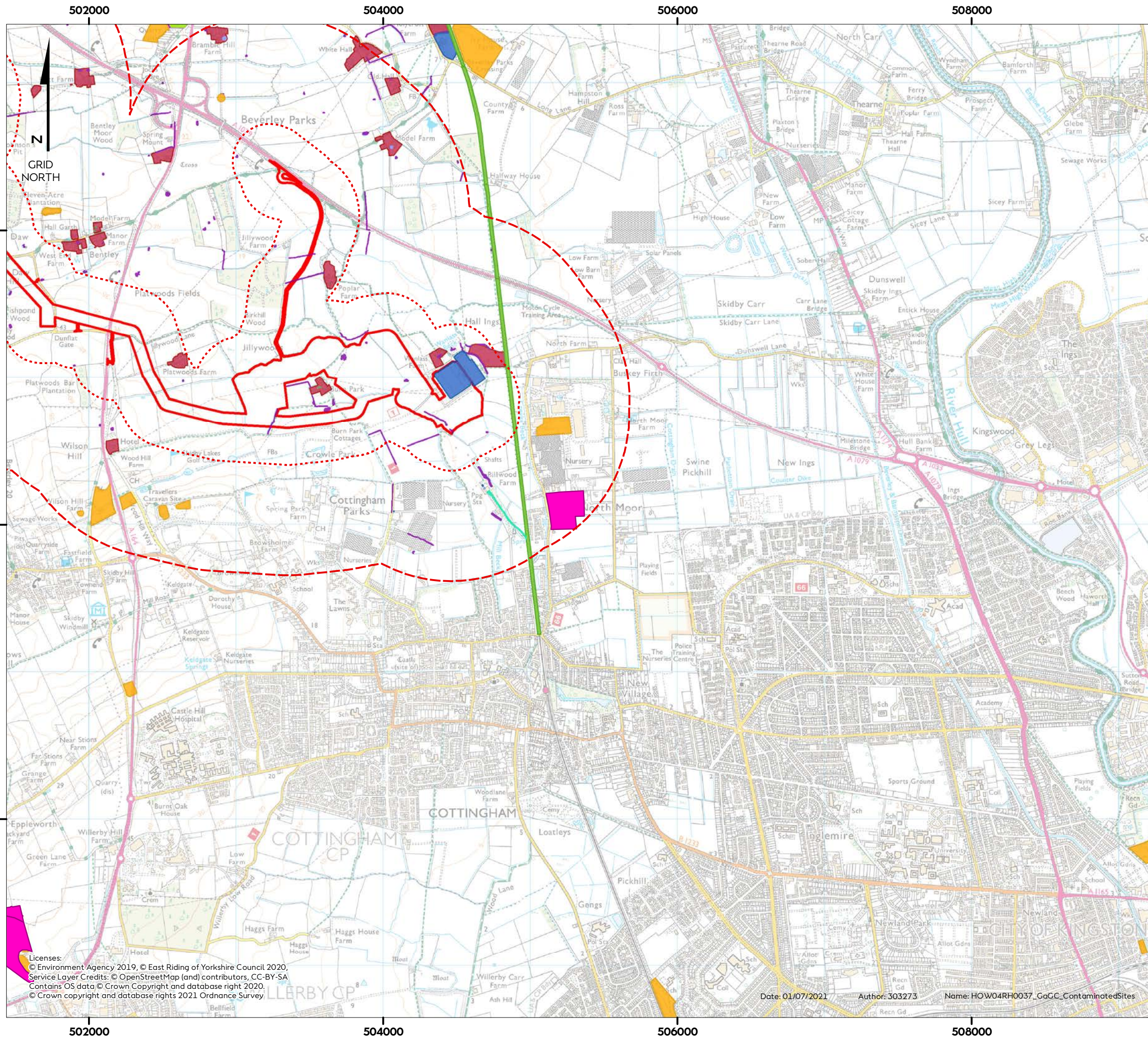
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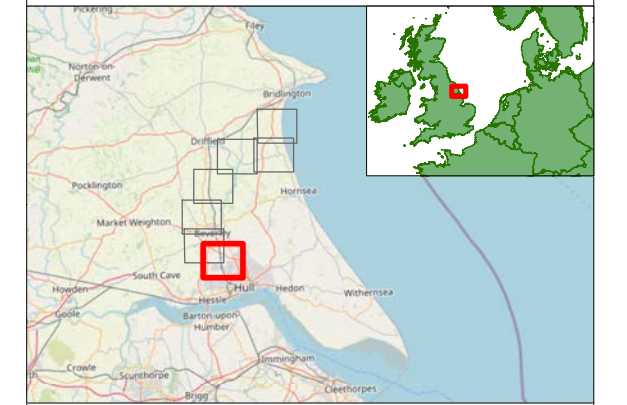
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Hornsea Four
 Figure 1.8
 Potential Sources of Contamination
 - Sheet 7 of 7

- Order Limits
- 250 m Study Area
- 1 km Study Area
- Authorised Landfill Site
- Electricity Sub Station
- Historic Landfill Site
- Existing Railway
- Old/Disused Railways
- Farm - Out Buildings
- Possible Landfill
- General Works
- Sheep Dips
- Industrial Estate
- Tank



Coordinate system: British National Grid
 Scale@A3: 1:25,000
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Human Health

- 1.7.1.20 The required onshore infrastructure comprises landfall works, onshore ECC, OnSS, EBI and 400 kV NGET connection as set out in [Volume A1, Chapter 4: Project Description](#). Haul and temporary access tracks, and temporary logistics compounds will also be required during the construction period.
- 1.7.1.21 During the construction of the onshore infrastructure, the critical human health receptors are potentially those involved with construction activities, adjacent off-site residents (noting that route selection has avoided all villages and towns), nearby workers (e.g. agricultural workers) and visitors (e.g. where Public Rights of Way (PRoW) might be in use). During the operational phase of the project, the human health receptors will be site users as no operations are planned that would create a new pathway for existing contamination such as contaminated fugitive dust.

Sensitive Land Use

- 1.7.1.22 The River Hull Headwaters SSSI is located within the Hornsea Four Order Limits (see Figures 7 to Figure 11; [Volume A6, Annex 1.1: Land Quality Preliminary Risk Assessment](#)).
- 1.7.1.23 The River Hull Headwaters is afforded protection as a SSSI as the most northerly chalk stream system in Britain. The SSSI is currently undergoing river restoration works as 65% of the River Hull Headwaters were assessed as being in an unfavourable condition by Natural England in 2003. The designation of the River Hull Headwaters as a SSSI is in relation to its biological characteristics rather than for its geological qualities.
- 1.7.1.24 Bryan Mills Field SSSI is located within the 250 m Hornsea Four geology and ground conditions study area and comprises a tall fen community which occupies the centre of a small ungrazed field, the surrounding drier areas of which have been planted with trees.
- 1.7.1.25 Further information regarding designated sites can be found in [Chapter 3: Ecology and Nature Conservation](#).
- 1.7.1.26 Parts of the Hornsea Four Order Limits are located within the following Nitrate Vulnerable Zones (NVZ):
- River Hull from Arram Bank to Humber NVZ (surface water);
 - Yorkshire Chalk NVZ (groundwater);
 - Barmston Sea Drain from Skipsea Drain to North Sea NVZ (surface water); and
 - Earls Dyke from source to North Sea NVZ (surface water).

Minerals






- 1.7.1.27 The land within the Hornsea Four Order Limits contains sand and gravel resources, associated with the superficial deposits, and chalks associated with the bedrock (as shown in [Figure 1.9](#) to [Figure 1.13](#)), some of which are located within designated Mineral

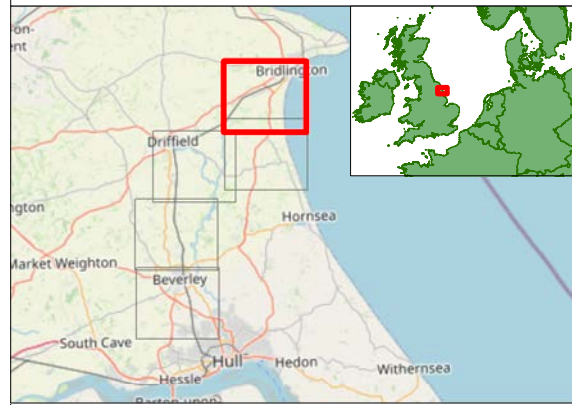
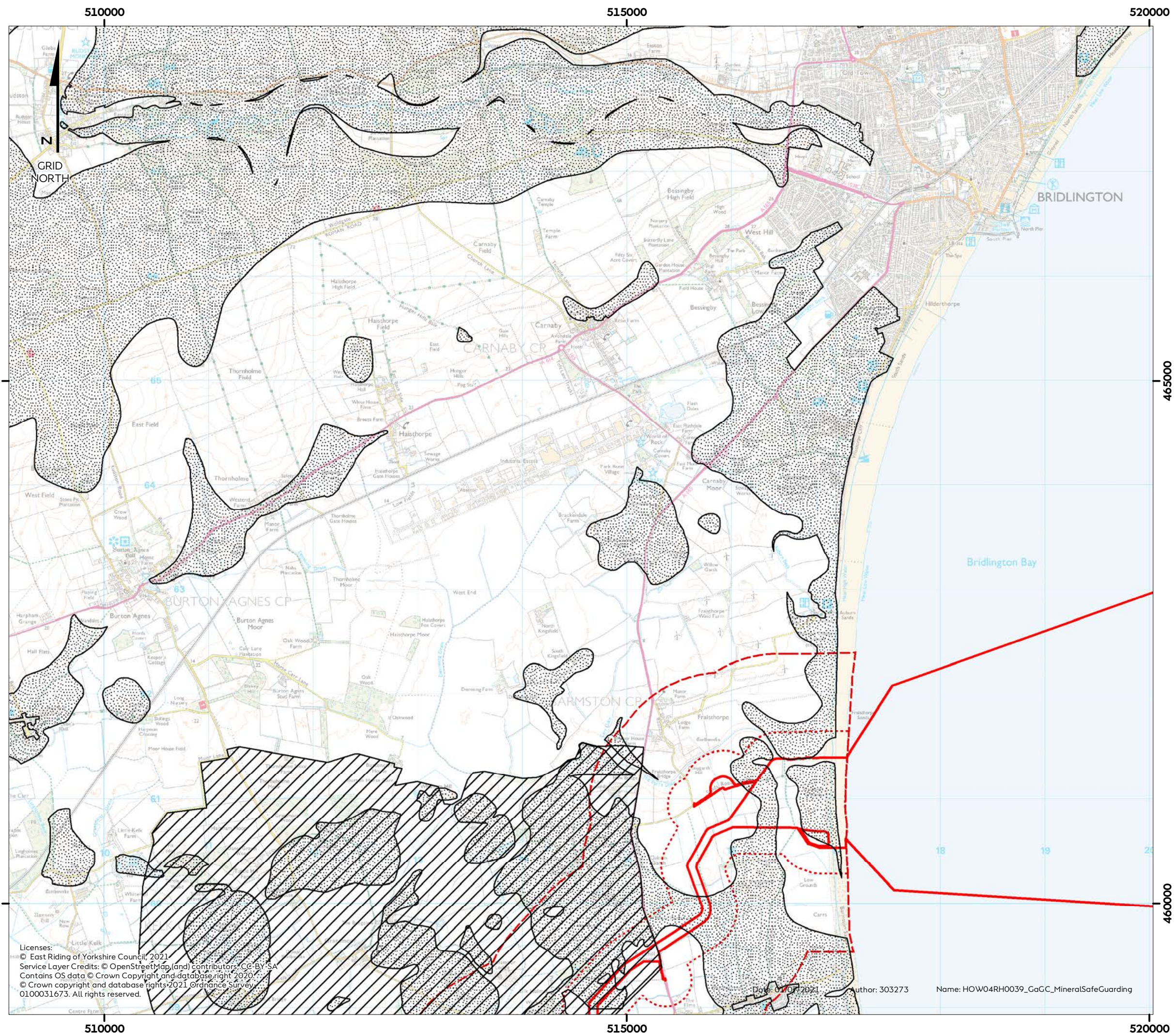
Safeguarding Areas. Within the Hornsea Four Order Limits, the Mineral Safeguarding Areas are approximately 1,130,000 m². This equates to 0.12% of the total Mineral Safeguarding Areas within the ERYC boundary. Within the onshore ECC a total area of 633,253 m² of Mineral Safeguarding Area is recorded, this equates to 0.07% of the total Mineral Safeguarding Area within the ERYC boundary.

- 1.7.1.28 An assessment of BGS recorded mineral sites conducted during the production of the PRA ([Volume A6, Annex 1.1: Land Quality Preliminary Risk Assessment](#)) identified five records of ceased mineral extraction quarries within the Hornsea Four Order Limits (three related to sand and gravel extraction and two related to chalk extraction).
- 1.7.1.29 A review of the East Riding of Yorkshire and Kingston Upon Hull Joint Mineral Plan, 2016 – 2033 Proposed Submission Polices Map (ERYC and Hull City Council, 2018) has identified one Area of Search (sands and gravels) that partially exists within the Hornsea Four Order Limits (see [Figure 1.9](#) to [Figure 1.13](#)).
- 1.7.1.30 The Area of Search (an area where knowledge of mineral resource is less certain) is referred to in the local plan as 'Gransmoor Land and Lissett' (identified area site brief – SG-G), the total area included within the Area of Search is approximately 1,650,000,0 m² with approximately 193,000 m² located within the Hornsea Four Order Limits, which equates to 4.35% of the total area of the onshore elements of Hornsea Four. The deposit identified as being present is recorded as sand and gravel; an estimated yield has not been identified within the local plan. The Area of Search is recorded as being located within an existing Mineral Safeguarding Area.
- 1.7.1.31 A Preferred Area (an area where resources are known to be present) for sand and gravel, referred to in the local plan as 'Land east of B1249, Cruckley Lane, Brigham' (identified area site brief – SG-E), has been identified as being located immediately adjacent to the onshore ECC. The total area of the Preferred Area is 199,000 m², none of which is located within the Hornsea Four Order Limits. The deposit identified as being present is recorded as soft sand with an estimated annual yield of 75,000 tonnes per annum. The Preferred Area is recorded as being located within an existing Mineral Safeguarding Area.
- 1.7.1.32 The current baseline description above provides an accurate reflection of the current state of the existing environment. The earliest possible date for the start of construction for the onshore elements of Hornsea Four is 2024 with an expected operational life of 35 years, and therefore there exists the potential for the baseline to evolve between the time of assessment and point of impact. Outside of short-term or seasonal fluctuations, changes to the baseline in relation to geology and ground conditions usually occur over an extended period of time (considered in [Section 1.7.2](#)). Based on current information regarding reasonably foreseeable events over the next four years, the baseline environment is not anticipated to have fundamentally changed from its current state at the point in time when impacts occur.

Hornsea Four

Figure 1.9
Mineral Safeguarding Areas
(Landfall area) - Sheet 1 of 5

-  Order Limits
-  250 m Study Area
-  1 km Study Area
-  Mineral Safeguarding Areas
-  Sand and Gravel Area of Search – Gransmoor Land and Lissett



Coordinate system: British National Grid
Scale@A3: 1:35,000

0 0.5 1 2 Kilometres

0 500 1,000 2,000 Yards

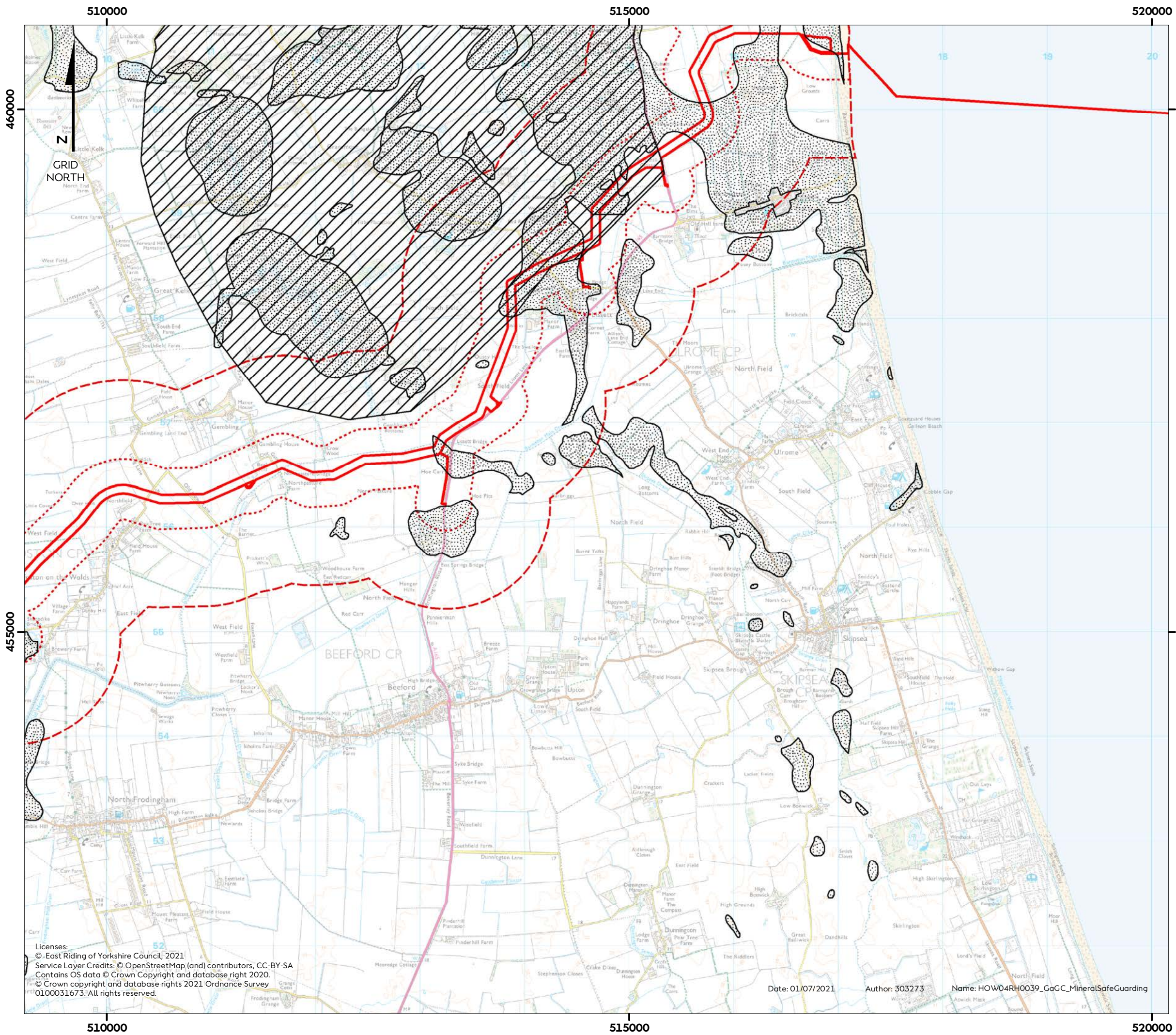
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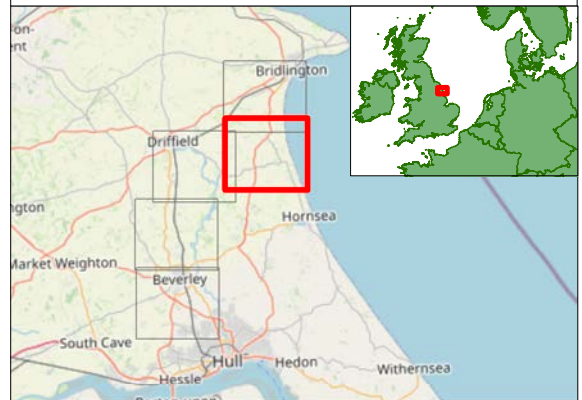


Hornsea Four


Figure 1.10

Mineral Safeguarding Areas (Onshore ECC #1) - Sheet 2 of 5

-  Order Limits
-  250 m Study Area
-  1 km Study Area
-  Mineral Safeguarding Areas
-  Sand and Gravel Area of Search – Gransmoor Land and Lissett



Coordinate system: British National Grid
 Scale@A3: 1:35,000



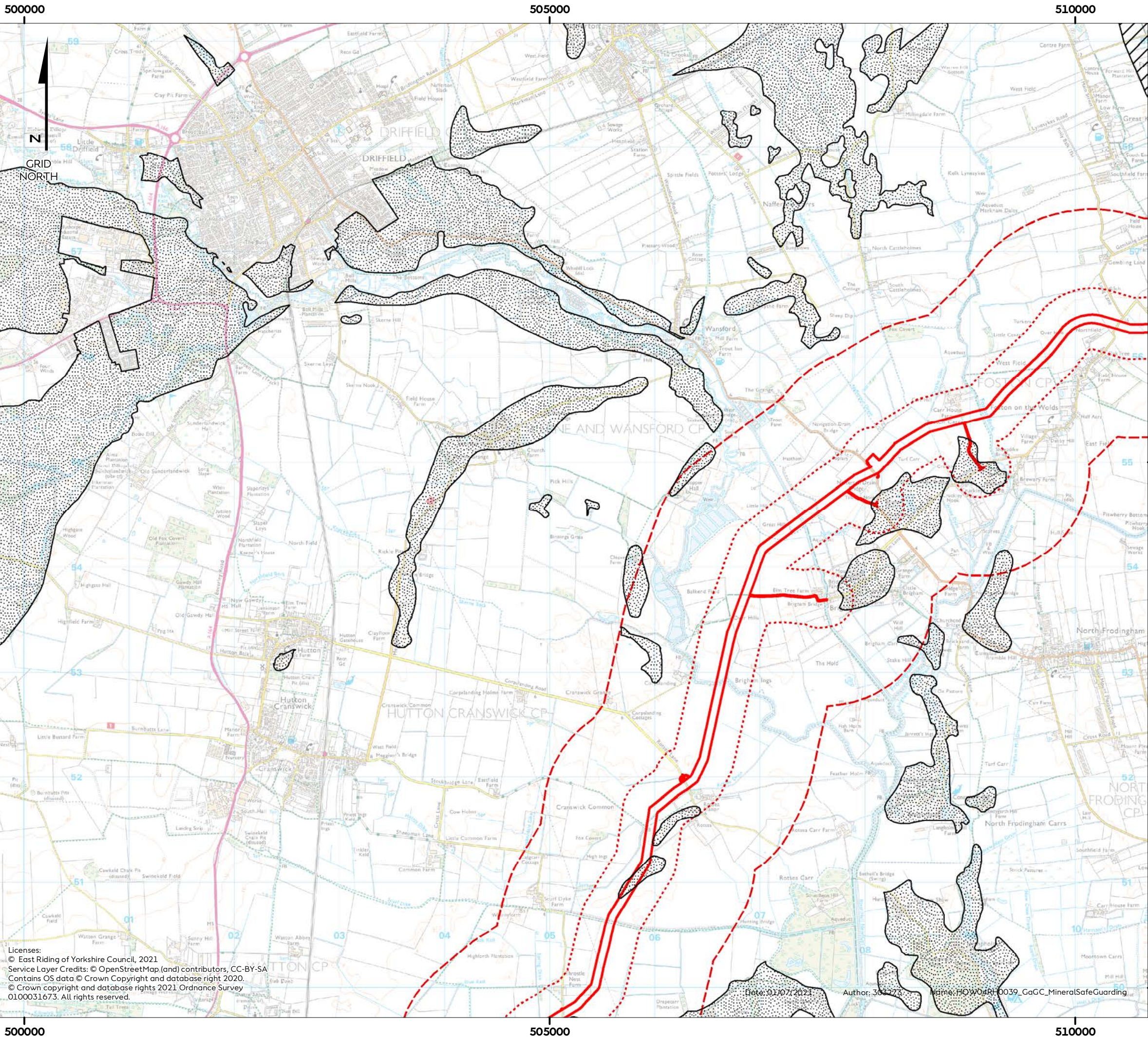
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
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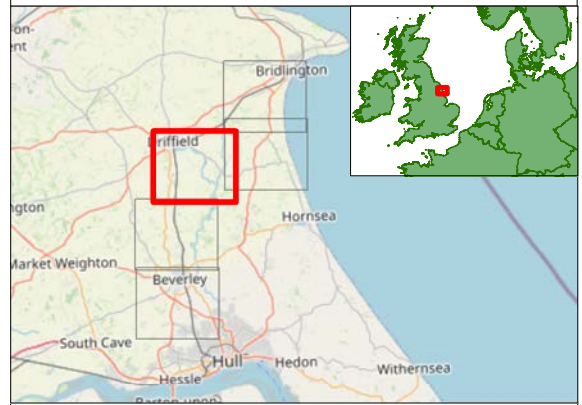
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Hornsea Four
 Figure 1.11
 Mineral Safeguarding Areas
 (Onshore ECC #2) - Sheet 3 of 5

-  Order Limits
-  250 m Study Area
-  1 km Study Area
-  Mineral Safeguarding Areas
-  Sand and Gravel Area of Search – Gransmoor Land and Lissett



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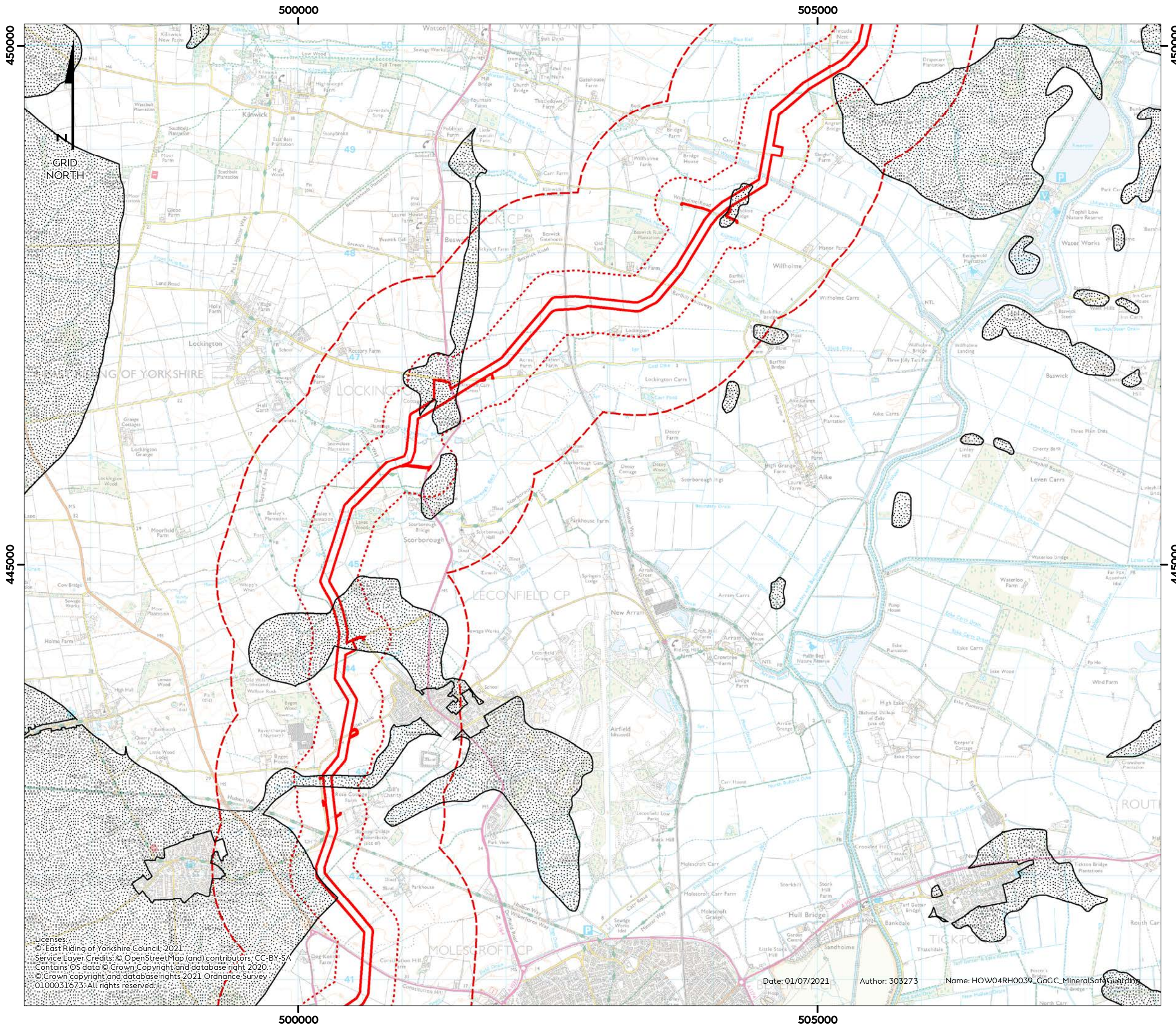
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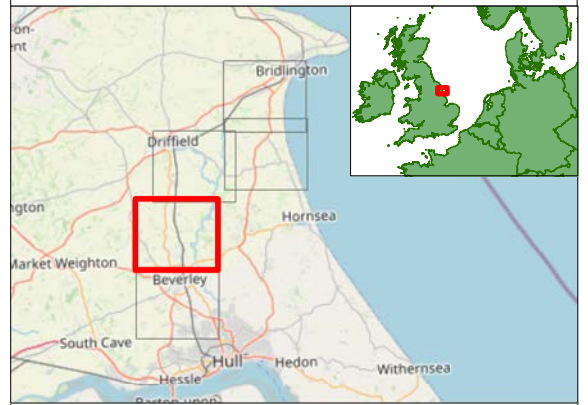
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Hornsea Four
 Figure 1.12
 Mineral Safeguarding Areas
 (Onshore ECC #3) - Sheet 4 of 5

-  Order Limits
-  250 m Study Area
-  1 km Study Area
-  Mineral Safeguarding Areas



Coordinate system: British National Grid
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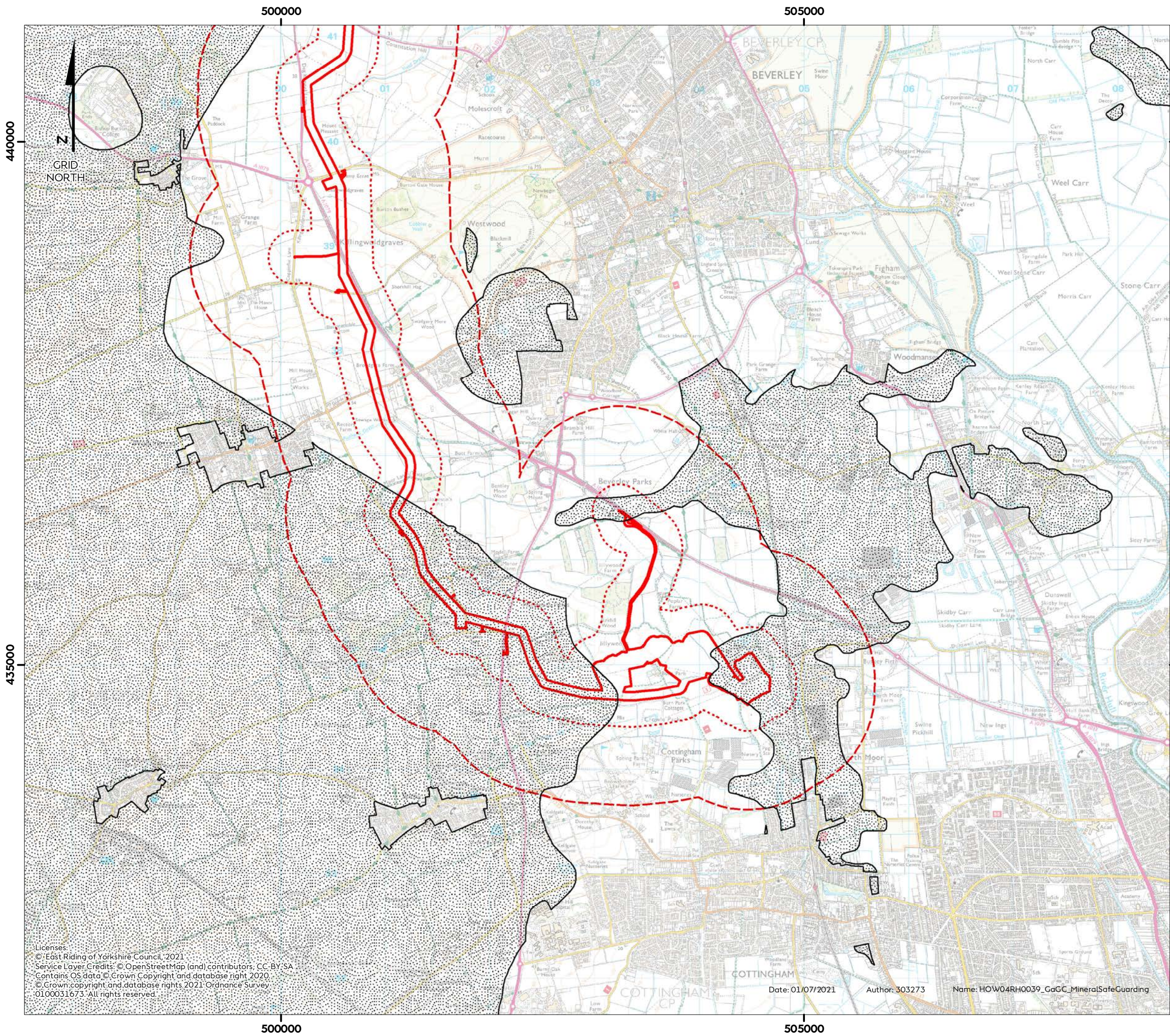
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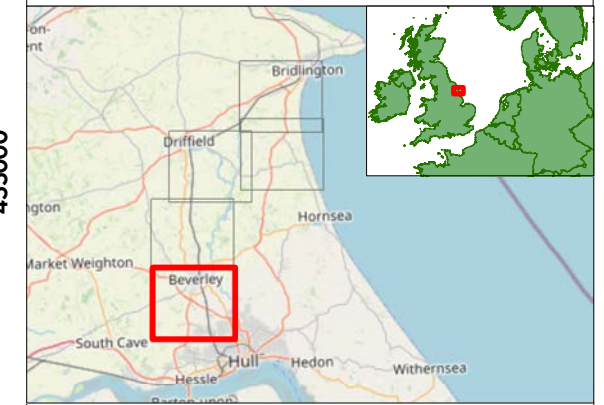


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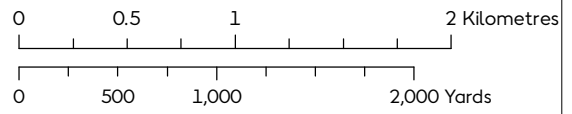
Figure 1.13

Mineral Safeguarding Areas (OnSS) - Sheet 5 of 5

-  Order Limits
-  250 m Study Area
-  1 km Study Area
-  Mineral Safeguarding Areas



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1.7.2 Evolution of the baseline

1.7.2.1 The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 require that *"an outline of the likely evolution thereof without implementation of the development as far as natural changes from the baseline scenario can be assessed with reasonable effort on the basis of the availability of environmental information and scientific knowledge"* is included within the ES (EIA Regulations, Schedule 4, Paragraph 3). From the point of assessment, over the course of the development and operational lifetime of the Hornsea Four (operational lifetime anticipated to be 35 years), long-term trends mean that the condition of the baseline environment is expected to evolve. This section provides a qualitative description of the evolution of the baseline environment, on the assumption that Hornsea Four is not constructed, using available information and specialist technical knowledge of geology and ground conditions.

1.7.2.2 This section discusses the likely future evolution of the existing baseline environment according to known trends in the base condition without implementation of the project.

Geology

1.7.2.3 No significant changes to land uses within the Hornsea Four Order Limits have been identified ([Chapter 6: Land Use and Agriculture](#)), therefore no major changes to geology are anticipated to occur in any location.

Hydrogeology and Groundwater Abstractions

1.7.2.4 The WFD aims to protect and enhance water bodies in Europe by controlling inputs of chemical pollutants and by reversing the effects of existing chemical contamination in order to achieve a good status. The current status of the groundwater bodies within the Hull and East Riding Chalk catchment is considered to have poor chemical quality elements (as classified by the Environment Agency 2016). This is due to the pressure from diffuse pollution sources (e.g. agriculture) and point source pollution (e.g. sewage discharge from the water industry) in addition to saline intrusion.

1.7.2.5 Further information is provided in detail within [Chapter 2: Hydrology and Flood Risk](#). In the future, increased regulation of agricultural chemicals and catchment-wide initiatives to reduce pressures on groundwater to achieve compliance with the WFD suggest that the baseline groundwater quality is likely to improve over time. However, any improvements are likely to become apparent only over long timescales due to, for example, long residence times of chemical pollutants within the environment.

1.7.2.6 The Water Abstraction Plan (DEFRA 2017) sets out how the government will reform water abstraction management over the coming years and how this will protect the environment and improve access to water. As part of the plan, the Environment Agency will review and amend existing abstraction licenses. As a result of the programme, it is anticipated that abstraction will decrease and approximately 90% of surface water bodies and 77% of

groundwater bodies will meet the required standards by 2021 (DEFRA 2017). Pressures on groundwater levels are therefore likely to decrease in the future.

Hydrology

1.7.2.7 Information regarding anticipated trends associated with surface water is provided in **Chapter 2: Hydrology and Flood Risk**. However, in summary it is predicted that the hydrology of the surface drainage network, which within the Hornsea Four Order Limits contains 53 water bodies (**Volume A6, Annex 1.1: Land Quality Preliminary Risk Assessment**) could change as a result of climate change with higher winter flows, lower summer flows and a greater number of storm related flood flows (refer to **Volume A6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment** for further details on the assessment of climate change and its impacts with regards to surface water drainage).

Land Quality

1.7.2.8 Land affected by contamination is primarily managed in the UK by Part IIA of the Environmental Protection Act (EPA), 1990 (EPA 1990) and the Town and County Planning Act, 1990. Part IIA of the Environmental Protection Act requires local authorities to identify contaminated land and ensure potential risks are assessed and mitigated accordingly. The regime does not consider future uses. However, it is likely these would require a specific grant of planning permission and consideration of the potential for contamination to represent unacceptable risks to ensure the site is suitable for the proposed end use.

1.7.2.9 Consequently, in relation to the project and its immediate receiving environment, it is reasonable to predict using professional judgement that no new sources of contaminated land would be introduced and that there would be a general improvement in land quality over time due to the natural breakdown of some contaminants that may be present in isolated areas.

1.7.3 Data Limitations

1.7.3.1 This desk-based assessment is based on a range of publicly available information and does not include site-specific intrusive (e.g. ground investigations), exploratory information. In the absence of such information the assessment adopts a precautionary approach i.e. if a potential pollutant linkage has been identified it is assumed to be present until further site-specific information is available to clarify whether a source-pathway-receptor linkage is present.

1.7.3.2 The direct assessments and judgements given in this report are therefore limited in this regard, but they do provide an adequate basis for the assessment, identifying areas of known contamination which may require further investigation through subsequent project phases, as well as the general level of contamination that may be expected in the various onshore project areas.

1.8 Project basis for assessment

1.8.1 Impact register and impacts “Not considered in detail in the ES”

1.8.1.1 Upon consideration of the baseline environment, the project description outlined in **Volume A1, Chapter 4: Project Description**, the Hornsea Four Commitments (**Volume A4, Annex 5.2: Commitments Register**) and response to formal consultation on the PEIR, several potential impacts upon geology and ground conditions are “Not considered in detail in the ES”. These impacts are outlined, together with a justification for why they are not considered further, in **Table 1.7**, which should be read in conjunction with **Volume A4, Annex 5.1: Impacts Register**.

1.8.1.2 In July 2019, Highways England issued an update to the Design Manual for Roads and Bridges (DMRB) significance matrix (see **Volume A1, Chapter 5: Environmental Impact Assessment Methodology**). Impacts formerly assessed within the category medium sensitivity and minor magnitude, as Minor (Not Significant), under the new guidance are now within the significance range of Slight or Moderate and therefore require professional judgement. Following a review of impacts, it was considered that the changes do not alter the overall significance of the impacts assessed at Scoping and in the PEIR (see **Volume A4, Annex 5.1: Impacts Register**). Therefore, impacts assessed as not significant at PEIR have not been considered in detail within this ES chapter, unless there has been a material change to Hornsea Four, baseline characterisation, or the assessment methodology that necessitates re-assessment. A summary of the justification for this consideration is provided in **Table 1.7**.

Table 1.7: Geology and ground conditions impact register - Impacts not considered in detail in the ES.

Project activity and impact	Likely significance of effect	Approach to assessment	Justification
Soil Compaction: construction phase (GGC-C-6)	No likely significant effects	Scoped Out	No LSE were determined during the scoping stage with agreement from PINS during EIA Scoping (November 2018, ID:4.13.4), as such the Applicant and Stakeholders agreed at Scoping that impact can be "Scoped Out". This approach has been sent to the relevant stakeholder (ERYC) via draft submission documentation for review.
Accidental spills: construction and operation phases (GGC-C/O-9)	No likely significant effect	Scoped Out	No LSE were determined during the scoping stage with agreement from PINS during EIA Scoping (November 2018, ID:4.13.5), as such an agreement between Hornsea Four and Stakeholders agreed at Scoping that impact can be "Scoped Out". This approach has been sent to with the relevant stakeholders (ERYC) via draft submission documentation for review.
Damage to designated geological SSSIs:	No likely significant effect	Not considered in	A desk-based review of the existing environment in relation to the presence of geological SSSIs to inform both the PEIR and ES chapters has identified that there

Project activity and impact	Likely significance of effect	Approach to assessment	Justification
construction phase (GGC-C-1)		detail in the ES	<p>are no geological SSSIs present within the 1 km Hornsea Four geology and ground conditions study area.</p> <p>PINS requested at the scoping stage (November, 2018), that if significant effects were likely to occur to geological SSSIs then they should be assessed. However, due to the absence of geological SSSIs located within the 1 km Hornsea Four geology and ground conditions study area, no significant effects are considered likely and so effects on geological SSSIs have not been assessed within the ES chapter. This approach has been agreed with the relevant stakeholders (ERYC and EA) (ON-ECO-1.1).</p>
Indirect effects: Damage to designated geological SSSIs: construction phase (GGC-C-2)	No likely significant effect	Not considered in detail in the ES	<p>A desk-based review of the existing environment in relation to the presence of geological SSSIs to inform both the PEIR and ES chapter has identified that there are no geological SSSIs within 1 km of the Hornsea Four Order Limits that may be indirectly affected by the onshore elements of Hornsea Four.</p> <p>This approach has been agreed with the relevant stakeholders (ERYC and EA) (ON-ECO-1.1).</p>
Decommissioning (GGC-D-10)	No likely significant effect	Not considered in detail in the ES	<p>No LSE were determined during the scoping stage, as such an agreement between Hornsea Four and Stakeholders agreed at Scoping that impact can be "Scoped Out". This approach has been sent to with the relevant stakeholders (ERYC and EA) via draft submission documentation for review.</p>
Sterilisation of future mineral resources (GGC-O-3)	No likely significant effect	Not considered in detail in the ES. No likely significant effect identified at PEIR.	<p>A desk-based review identified the presence of Mineral Safeguarding Areas within the Hornsea Four Order Limits. It was calculated that 0.13% of the total Mineral Safeguarding Area within the ERYC jurisdiction is located within the Hornsea Four Order Limits, with 0.07% of the total Mineral Safeguarding Area within the ERYC jurisdiction located within the Onshore ECC.</p> <p>Following a review of the available data, it was concluded within the PEIR assessment (Orsted 2019) that there was no likely significant effect on Mineral Safeguarding Areas during the operational phase and therefore they have not been considered within the ES chapter. The approach has been sent to relevant stakeholders (EYRC) for review prior to submission, however a response has yet to be received.</p>

Project activity and impact	Likely significance of effect	Approach to assessment	Justification
Dewatering of trenches and excavations: construction phase (GGC-C-7)	No likely significant effect	Not considered in detail in the ES. No likely significant effect identified at PEIR.	<p>"Whilst there is the possibility that the local hydraulic regime may be altered as a result of construction, the Applicant has committed to installing drainage channels either side of the onshore ECC to ensure that direct impacts to the hydraulic regime are not altered, (see Volume F2, Chapter 6: Outline Onshore Infrastructure Drainage Strategy) to be developed in consultation with the Environment Agency and LLFA/IDB as appropriate (Co19). The Onshore Infrastructure Drainage Strategy will be used alongside the most relevant PPG available at the time (Co4). Prior to discharge to watercourses, water from temporary discharge will be passed through a treatment system such as a silt interceptor (Volume F2, Chapter 6).</p> <p>Appropriate licences relating to dewatering will be obtained from the relevant bodies (EA, LLFA, IDB). Volume F1, Chapter 5: Consents Management Plan includes details of other consent and licences relevant to Hornsea Four.</p> <p>Impacts on the hydraulic regime of the local area was assessed in the PEIR as part of the EIA, as set out in the PEIR (Orsted 2019) and confirmed in the impact register, and no likely significant effect was identified (Volume A4, Annex 5.1: Impacts Register) and the assessment concluded that the impacts were not significant and so not considered further in the ES chapter. This approach has been sent to relevant stakeholders (EYRC) for review prior to submission, however a response has yet to be received.</p>
Physical intrusion into groundwater resource: construction phase - (GGC-C-8)	No likely significant effect	Not considered in detail in the ES. No likely significant effect identified at PEIR.	<p>Whilst there is the potential for contaminative sources to be introduced to the Principal Aquifer via piling activities (as detailed in the PEIR assessment (Orsted 2019)), a commitment has been made to adhere to the 'Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention (Environment Agency, 2001) or the latest relevant guidance (Co6) to minimise significant effects during construction.</p> <p>Following the implementation of the embedded mitigation measures detailed in the PEIR assessment (Orsted 2019), the impacts on groundwater resources</p>

Project activity and impact	Likely significance of effect	Approach to assessment	Justification
			due to physical intrusion was assessed as being no LSE and therefore has not been considered within the ES chapter. This approach has been sent to relevant stakeholders (EYRC) for review prior to submission, however a response has yet to be received.
Impacts on groundwater resources: Construction phase (GGC-C-11)	No likely significant effect	Not considered in detail in the ES. No likely significant effect identified at PEIR.	<p>Although there is the potential for direct impacts to groundwater resources during the construction phase of Hornsea Four, through the introduction of contamination via deep excavations, embedded mitigation (e.g. Co77) will be in place to protect groundwater resources and avoid significant effects during the construction phase.</p> <p>Following the implementation of the embedded mitigation measures the impacts on groundwater resources due to deep excavations was assessed as being no LSE (Orsted 2019) and therefore has not been considered within the ES chapter. This approach has been sent to relevant stakeholders (EYRC) for review prior to submission, however a response has yet to be received.</p>

Notes:

Grey - Potential impact is scoped out and both PINS and Hornsea Four agree.

Red – Potential impact is not considered in detail in the ES with no consensus between PINS and Hornsea Four at EIA Scoping and further justification provided during the pre-application stage.

Purple - Not considered in detail in the ES. No likely significant effect identified at PEIR.

1.8.2 Commitments

1.8.2.1 Hornsea Four has adopted commitments (primary design principles inherent as part of Hornsea Four, installation techniques and engineering designs/modifications) as part of their pre-application phase, to eliminate and/or reduce the likely significant effect (LSE) of a number of impacts. These are outlined in [Volume A4, Annex 5.2 Commitments Register](#). Further commitments (adoption of best practice guidance), referred to as tertiary commitments in [Table 1.8](#) below, are embedded as an inherent aspect of the EIA process. Secondary commitments are incorporated to reduce LSE to environmentally acceptable levels following initial assessment i.e. so that residual effects are reduced to environmentally acceptable levels.

1.8.2.2 The commitments adopted by Hornsea Four in relation to geology and ground conditions are presented in [Table 1.8](#).

Table 1.8: Relevant Geology and Ground Conditions Commitments.

Commitment ID	Measure Proposed	How the measure will be secured
Co1	<p>Primary: All Environment Agency (EA) main rivers, Internal Drainage Board (IDB) maintained drains, main roads and railways will be crossed by HDD or other trenchless technology as set out in the Onshore Crossing Schedule. Where HDD technologies are not practical, the crossing of Ordinary watercourses may be undertaken by open cut methods. In such cases, temporary measures will be employed to maintain flow of water along the watercourse. Main rivers will not be temporarily dammed and/or rerouted.</p>	DCO Requirement 17 (CoCP)
Co2	<p>Primary: A range of sensitive historical, cultural and ecological conservation areas (including statutory and non-statutory designations) have been directly avoided by the permanent Hornsea Four footprint, at the point of Development Consent Order Submission (DCO). These include, but are not restricted to: Listed Buildings (564 sites); Scheduled Monuments (30 sites); Registered Parks and Gardens (Thwaite Hall and Risby Hall); Onshore Conservation Areas (18 sites); Onshore National Site Network (one site); Offshore National Site Network (three sites); Offshore Marine Conservation Zones (two sites); Sites of Special Scientific Interest (two sites); Local Nature Reserves (none have been identified); Local Wildlife sites (33 sites); Yorkshire Wildlife Trust Reserves (none have been identified); Royal Society for the Protection of Birds (RSPB) Reserves (none have been identified); Heritage Coast; National Trust land; Ancient Woodland (10 sites and known Tree Preservation Orders (TPOs)); non-designated built heritage assets (334 sites); and historic landfill (none have been identified). Where possible, unprotected areas of woodland, mature and protected trees (i.e. veteran trees) have and will also be avoided.</p>	DCO Works Plan - Onshore
Co4	<p>Tertiary: A Pollution Prevention Plan (PPP) will be developed in accordance with the outline PPP and will include details of emergency spill procedures. Good practice guidance detailed in the Environment Agency's Pollution Prevention Guidance (PPG) notes (including PPG01, PPG05, PPG08 and PPG21) will be followed where appropriate, or the latest relevant available guidance.</p>	DCO Requirement 17 (CoCP)
Co6	<p>Tertiary: During construction of piled foundations, the following guidance will be used: Piling and Penetrative Ground Improvement Methods on land Affected by Contamination: Guidance on Pollution Prevention (Environment Agency, 2001), or latest relevant available guidance.</p>	DCO Requirement 17 (CoCP)
Co7	<p>Primary: The construction work area associated with onshore export cable corridor will be 80 m working width to minimise the construction footprint, except at the Network Rail Crossing near Beswick, the approach to landfall and the approach to the onshore substation. At the Network Rail Crossing the working width is extended up to 120 m to facilitate HDD of the railway line. The permanent onshore export cable corridor width will be 60 m except where obstacles are encountered such as the Network Rail Crossing near Beswick (where the permanent footprint may be extended</p>	DCO Works Plan - Onshore

Commitment ID	Measure Proposed	How the measure will be secured
	up to 120 m to facilitate HDD of the railway line), and on the approach to the landfall and onshore substation.	
Co8	Tertiary: Soil will be stored and managed in accordance with DEFRA Construction Code of Practice for Sustainable Use of Soils on Construction Sites (Ref PB1328) or the latest relevant available guidance.	DCO Requirement 17 (CoCP)
Co10	Tertiary: Post-construction, the working area will be reinstated to pre-existing condition as far as reasonably practical in line with DEFRA 2009 Construction Code of Practice for the Sustainable Use of Soils on Construction Sites PB13298 or latest relevant available guidance.	DCO Requirement 17 (CoCP) DCO Requirement 20 (Restoration of land used temporarily for construction)
Co13	Tertiary: Where cable trenching or road widening of the construction accesses is required across perched or near-surface secondary A or B aquifers, measures will be implemented to protect groundwater quality. These will be detailed within the Pollution Prevention Plan (PPP) (Co4). Additionally, in such areas, thermally insulated cables will be used to minimise effects on groundwater temperature). Furthermore, measures to ensure that the cable trench does not become a conduit for groundwater flow will also be implemented. All such measures will be identified following consultation with the Environment Agency and will be reported within the CoCP (Co124) and in line with the requirements of Section 23-25 of the Land Drainage Act 1991, or the latest relevant available guidance.	DCO Requirement 17 (CoCP)
Co14	Tertiary: A Construction Drainage Scheme will be developed for the temporary onshore construction works in accordance with the Outline Onshore Infrastructure Drainage Strategy. The Construction Drainage Scheme will ensure that existing land drainage is maintained during construction and will identify specific drainage measures for each area of land based on information identified and recorded by a Land Drainage Consultant prior to construction. The Construction Drainage Scheme will be developed in consultation with landowners, the Lead Local Flood Authority (ERYC), the Environment Agency and relevant Internal Drainage Board.	DCO Requirement 13 (Surface and foul water drainage)
Co18	Secondary: HDD entry and exit points will be located at least 9 m away from IDB and Ordinary surface watercourses and 20 m from EA surface water courses or the landward toe of the EA surface watercourse's flood defences. Where a surface watercourse is to be crossed by HDD, the onshore export cables will be installed at least 1.2 m beneath the hard bed of any watercourses and the optimal clearance depth beneath watercourses will be agreed with the relevant authorities prior to construction. Where EA flood defences are present a minimum 1.2 m vertical clearance will be maintained between the hard bed of the watercourse and the landward toe of those flood defences. Where	DCO Requirement 17 (CoCP)

Commitment ID	Measure Proposed	How the measure will be secured
	Hornsea Four crosses sites of particular sensitivity (e.g. embanked EA watercourses, SSSIs or groundwater Inner Source Protection Zones (SPZs)) a hydrogeological risk assessment will be undertaken to inform a site specific crossing method statement which will also be agreed with the relevant authorities prior to construction.	
Co19	Tertiary: An Onshore Infrastructure Drainage Strategy will be developed for the permanent onshore operational development in accordance with the Outline Onshore Infrastructure Drainage Strategy. The Onshore Infrastructure Drainage Strategy will include measures to ensure that existing land drainage is reinstated and/or maintained. This will include measures to limit discharge rates and attenuate flows to maintain greenfield run-off rates at the Onshore Substation. The Onshore Infrastructure Drainage Strategy will be developed in line with the latest relevant drainage guidance notes in consultation with the Environment Agency, Lead Local Flood Authority and relevant Internal Drainage Board as appropriate.	DCO Requirement 13 (Surface and foul water drainage) DCO Requirement 15 (Surface water)
Co41	Primary: All HDD crossings will be undertaken by non-impact methods in order to minimise construction vibration beyond the immediate location of works.	DCO Requirement 17 (CoCP)
Co61	Secondary: Prior to the commencement of works, the contractor (or project appointed Agricultural Liaison Officer) will undertake soil condition surveys and intrusive soil survey trial pits to identify and describe the physical and nutrient characteristics of the existing soil profiles. Such work will inform the reinstatement under Co10.	DCO Requirement 17 (CoCP)
Co64	Tertiary: Topsoil and subsoil will be stored in separate stockpiles in line with DEFRA Construction Code of Practice for the Sustainable Use of Soils on Construction Sites PB13298 or the latest relevant available guidance. Any suspected or confirmed contaminated soils will be appropriately separated, contained and tested before removal (if required).	DCO Requirement 17 (CoCP) DCO Requirement 14 (Contaminated land and groundwater scheme)
Co65	Tertiary: A Site Waste Management Plan (SWMP) will be developed in accordance with the Outline Site Waste Management Plan, with consideration of the latest relevant available guidance.	DCO Requirement 17 (CoCP)
Co68	Secondary: All logistics compounds will be removed and sites will be reinstated when construction has been completed.	DCO Requirement 17 (CoCP) DCO Requirement 20 (Restoration of land used temporarily for construction)

Commitment ID	Measure Proposed	How the measure will be secured
Co76	Tertiary: Appropriate Personal Protective Equipment (PPE) will be used and relevant good working practices applied to avoid potential risk to human health from any potential ground contamination, in line with relevant available guidance.	DCO Requirement 17 (CoCP)
Co77	Tertiary: A contaminated land and groundwater scheme will be prepared to identify any contamination and any remedial measures which may be required.	DCO Requirement 14 (Contaminated land and groundwater scheme)
Co124	Tertiary: A Code of Construction Practice (CoCP) will be developed in accordance with the outline CoCP. The outline CoCP will include measures to reduce temporary disturbance to residential properties, recreational users and existing land users.	DCO Requirement 17 (CoCP)
Co127	Tertiary: An Onshore Decommissioning Plan will be developed prior to decommissioning in a timely manner. The Onshore Decommissioning Plan will include provisions for the removal of all onshore above ground infrastructure and the decommissioning of below ground infrastructure and details relevant to flood risk, pollution prevention and avoidance of ground disturbance. The Onshore Decommissioning Plan will be in line with the latest relevant available guidance.	DCO Requirement 24 (Onshore decommissioning)
Co187	Secondary: The installation of the offshore export cables at landfall will be undertaken by Horizontal Directional Drilling or other trenchless methods.	DCO Requirement 17 (CoCP)

1.9 Maximum Design Scenarios

1.9.1.1 This section describes the parameters on which the geology and ground conditions assessment has been based. These are the parameters which are judged to give rise to the maximum levels of effect for the assessment undertaken, as set out in [Volume A1, Chapter 4: Project Description](#). Should Hornsea Four be constructed to different parameters within the design envelope, then impacts would not be any greater than those set out in this ES using the MDS presented in [Table 1.9](#).

Table 1.9: Maximum design scenario for impacts on geology and ground conditions.

Impact and Phase	Embedded Mitigation Measures	Maximum Design Scenario	Justification
<i>Construction</i>			
<p>Exposure of workforce to health impacts (GGC-C-4)</p> <p>Construction activities (all project components), such as trenching, excavations and other earthworks could disturb contaminants, which could result in impacts on soil / land use; and pollution of groundwater.</p>	<p>Primary: Co1 Co41</p> <p>Tertiary: Co4 Co76 Co77 Co124</p>	<p>Landfall:</p> <ul style="list-style-type: none"> • Construction duration: 32 months • Transition Joint Bays (located within Landfall compound area): Number: 8, Depth 6 m • HDD cable ducts: Number: 8, Diameter: 1 m, Length: 1.5 km • HDD Entry Pits: Area: 125 m² per entry pit, Depth: 6 m • HDD burial depth: Maximum: 40 m, Minimum: 5 m • HDD Exit Pits: Number: 8, Area: 900 m² per exit pit, Depth: 5 m • Temporary onshore/intertidal exit pit working area: 1,600 m² per exit pit • Simultaneous HDDs: Number: 3 <p>Onshore Export Cable Corridor:</p> <ul style="list-style-type: none"> • Construction duration: 30 months • ECC: Length: 39 km (approximate), Width: 80 m, Area: 3,120,000 m² • Number of cable circuits (HVAC system): 6 • Joint Bays: Number: 240, Depth 2.5 m, Area: 225 m² per Joint Bay, Joint Bay compounds: 240 40x40 m compounds • Link Boxes: Number: 240, Depth: 2 m, Area: 9 m² per Link Box • Cable trench: Depth: 1.5 m, Width at base: 1.5 m, Width at surface: 5 m • Temporary access roads: Number: 36, Width: 6 m (with 7 m passing places), Maximum Depth: 1 m, Average Depth: 0.4 m • Primary logistics compounds: Number: 1, Size: 140x140 m, Duration: 36 months • Secondary Logistics compounds: Number: 7, Size: 90x90 m, Duration: 36 months 	<p>These parameters represent the maximum ground disturbance within the project area in which the potential disturbance of existing contamination could occur. They also represent the maximum construction duration which could affect health of the construction workforce.</p>

Impact and Phase	Embedded Mitigation Measures	Maximum Design Scenario	Justification
		<p>400 kV ECC:</p> <ul style="list-style-type: none"> • Number of cable circuits: 4 • Cable trench depth: 1.5 m • Approximate Length: 1 km • Width: 60 m <p>Onshore substation:</p> <ul style="list-style-type: none"> • Construction duration: 43 months • Permanent infrastructure area: 164,000 m² • Temporary works area: 130,000 m² • Permanent access road: Number 1. Length 1,800 m, Width: 10 m (7 m road, 3 m soil stabilisation and below ground utilities). 	
<p>Encountering contamination during intrusive works (GGC-C-5)</p> <p>Construction activities (all project components), such as trenching, excavations and other earthworks could disturb contaminants, which could result in impacts on soils / land used; and pollution of groundwater.</p>	<p>Primary: Co1</p> <p>Tertiary: Co6 Co64 Co65 Co77 Co124</p>	<p>Landfall:</p> <ul style="list-style-type: none"> • Transition Joint Bays (located within Landfall compound area): Number: 8, Depth 6 m • HDD cable ducts: Number: 8, Diameter: 1 m, Length: 1.5 km • HDD Entry Pits: Area: 125 m² per entry pit, Depth: 6 m • HDD burial depth: Maximum: 40 m, Minimum: 5 m • HDD Exit Pits: Number: 8, Area: 900 m² per exit pit, Depth: 5 m • Temporary onshore/intertidal exit pit working area: 1,600 m² per exit pit • Simultaneous HDDs: Number: 3 <p>Onshore Export Cable Corridor:</p> <ul style="list-style-type: none"> • Construction duration: 30 months • ECC: Length: 39 km (approximate), Width: 80 m, Area: 3,120,000 m² • Number of cable circuits (HVAC system): 6 • Joint Bays: Number: 240, Depth 2.5 m, Area: 225 m² per Joint Bay, Joint Bay compounds: 240 40x40 m compounds • Link Boxes: Number: 240, Depth: 2 m, Area: 9 m² per Link Box • Cable trench: Depth: 1.5 m, Width at base: 1.5 m, Width at surface: 5 m • Distance between Joint Bay/ Link Box: Minimum: 750 m, Maximum: 3,000 m 	<p>These parameters represent the maximum ground disturbance within the project area in which the potential disturbance of existing contamination could occur during the construction phase.</p>

Impact and Phase	Embedded Mitigation Measures	Maximum Design Scenario	Justification
		<ul style="list-style-type: none"> • Primary logistics compounds: Number: 1, Size: 140x140 m, Duration: 36 months • Secondary Logistics compounds: Number: 7, Size: 90x90 m, Duration: 36 months • HDDs: Number: 112, HDD compounds (entry and exit):224 70x70 m compounds, HDD compounds hardstanding: 46 50x50 m (at approximately 20% of all HDD locations) <p>400 kV ECC:</p> <ul style="list-style-type: none"> • Number of cable circuits: 4 • Cable trench depth: 1.5m • Approximate Length: 1 km • Width: 60 m <p>Onshore substation:</p> <ul style="list-style-type: none"> • Construction duration: 43 months • Permanent infrastructure area: 164,000 m² • Temporary works area: 130,000 m² • Temporary access road: Number: 1, Length: 1,800 m, Width: 15 m (7 m road, 8 m soil storage) • Permanent access road: Number 1. Length 1,800 m, Width: 10 m (7 m road, 3 m soil stabilisation and below ground utilities) • Foundations: 500 pre-cast or Continuous Flight Auger piles. 	

Operation

Impacts relating to sterilisation of mineral resources during operation have not been considered in detail in the ES. No likely significant effect identified at PEIR.

Decommissioning

Scoped out of assessment

1.10 Assessment methodology

1.10.1.1 The assessment methodology for geology and ground conditions is presented as a variation of that included for soils and geology within Appendix C of the Scoping Report (Orsted 2018) and subsequent consultation feedback ([Section 1.4](#)) with regards to sensitivity and value of receptors and the magnitude of effect upon the receptors assessed as part of this ES.

1.10.2 Impact assessment criteria

1.10.2.1 The criteria for determining the significance of effects is a two-stage process that involves defining the sensitivity of the receptors and the magnitude of the impacts. This section describes the criteria applied in this chapter to assign values to the sensitivity of receptors and the magnitude of potential impacts. The terms used to define sensitivity and magnitude are based on those used in the DMRB methodology that were adopted during Scoping, which is described in further detail in [Volume A1, Chapter 5: Environmental Impact Assessment Methodology](#).

1.10.3 Sensitivity

1.10.3.1 The sensitivity of receptors is assessed according to the criteria set out in [Table 1.10](#) and is based on the capacity of receptors to tolerate change and whether or not increased risks would be acceptable within the scope of the prevailing legislation and guidelines (e.g. Environment Agency Land Contamination: Risk Management, EA 2019). The degree of change that is considered to be acceptable is dependent on the value of a receptor, which is discussed below. It should be noted that human health is considered a very high sensitivity receptor in all cases.

Table 1.10: Definition of Terms Relating to Receptor Sensitivity.

Sensitivity	Definition used in this chapter	Examples
Very High	Very high importance and rarity, international scale and very limited potential for substitution	<p>Controlled Waters</p> <ul style="list-style-type: none"> Groundwater used for public water supply for a large population and/or in SPZs 1. Supports Principal Aquifer with public water supply for large population. Surface water with naturally diverse geomorphology which supports habitats of species that are highly sensitive to changes in water quality. Surface water with very good water quality. <p>Human Health</p> <ul style="list-style-type: none"> Construction workers. Site operatives. General public (off-site).

Sensitivity	Definition used in this chapter	Examples
High	High importance and rarity, national scale and limited potential for substitution	<p>Controlled Waters</p> <ul style="list-style-type: none"> • Groundwater SPZs 2. • Surface Waters with good water quality. • Surface water or groundwater supporting internationally designated or nationally important conservation sites (e.g. Special Areas of Conservation, Special Protection Area, Ramsar site / Site of Special Scientific Interest) or fisheries. • Surface Waters that are almost unmodified and highly sensitive to changes in water quality. • Supports Principal Aquifer with public water supply abstractions for a small population (including private abstraction wells).
Medium	High or medium importance and rarity, regional scale, limited potential for substitution	<p>Controlled Waters</p> <ul style="list-style-type: none"> • Secondary A or Secondary B Aquifer with water supply abstractions. • Groundwater SPZ 3 - total catchment. • Surface water or groundwater supporting regionally important wildlife sites (Local Nature Reserves, Sites of Nature Conservation Interest) or commercial aquaculture. • Surface water with geomorphology that sustains natural variations and water quality that is not contaminated to the extent habitat quality is constrained.
		<p>Mineral Resources</p> <ul style="list-style-type: none"> • Mineral Safeguarding Area (regionally important resource).
Low	Low or medium importance and rarity, local scale	<p>Controlled Waters</p> <ul style="list-style-type: none"> • Surface waters with geomorphology that supports limited natural variation and water quality that may constrain some ecological communities. • Secondary B Aquifer with no water supply abstractions. • Surface water or groundwater supporting locally important wildlife or amenity site.
Negligible	Very low importance and rarity, local scale	<p>Controlled Waters</p> <ul style="list-style-type: none"> • Undifferentiated Aquifer (resource potential). • Highly modified surface waters with water quality that constrains ecological communities. • Aquatic or water-dependant habitats and/or species are tolerant to changes in water quality.

1.10.4 Magnitude

1.10.4.1 Potential effects may be adverse, beneficial or neutral. The magnitude of an effect is assessed qualitatively, according to the criteria set out in [Table 1.11](#). The following definitions apply to time periods used in the magnitude assessment:

- Long-term: >5 years;
- Medium-term: 1 to 5 years; and
- Short-term: <1 year.

1.10.4.2 For effects related to human health, magnitude reflects the likely increase or decrease in exposure risk for a receptor. For controlled waters, magnitude represents the likely effect that an activity would have on resource usability or value, at the receptor. Magnitude is therefore affected by the distance and connectivity between an impact source and the receptor.

1.10.4.3 The criteria for defining magnitude in this chapter are outlined in [Table 1.11](#).

Table 1.11: Definition of Terms Relating to Magnitude of an Impact.

Magnitude of impact	Definition used in this chapter	
	<i>Human Health Risk - Proposed Development or activity is likely to result in:</i>	<i>Controlled Waters - Physical, biological or chemical effects on groundwater or surface water likely to result in:</i>
Major	<ul style="list-style-type: none"> • Permanent or major change to existing risk of exposure (Adverse / Beneficial); • Unacceptable risks to one or more receptors over the long-term or permanently (Adverse); • Land that does not meet the statutory definition of 'Contaminated Land' in the existing baseline becomes capable of being determined under Part 2A (Category 1) (Adverse); • Remediation and complete source removal (Beneficial); • Construction workers at risk of "significant harm" due to lack of appropriate mitigation or personal protective equipment (Adverse). 	<ul style="list-style-type: none"> • Permanent, long-term or wide scale effects on water quality or availability (Adverse / Beneficial); • Permanent loss or long-term derogation of a water supply source resulting in prosecution (Adverse); • Change in WFD water body status / potential or its ability to achieve WFD status objectives in the future (Adverse / Beneficial); • Permanent habitat creation or complete loss (Adverse / Beneficial); • Measurable habitat change that is sustainable / recoverable over the long-term (Adverse / Beneficial).
Moderate	<ul style="list-style-type: none"> • Medium-term or moderate change to existing risk of exposure (Adverse / Beneficial); • Unacceptable risks to one or more receptors over the medium-term (Adverse); 	<ul style="list-style-type: none"> • Medium-term or local scale effects on water quality or availability (Adverse / Beneficial); • Medium-term derogation of a water supply source (Adverse);

Magnitude of impact	Definition used in this chapter	
	<i>Human Health Risk - Proposed Development or activity is likely to result in:</i>	<i>Controlled Waters - Physical, biological or chemical effects on groundwater or surface water likely to result in:</i>
	<ul style="list-style-type: none"> Land that does not meet the statutory definition of 'Contaminated Land' in the existing baseline becomes capable of being determined under Part 2A (Category 2). 	<ul style="list-style-type: none"> Observable habitat change that is sustainable / recoverable over the medium-term (Adverse / Beneficial); Temporary change in status / potential of a WFD water body or its ability to meet objectives (Adverse / Beneficial).
Minor	<ul style="list-style-type: none"> Short-term temporary or minor change to existing risk of exposure (Adverse / Beneficial); Unacceptable risks to one or more receptors over the short-term (Adverse). 	<ul style="list-style-type: none"> Short-term or very localised effects on water quality or availability (Adverse / Beneficial); Short-term derogation of a water supply source (Adverse); Measurable permanent effects on a water supply source that do not impact on its operation (Adverse). Observable habitat change that is sustainable / recoverable over the short-term (Adverse / Beneficial); No change in status / potential of a WFD water body or its ability to meet objectives (Neutral).
Negligible	<ul style="list-style-type: none"> Negligible change to existing risk of exposure; Activity is <i>unlikely</i> to result in unacceptable risks to receptors (Category 4 under Part 2A) (Neutral). 	<ul style="list-style-type: none"> Very minor or intermittent impact on local water quality or availability (Adverse / Beneficial); Usability of a water supply source will be unaffected (Neutral); Very slight local changes that have no observable impact on dependent receptors (Neutral); No change in status / potential of a WFD water body or its ability to meet objectives (Neutral).

1.10.4.4 The significance of the effect upon geology and ground conditions is determined by correlating the magnitude of the impact and the sensitivity of the receptor. The method employed for this assessment is presented in [Table 1.12](#). Where a range for the significance of an effect is presented in [Table 1.12](#), the final assessment for each effect is based upon expert judgement.

1.10.4.5 For the purposes of this assessment, any effects with a significance level of minor or less have been concluded to be not significant in terms of the EIA Regulations.

Table 1.12: Matrix used for the assessment of the significance of the effect.

		Magnitude of impact (degree of change)			
		<i>Negligible</i>	<i>Minor</i>	<i>Moderate</i>	<i>Major</i>
Environmental value (sensitivity)	<i>Low</i>	Neutral or Slight (Not Significant)	Neutral or Slight (Not Significant)	Slight (Not Significant)	Slight (Not Significant) or Moderate (Significant)
	<i>Medium</i>	Neutral or Slight (Not Significant)	Slight (Not Significant) or Moderate (Significant)	Moderate or Large (Significant)	Moderate or Large (Significant)
	<i>High</i>	Slight (Not Significant)	Slight (Not Significant) or Moderate (Significant)	Moderate or Large (Significant)	Large or Very Large (Significant)
	<i>Very High</i>	Slight (Not Significant)	Moderate or Large (Significant)	Large or Very Large (Significant)	Very Large (Significant)

1.11 Impact assessment

1.11.1 Construction

1.11.1.1 The potential significant environmental impacts arising from the construction of Hornsea Four are listed in [Table 1.9](#) along with details of the maximum design scenario against which each potential construction phase impact has been assessed.

1.11.1.2 A description of the potential effect on geology and ground conditions receptors within the 1 km Hornsea Four geology and ground conditions study area caused by each identified impact scoped into the assessment is provided below (with relevant commitments incorporated within the determination of the impact magnitude). The PRA ([Volume A6, Annex 1.1: Land Quality Preliminary Risk Assessment](#)) that has been used to inform the following impacts (within the 1 km Hornsea Four geology and ground conditions study area) adopted a precautionary approach due to the absence of site-specific ground investigation data. As such the impacts described below also adopt a precautionary approach and therefore assumes there will be situations where potential contamination sources cannot be avoided.

Exposure of Workforce to Health Impacts (GGC-C-4).

1.11.1.3 The excavation of cable trenches, earthworks and piling (if required) and the movement and stockpiling of soils within the Hornsea Four Order Limits have the potential to mobilise existing ground contamination (where present), which could result in impacts to human health through dermal contact, inhalation and ingestion.

1.11.1.4 Potential Contaminants of Concern (PCOC) could be present in the Hornsea Four Order Limits and represent a risk to construction workers and the public (such as users of

neighbouring sites and surrounding areas) if exposed during construction activities. Construction activities, particularly earthworks could disturb and expose construction workers to localised Made Ground soils and potential soil and/or groundwater contamination associated with historical and current land uses within the Hornsea Four Order Limits. Construction activities could create pollutant linkages through ingestion, inhalation and direct dermal contact pathways.

1.11.1.5 In the event of exposing soils and stockpiling construction waste (including excavated materials), dust could be generated during dry and windy conditions. Under these conditions, construction workers and the general public, such as users of neighbouring sites and surrounding residents, could temporarily be exposed to contamination via the inhalation of potentially contaminated dusts.

1.11.1.6 The PRA ([Volume A6, Annex 1.1: Land Quality Preliminary Risk Assessment](#)) showed that a large section of land within the Hornsea Four Order Limits crosses agricultural land where areas of significant contamination are not anticipated. The Applicant has also committed to provide a contaminated land and groundwater scheme (Co77, [Table 1.8](#)).

Magnitude of impact

1.11.1.7 With the inclusion of the embedded mitigation measures outlined as part of the project design, the impact is predicted to be of local spatial extent (localised to the work areas), of medium-term duration and temporary occurrence (only occurring during the works). It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **minor**.

Sensitivity of the receptor

1.11.1.8 Human health is deemed to be of high vulnerability, moderate recoverability and high value. The sensitivity of the receptor is therefore, considered to be **high**.

Significance of the effect

1.11.1.9 Overall, it is predicted that the sensitivity of the receptor is **high**, and the magnitude is **minor**. The effect is of **moderate adverse** significance due to the potential of encountering contaminated materials in areas that cannot be avoided.

Further mitigation

1.11.1.10 Where potential sources of contamination cannot be avoided, a targeted ground investigation shall be undertaken during the pre-construction stage of the project so that the potential risks can be identified, and appropriate mitigation measures put in place to protect key receptors (Co77).

1.11.1.11 Further mitigation (such as the implementation of appropriate Personal Protection Equipment (PPE) through Co76) may also be considered necessary if areas of unexpected contamination are encountered during construction works. This will involve the halting of works while a written statement on how the contamination will be dealt with, and by extension reduce the risk associated with the contamination, is produced and agreed with ERYC (Co77, [Table 1.8](#)).

1.11.1.12 With the adoption of the additional mitigation measures the magnitude of impact will be **negligible** therefore the significance of effect is predicted to be **slight (not significant)**, which is not significant in EIA terms.

Encountering Contamination During Intrusive Works (GGC-C-5).

1.11.1.13 The PRA ([Volume A6, Annex 1.1: Land Quality Preliminary Risk Assessment](#)) showed that a large section of land within the Hornsea Four Order Limits crosses agricultural land where areas of significant contamination are not anticipated. However, there is always the risk of encountering unforeseen contamination during construction works which could ultimately have detrimental impacts on sensitive receptors such as human health and controlled waters. The Applicant has committed to prepare a contaminated land and groundwater scheme to identify any contamination and any remedial measures which may be required (Co77, [Table 1.8](#)).

1.11.1.14 Sensitive receptors include construction workers and the public (such as users of neighbouring sites and surrounding areas), groundwater aquifers (Secondary A, B and Principal Aquifers) and associated abstractions, and surface waters specifically the River Hull headwaters which is designated as a SSSI.

Magnitude of impact

1.11.1.15 With the inclusion of the embedded mitigation measures, the impact is predicted to be of local spatial extent (localised to the work areas), of short-term duration and intermittent occurrence (only occurring during the works). It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be **minor**.

Sensitivity of the receptor

1.11.1.16 The sensitivity of the controlled waters receptors is considered to be **high** except for the River Hull headwaters SSSI which is considered to be **very high**. The sensitivity of the human health receptors are considered to be **high**.

Significance of the effect

1.11.1.17 Overall, it is predicted that the sensitivity of receptors is **high** or **very high** in consideration of the River Hull headwaters SSSI, and the magnitude is minor. The effect is therefore of **moderate adverse** (for the high sensitivity receptors) to **large adverse** (for the very high sensitivity receptor) significance due to the potential of encountering contaminated materials.

Further mitigation

1.11.1.18 Where areas of unexpected contamination are encountered during construction works, the works will be halted whilst a written statement on how the contamination will be dealt with, and by extension reduce the risk associated with the contamination, is produced and agreed with EYRC (Co77, [Table 1.8](#)).

1.11.1.19 With the adoption of the further mitigation measures the magnitude of impact will be **negligible** therefore the significance of effect is predicted to be **slight (not significant)**, which is not significant in EIA terms.

1.11.2 Operation and Maintenance

1.11.2.1 No potentially significant impacts were identified in relation to operation and maintenance of Hornsea Four on geological and ground conditions at PEIR. Further details are provided in [Volume A4, Annex 5.1: Impacts Register](#).

1.11.3 Decommissioning

1.11.3.1 It is expected that the detail and scope of the decommissioning works for the landfall, onshore ECC and OnSS will be determined by the relevant rules and regulations, as well as industry best practices at the time of decommissioning with an associated Decommissioning Plan being subsequently prepared (Co127).

1.11.3.2 It is considered that impacts associated with the decommissioning phase will be of equal and no more than those identified for the construction phase with no additional significant effects identified above those set out for the construction phase. The onshore export cables will be left in situ underground with the cable ends cut, sealed and securely buried. The external structures of the jointing pits and link boxes along the corridor will be removed only if it is feasible with minimal environmental disturbance. All relevant construction management, mitigation and project commitments are applicable to the decommissioning phase also. For further information on decommissioning see Section 4.13, [Volume A1, Chapter A4: Project Description](#).

1.11.3.3 Potential impacts arising from the decommissioning phase of Hornsea Four have been scoped out of further assessment following consultation with the Planning Inspectorate (ON-HYD-3.3).

1.12 Cumulative effect assessment (CEA)

1.12.1.1 Cumulative effects can be defined as:

- effects upon a single receptor to arise as a result of impact interaction between different environmental topics from Hornsea Four; and
- incremental effects on that same receptor from other proposed and reasonably foreseeable projects and developments in combination with Hornsea Four. This includes all projects that result in a comparative effect that is not intrinsically considered as part of the existing environment and is not limited to offshore wind projects.

1.12.1.2 The overarching method followed in identifying and assessing potential cumulative effects in relation to the onshore environment is set out in [Volume A4, Annex 5.5: Onshore Cumulative Effects](#) and [Volume A4, Annex 5.6: Location of Onshore Cumulative Schemes](#). The approach is based upon the Planning Inspectorate (PINS) Advice Note 17: Cumulative Effects Assessment (PINS 2017). The approach to the CEA is intended to be specific to Hornsea Four and takes account of the available knowledge of the environment and other activities around the Hornsea Four Order Limits.

1.12.1.3 The CEA has followed a four-stage approach developed from PINS Advice Note 17. These stages are set out in Table 2 of [Volume A4, Annex 5.5: Onshore Cumulative Effects](#), with Table 4 detailing the onshore long list search areas extents or Zone of Impacts for each topic area. The proposed tier structure that is intended to ensure that there is a clear understanding of the level of confidence in the cumulative assessments provided in the Hornsea Four ES is set out in Table 3 of [Volume A4, Annex 5.5: Onshore Cumulative Effects](#).

1.12.2 CEA Stage 2 Shortlist and Stage 3 Information Gathering

1.12.2.1 A shortlist of projects for CEA has been produced using the screening buffer/criteria set out in Table 2 of [Volume A4, Annex 5.5: Onshore Cumulative Effects](#). Information regarding all other developments is provided in [Volume A4, Annex 5.5: Onshore Cumulative Effects](#) and [Volume A4, Annex 5.6: Location of Onshore Cumulative Schemes](#).

1.12.2.2 There are 16 projects that have been identified for inclusion on the shortlist of projects to be assessed cumulatively for geology and ground conditions. The remaining projects have not been considered as resulting in likely cumulative significant effects as they are located in excess of 1 km from the Hornsea Four Order Limits.

1.12.3 CEA Stage 3 Assessment

1.12.3.1 As stated in Table 2 of [Volume A4, Annex 5.5: Onshore Cumulative Effects](#) the assessment is undertaken in two phases:

- [Table 1.13](#) sets out the potential impacts assessed in this chapter and identifies the potential for cumulative effects to arise, providing a rationale for such determinations; and [Table 1.14](#) sets out the CEA for each of the projects/developments that have been identified on the short-list of projects screened.

1.12.3.2 It should be noted that the second phase of this assessment is only undertaken if the first phase identifies that cumulative effects are possible. This summary assessment is set out in [Table 1.13](#).

Table 1.13: Potential Cumulative Effects.

Impact		Potential for Cumulative Effect?	Rationale
<i>Construction</i>			
GGC-C-4	Exposure of workforce to health impacts.	Yes	Impact to both onsite and offsite human health receptors, e.g. via generation of dusts, which may be exacerbated by other projects.
GGC-C-5	Encountering contamination during intrusive works	No	Due to the highly localised nature of the impacts (i.e. the impacts will be confined to the work area) and the management in place for Hornsea Four being in place for other projects there is no potential for cumulative effects from encountering contamination during intrusive works.
GGC-C-8	Physical intrusion into groundwater resource - Impacts on groundwater quality in superficial secondary aquifers during earthworks activities.	Yes	Impacts to secondary aquifers may be exacerbated by other projects.
GGC-C-8	Physical intrusion into groundwater resource - Impacts on groundwater quality in principal bedrock aquifers resulting from HDD.	Yes	Impacts to principal aquifers may be exacerbated by other projects.
GGC-C-8	Physical intrusion into groundwater resource - Impacts on groundwater quality in principal bedrock aquifers resulting from piling.	Yes	Impacts to principal aquifers may be exacerbated by other projects.
GGC-C-8	Physical intrusion into groundwater resource - Impacts on controlled	Yes	Impacts to groundwater may be exacerbated by other projects.

Impact		Potential for Cumulative Effect?	Rationale
	waters as a result of dewatering of trenches and excavations.		
GCC-C-11	Impacts on groundwater resources - Underground works along the cable route and at the project substation (e.g. HDD, deep excavations, piling) could introduce new contaminants into groundwater.	Yes	Impacts to groundwater resources may be exacerbated by other projects.

Operation

GGC-O-3	Sterilisation of future mineral resources.	No	The impacts will be confined to the work area.
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There are unlikely to be any additional significant cumulative impacts from the operation of the project.

Decommissioning

The detail and scope of the decommissioning works will be determined by the relevant legislation and guidance at the time of decommissioning and agreed with the regulator. A decommissioning plan will be provided (Co127). As such, cumulative impacts during the decommissioning stage are assumed to be the same as those identified during the construction stage. Additionally, PINS have stated in their Scoping Opinion that cumulative decommissioning effects are scoped out of the EIA (ON-HYD-3.3).

1.12.3.3 The second phase of the CEA is a project specific assessment of the potential for any significant cumulative effects to arise due to the construction and/or operation and maintenance of Hornsea Four. To identify whether this may occur each shortlisted project is discussed in [Table 1.14](#).

1.12.3.4 The CEA has been based on information available on each potential project (e.g. as set out on ERYC planning portal or in an attendant, available ES) and it is noted that the project details available may change in the period up to construction or may not be available in detail at all. The assessment presented here is therefore considered to be conservative, with the level of impacts expected to be reduced compared to those presented here.

1.12.3.5 The CEA has not identified impacts that are considered to be of any greater significance than those identified in isolation and no cumulative effects of significance are forecast.

Table 1.14: Project Screening for CEA for Geology and Ground Conditions.

Project Name	Tier	Discussion	Likelihood and Significance of Cumulative Effects
Jocks Lodge Highway Improvement Scheme	1	<p>Due to the proximity of the development to the project there is the potential for cumulative effects of a direct and / or indirect nature on the receptors identified. However, due to the nature of the development and the regulatory regime under which it will be constructed, it is assumed (with high confidence) that appropriate mitigation measures are to be incorporated into the design thus limiting the potential for cumulative effects to occur.</p> <p>With planning permission for the Jocks Lodge improvement scheme granted in July 2020, it is anticipated that the majority of construction works will have been completed prior to the start of construction works at Hornsea Four in 2024.</p>	No potential for significant cumulative effects.
Dogger Bank A and B	2	<p>Dogger Bank A and B are predicted to finish construction in 2022 and will potentially be operational during the construction period of Hornsea Four. No cumulative impacts on any shared receptors identified are predicted.</p> <p>However, should there be any delays with the construction of either Dogger Bank A or B, the works will take place under a DCO and appropriate mitigation measures (e.g. CoCP and piling risk assessments etc.) will be incorporated into the design thus limiting the potential for cumulative effects to occur.</p>	No potential for significant cumulative effects.
Dogger Bank Cable Corridor	2	<p>As Dogger Bank is predicted to finish construction in 2022 and will potentially be operational during the construction period of Hornsea Four no cumulative impacts on any shared receptors identified are predicted.</p> <p>However, should there be any delays with the construction of the Dogger Bank, the works will take place under a DCO and appropriate mitigation measures (e.g. CoCP) will be incorporated into the design thus limiting the potential for cumulative effects to occur.</p>	No potential for significant cumulative effects.
Low Farm Development	1	<p>Due to the nature of the development and the distance from the Hornsea Four Order Limits (800 m north east of the OnSS) no cumulative effects on receptors identified are considered likely.</p>	No potential for significant cumulative effects.

Project Name	Tier	Discussion	Likelihood and Significance of Cumulative Effects
		<p>It is also assumed that the construction works at Low Farm will be completed prior to the start of construction works at Hornsea Four, therefore no cumulative impacts on any shared receptors identified are predicted.</p>	
Leconfield Post Office Development #1	1	<p>Due to the nature of the development and the distance from the Hornsea Four Order Limits (~1 km from the onshore ECC) no cumulative effects on receptors identified are considered likely.</p>	No potential for significant cumulative effects.
Leconfield Post Office Development #2		<p>It is also assumed, should planning permission be granted, that the construction works at this residential development will be completed prior to the start of construction works at Hornsea Four, therefore no cumulative impacts on any shared receptors identified are predicted.</p>	
Eastfield Farm Solar	1	<p>The earliest construction start date for Hornsea Four is anticipated to be in 2024. Planning permission has been granted for the solar farm and battery storage area, therefore there is the possibility that construction works could overlap.</p> <p>However, due to the nature of the development and the regulatory regime under which it will be constructed, it is assumed (with high confidence) that appropriate mitigation measures are to be incorporated into the design thus limiting the potential for cumulative effects to occur.</p>	No potential for significant cumulative effects.
Canada Drive Housing Development	1	<p>Due to the nature of the development and the distance from the Hornsea Four Order Limits (~1 km from the onshore ECC) no cumulative effects on receptors identified are considered likely.</p> <p>It is also assumed that the construction works at this residential development will be completed prior to the start of construction works at Hornsea Four, therefore no cumulative impacts on any shared receptors identified are predicted.</p>	No potential for significant cumulative effects.
Beverley Racecourse	1	<p>Due to the nature of the development and distance from the Hornsea Four Order Limits (650m east from the onshore ECC) no cumulative effects on receptors identified are considered likely.</p>	No potential for significant cumulative effects.

Project Name	Tier	Discussion	Likelihood and Significance of Cumulative Effects
		<p>It is also assumed, should planning permission be granted, that the construction works at Beverley racecourse will be completed prior to the start of construction works at Hornsea Four, therefore no cumulative impacts on any shared receptors identified are predicted.</p>	
Decoy House Farm Development	1	<p>Due to the nature of the development and distance from the Hornsea Four Order Limits (~1km east from the onshore ECC) no cumulative effects on receptors identified are considered likely.</p> <p>It is also assumed, should planning permission be granted, that the construction works at Decoy House Farm will be completed prior to the start of construction works at Hornsea Four, therefore no cumulative impacts on any shared receptors identified are predicted.</p>	No potential for significant cumulative effects.
White House Farm Development	1	<p>Due to the nature of the development and distance from the Hornsea Four Order Limits (400m south of an access track for the onshore ECC) no cumulative effects on receptors identified are considered likely.</p> <p>It is also assumed, should planning permission be granted, that the construction works at White House Farm will be completed prior to the start of construction works at Hornsea Four, therefore no cumulative impacts on any shared receptors identified are predicted.</p>	No potential for significant cumulative effects.
Model Farm Development	1	<p>Due to the nature of the development and distance from Hornsea Four Order Limits (700m north east of the OnSS access track) no cumulative effects on receptors identified are considered likely.</p> <p>It is also assumed, should planning permission be granted, that the construction works at Model Farm will be completed prior to the start of construction works at Hornsea Four, therefore no cumulative impacts on any shared receptors identified are predicted.</p>	No potential for significant cumulative effects.
Albanwise Solar Farm	1	<p>The earliest construction start date for Hornsea Four is anticipated to be in 2024. A planning application for the solar farm and battery storage area has been submitted in August 2021, and although a start date for construction works is as yet unknown, there is the possibility that construction works could overlap.</p>	No potential for significant cumulative effects.

Project Name	Tier	Discussion	Likelihood and Significance of Cumulative Effects
		<p>However, due to the nature of the development and the regulatory regime under which it will be constructed, it is assumed (with high confidence) that appropriate mitigation measures will be incorporated into the design thus limiting the potential for cumulative effects to occur.</p>	
Creyke Beck substation expansion	3	<p>Construction works associated with the expansion of an existing substation at Creyke Beck is anticipated to be between 2024 and 2027. The earliest construction date for Hornsea Four is also anticipated to be in 2024, therefore there is the potential that construction works would overlap.</p> <p>However, due to the nature of the development and the regulatory regime under which it will be constructed, it is assumed (with high confidence) that appropriate mitigation measures will be incorporated into the design thus limiting the potential for cumulative effects to occur.</p>	No potential for significant cumulative effects.
Scotland England Green Link 2 (SEGL2)	3	<p>The earliest construction start date for Hornsea Four is anticipated to be in 2024. A planning application for the SEGL2 project is due to be submitted in March 2022. The proposed construction phase of the works is anticipated to start in 2024. Therefore, there is the potential for an overlap during construction phases of both SEGL2 and Hornsea Four. It is anticipated that the overlap between projects will be focused on the landfall location.</p> <p>Due to the nature of the development and the regulatory regime under which it will be constructed, it is assumed (with high confidence) that appropriate mitigation measures will be incorporated into the design thus limiting the potential for cumulative effects to occur.</p>	No potential for significant cumulative effects.

1.12.3.6 The CEA for geology and ground conditions does not identify any reasonably foreseeable projects or developments where significant cumulative effects could arise.

1.13 Transboundary effects

1.13.1.1 A screening of transboundary impacts has been carried out and is presented in Appendix K of the Scoping Report (Orsted 2018). This screening exercise identified that there was no potential for significant transboundary effects regarding geology and ground conditions from Hornsea Four upon the interests of other EEA States and this is not discussed further.

1.14 Inter-related effects

1.14.1.1 Inter-related effects consider impacts from the construction, operation or decommissioning of Hornsea Four on the same receptor (or group). The potential inter-related effects that could arise in relation to geology and ground conditions are presented in [Table 1.15](#). Such inter-related effects include both:

- **Project lifetime effects:** i.e. those arising throughout more than one phase of the project (construction, operation, and decommissioning) to interact to potentially create a more significant effect on a receptor than if just one phase were assessed in isolation; and
- **Receptor led effects:** Assessment of the scope for all relevant effects to interact, spatially and temporally, to create inter-related effects on a receptor (or group). Receptor-led effects might be short term, temporary or transient effects, or incorporate longer term effects.

1.14.1.2 A description of the process to identify and assess these effects is presented in Section 2 of [Volume A1, Chapter 5: Environmental Impact Assessment Methodology](#).

Table 1.15: Inter-related effects assessment for geology and ground conditions.

Nature of inter-related effect	Assessment
<i>Project-lifetime effects</i>	
<i>There are no potential impacts that are scoped into this assessment and could therefore constitute a cumulative project lifetime effect.</i>	
<i>Receptor-led effects</i>	
Human Health: Impacts on human health, including construction workers and members of the public during any excavations associated with construction, operation and decommissioning. (Volume A4, Annex 5.8: Health Impact Assessment) (CGC-C-4).	The greatest potential for impacts on human health will be during the construction phase of the project. There are unlikely to be significant additional impacts from the operation of the project as any maintenance work will follow standard procedures (e.g. Co4) thereby minimising potential impacts. Whilst details regarding the decommissioning are unknown, it is anticipated that, using a worst-case scenario, the impacts would be similar to those during construction. However, these two phases are significantly temporally separate and so there will be no interaction between the two.
Hydrology and Flood Risk: Impacts on the quantity and quality of controlled waters during construction,	The greatest potential for spatial and temporal interactions is likely to occur during construction. There

Nature of inter-related effect	Assessment
<p>operation and decommissioning (Chapter 2: Hydrology and Flood Risk) (CGC-C-5, CGC-C-11).</p>	<p>are unlikely to be significant additional impacts from the operational phase of the project as any maintenance work will be conducted in accordance with standard procedures (e.g. Co4) thereby minimising potential impacts. Whilst details regarding the decommissioning are unknown, it is anticipated that, using a worst-case scenario, the impacts would be similar to those during construction. It is not anticipated that any inter-related effects will be produced that are of greater significance than those already identified.</p>
<p>Hydrology and Flood Risk: Mobilisation of soil contaminants to surface water via run-off and physical/chemical degradation of soils (Chapter 2: Hydrology and Flood Risk) (CGC-C-11).</p>	<p>The greatest potential for spatial and temporal interactions is likely to occur if contamination is encountered during the intrusive works (i.e. during the construction phase). Impacts in relation to the mobilisation of soil contaminants to surface water via run-off have not been assessed within this chapter (refer to Volume A4, Annex 5.1: Impacts Register for further details) and have been scoped out of Chapter 2: Hydrology and Flood Risk. It is therefore not anticipated that any inter-related effects will be produced.</p> <p>The greatest potential for spatial and temporal interactions is likely to occur during earthwork activities (i.e. during the construction and decommissioning phases).</p>
<p>Air Quality: Mobilisation of potentially contaminated dust (Chapter 9: Air Quality) (AQ-C-1, AQ-A-2, AQ-O-3 and AQ-D-5).</p>	<p>The greatest potential for spatial and temporal interactions is likely to occur during earthwork activities (i.e. during the construction phase). However, the effects of construction phase dust emissions were scoped out of the air quality assessment as a range of control measures will be implemented as part of the embedded mitigation, therefore the inter-related effects are considered insignificant.</p>

1.14.1.3 The assessment concludes that there are no significant inter-related impacts from the construction or operation of Hornsea Four on geology and ground conditions.

1.15 Conclusion and summary

- 1.15.1.1 This chapter of the ES has assessed the potential impacts from the onshore development of Hornsea Four on geology and ground conditions.
- 1.15.1.2 **Table 1.16** presents a summary of the impacts assessed within this ES, the associated mitigation and the residual effects.
- 1.15.1.3 Through implementation of the mitigation measures identified (both embedded and additional) to prevent or reduce impacts on receptors, residual impacts are anticipated to be **negligible adverse** in relation to geology and ground conditions, and therefore non-significant in EIA terms for all phases of development.

Table 1.16: Summary of potential impacts assessed for geology and ground conditions.

Impact and Phase	Receptor and value/sensitivity	Magnitude and significance	Mitigation	Residual impact
<i>Construction</i>				
Exposure of Workforce to Health Impacts (GGC-C-4)	Construction workers and site neighbours High sensitivity	Minor magnitude of impact, moderate adverse significance	Primary: Co1 Co41 Tertiary: Co4 Co76 Co77 Co124	Slight (Not significant)
Encountering Contamination During Intrusive Works (GGC-C-5)	Construction workers and site neighbours; Secondary and Principal Aquifers, abstractions and surface waters High sensitivity River Hull Headwaters SSSI Very High sensitivity	Minor magnitude of impact, moderate adverse significance (for the high sensitivity receptors) Minor magnitude of impact, large adverse significance (for the very high sensitivity receptor).	Primary Co1 Tertiary: Co6 Co64 Co65 Co77 Co124	Slight (Not significant)

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