



Hornsea Project Four: Environmental Statement (ES)

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Volume A3, Chapter 2 : Hydrology and Flood Risk

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2.2	Onshore Infrastructure Flood Risk Assessment
2.3	Water Framework Directive Compliance Assessment

Glossary

Term	Definition
Bankfull	The water level, or stage, at which a stream, river or lake is at the top of its banks and any further rise would result in water moving into the flood plain.
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 Project 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 Project Four design options under consideration, as set out in detail in the project description. This envelope is used to define Hornsea Project 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 Directive	European Union Directive 85/337/EEC, as amended by Directives 97/11/EC, 2003/35/EC and 2009/31/EC and then codified by Directive 2011/92/EU of 13 December 2011 (as amended in 2014 by Directive 2014/52/EU).
EIA Regulations	The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (the 'EIA Regulations').
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.

Term	Definition
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
Export cable corridor (ECC)	The specific corridor of seabed (seaward of Mean High Water Springs (MHWS)) and land (landward of MHWS) from the Hornsea Project Four array area to the Creyke Beck National Grid substation, within which the export cables will be located.
Haul Road	The track along the onshore cable route which the construction traffic would use to access work fronts.
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.
IDB maintained drains	Ordinary watercourses within an Internal Drainage District that have been adopted and managed for land drainage and flood risk management purposes by the Internal Drainage Board.
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.
Main Rivers	Main Rivers are usually large rivers or streams that are designated under the Water Resources Act (1991) and are shown on the statutory Main River Map. They are managed by the Environment Agency, who carry out construction, maintenance and improvement works to manage flood risk.
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.
Mitigation	A term used interchangeably with Commitment(s) by the Applicant. Mitigation measures (Commitments) are embedded within the assessment at the relevant point in the EIA (e.g. at Scoping, PEIR or ES).
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

Term	Definition
	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 Project Four (the 'authorised project') may be carried out.
Ordinary watercourses	Ordinary watercourses are watercourses that are not designated as Main Rivers under the Water Resources Act (1991). Responsibility for their maintenance with regards to flood risk lies with the Lead Local Flood Authority, or an Internal Drainage Board for some watercourses within an Internal Drainage District.
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).
Reach	A section of a watercourse, typically defined according to its predominant flow or geomorphological characteristics.
Surface watercourses	Generic term for all surface watercourses, including Main Rivers and all types of Ordinary Watercourses.
Transition Joint Bay (TJBs)	TJBs are pits dug and lined with concrete, in which the jointing of the offshore and onshore export cables takes place.
Trenchless Techniques	Also referred to as trenchless crossing techniques or trenchless methods. These techniques include Horizontal Directional Drilling (HDD), thrust boring, auger boring, and pipe ramming, which allow ducts to be installed under an obstruction without breaking open the ground and digging a trench.
Water body	Unit of surface water (river, lake, estuary or coastal waters) or groundwater defined under the Water Framework Directive in a River Basin Management Plan.

Acronyms

Acronym	Definition
BGS	British Geological Survey
CoCP	Code of Construction Practice
COPFAS	Cottingham and Orchard Park Flood Alleviation Scheme
DCO	Development Consent Order
DECC	Department for Energy and Climate Change
DEFRA	Department for Environment, Food and Rural Affairs
DMRB	Design Manual for Roads and Bridges
EBI	Energy Balancing Infrastructure
EC	European Commission
ECC	Export Cable Corridor
EEA	European Economic Area
EIA	Environmental Impact Assessment

Acronym	Definition
ERYC	East Riding of Yorkshire Council
ES	Environmental Statement
EU	European Union
FWMA	Flood and Water Management Act
GEP	Good Ecological Potential
GES	Good Ecological Status
HDD	Horizontal Directional Drilling
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IDB	Internal Drainage Board
JNCC	Joint Nature Conservation Committee
LFRMS	Local Flood Risk Management Strategy
LLFA	Lead Local Flood Authority
LSE	Likely Significant Effects
MDS	Maximum Design Scenarios
MHWS	Mean High-Water Springs
MLWS	Mean Low-Water Springs
NGET	National Grid Electricity Transmission
NPPF	National Planning Policy Framework
NPPG	National Planning Policy Guidance
NPS	National Policy Statement
NSIP	Nationally Significant Infrastructure Project
OnSS	Onshore Substation
PEIR	Preliminary Environmental Information Report
PFRA	Preliminary Flood Risk Assessment
PINS	Planning Inspectorate
PPG	Pollution Prevention Guidance
PRA	Preliminary Risk Assessment
RBD	River Basin District
RBMP	River Basin Management Plan
SAC	Special Area of Conservation
SPA	Special Protection Area
SPZ	Source Protection Zone
SSSI	Site of Special Scientific Interest
TJB	Transition Joint Bay
WFD	Water Framework Directive

Units

Unit	Definition
kV	kilovolt
km	kilometres

2.1 Introduction

- 2.1.1.1 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.
- 2.1.1.2 This chapter of the Environmental Statement (ES) presents the results of the Environmental Impact Assessment (EIA) for the potential impact of Hornsea Four on hydrology and flood risk. 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.
- 2.1.1.3 Baseline geomorphological surveys were undertaken and are reported on in [Volume A6, Annex 2.1: Geomorphological Baseline Survey Report](#). A flood risk assessment (FRA) has been completed for all onshore project elements and can be found in [Volume A6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment](#). A Water Framework Directive (WFD) Compliance Assessment has also been undertaken and is provided separately in [Volume A6, Annex 2.3: Water Framework Directive Compliance Assessment](#). In addition, all crossings identified to date, including watercourses are set out in detail within [Volume A4, Annex 4.2: Onshore Crossing Schedule](#).
- 2.1.1.4 This chapter should be read in conjunction with:
- [Chapter 1: Geology and Ground Conditions](#) which summarises baseline hydrogeology and assesses potential scheme impacts on groundwater receptors; and
 - [Chapter 3: Ecology and Nature Conservation](#) which provides further details on designated sites (including those that support water-dependent habitats) and potential impacts on them.

2.2 Purpose

- 2.2.1.1 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.
- 2.2.1.2 The ES has been finalised with due consideration of pre-application consultation to date (see [Volume B1, Chapter 1: Consultation Report](#) and [Table 2.3](#)) and the ES will accompany the application to the Planning Inspectorate (PINS) for Development Consent.

2.2.1.3 This ES chapter:

- Presents the existing environmental baseline established from desk studies, a walkover survey and consultation;
- Presents the potential environmental effects on hydrology and flood risk arising from Hornsea Four, based on the information gathered and the analysis and assessments undertaken to date;
- Identifies any assumptions and limitations encountered in compiling the environmental information; and
- Highlights any necessary monitoring, management and/or mitigation measures which could prevent, minimise, reduce or offset the possible environmental effects identified in the EIA process.

2.3 Planning and Policy Context

2.3.1.1 Planning policy on offshore renewable energy Nationally Significant Infrastructure Projects (NSIPs), specifically in relation to hydrology and flood risk, is contained in the Overarching National Policy Statement (NPS) for Energy (EN-1; Department for Energy and Climate Change (DECC) 2011a), the NPS for Renewable Energy Infrastructure (EN-3, DECC 2011b) and the NPS for Electricity Networks Infrastructure (EN-5, DECC 2011c).

2.3.1.2 NPS EN-1, NPS EN-3 and NPS EN-5 include guidance on what matters are to be considered in the assessment. These are summarised in [Table 2.1](#) below.

2.3.1.3 The UK planning and policy context for Hornsea Four is set out in [Volume A1, Chapter 2: Planning and Policy Context](#).

Table 2.1: Summary of NPS EN-1 and EN-3 policy on relevant assessment considerations for Hydrology and Flood Risk.

Summary of NPS EN-1, EN-3 and EN-5 provisions	How and where considered in the ES
<i>"Applicants should carry out a flood risk assessment (FRA) which should identify and assess the risks of all forms of flooding to and from the project and demonstrate how these flood risks shall be managed"</i> (paragraph 5.7.4 of NPS-EN1).	An FRA which identifies and assesses the risks of flooding to and from the project has been undertaken and is provided within Volume A6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment .
<i>"Applicants should undertake pre-application stakeholder engagement with the Environment Agency (EA) and other such bodies including relevant Internal Drainage Boards, sewerage undertakers, navigation authorities, highways authorities and reservoir owners and operators to define the scope of the FRA and identify impacts"</i> (paragraph 5.7.7 of NPS-EN1).	Consultation has been undertaken with the Environment Agency, Lead Local Flood Authority (East Riding of Yorkshire Council (ERYC)) and the Beverley and North Holderness Internal Drainage Board (IDB) in relation to Hornsea Four. The outcomes and summary of the consultation process relevant to hydrology and flood risk and the accompanying FRA (Volume A6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment) and WFD Compliance Assessment (Volume A6, Annex 2.3: Water Framework Directive Compliance Assessment) are summarised in Table 2.3 . A summary of

Summary of NPS EN-1, EN-3 and EN-5 provisions	How and where considered in the ES
	<p>consultation is provided in Volume B1, Chapter 6: Consultation Report, with further details in relation to the Evidence Plan process being provided in Volume B1, Annex 1.1: Evidence Plan.</p>
<p><i>"Applicants should undertake an assessment of existing status of, and impacts of the proposed project on, water quality, water resources and physical characteristics of the water environment"</i> (paragraph 5.15.2 of NPS-EN1).</p>	<p>The existing status of the water environment is outlined in Section 2.7, and the impacts on water quality in relation to the Water Framework Directive (WFD) have been assessed in Volume A6, Annex 2.3: Water Framework Directive Compliance Assessment. Impacts from the proposed project on water quality and water resources resulting from both the construction and operation are discussed in Table 2.9 with further details of the assessment provided in the 'Hydrology and Flood Risk' section of Volume A4, Annex 5.1: Impacts Register. Water quality and the water environment are considered in impacts HFR-C-1, HFR-C-2, HFR-C-3, HFR-C-4, HFR-C-6, HFR-C-8, HFR-D-9, HFR-O-11, HFR-C-12, HFR-O-13. These impacts are not considered in detail in this ES.</p>
<p><i>"Applicants should consider the impact of increased risk of drought as a result of higher temperatures in the water quality and resources section of the ES"</i> (paragraph 2.3.5 of NPS-EN3).</p>	<p>The predicted future baseline is considered in Section 2.7.7 which considers the future impact of climate change and increased risk of drought. The impact assessments summarised in the 'Hydrology and Flood Risk' section of Volume A4, Annex 5.1: Impacts Register concludes that there is little mechanism for operational impacts on water quality or resources resulting from Hornsea Four (impacts HFR-O-7, HFR-O-11 and HFR-O-13). Therefore, increased drought and higher temperatures are unlikely to act cumulatively with the project.</p>
<p><i>"An Applicant's assessment should be undertaken for all stages of the lifespan of the proposed wind farm in accordance with the appropriate policy for offshore wind farm EIAs"</i> (paragraph 2.6.190 of NPS-EN3).</p>	<p>All identified hydrology and flood risk impacts associated with the construction, operation and decommissioning of Hornsea Four are set out in Section 2.8.1, with the assessment methodology set out in Section 2.10. No impacts related to hydrology and flood risk have been considered in detail in this ES but are all summarised in the 'Hydrology and Flood Risk' section of Volume A4, Annex 5.1: Impacts Register. The WFD Compliance Assessment and FRA are set out in Volume A6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment and Volume A6, Annex 2.3: Water Framework Directive Compliance Assessment, respectively. This approach was discussed and agreed with the Environment Agency and Beverley and North Holderness Internal Drainage Board (IDB) at a Hornsea Four water and flood risk Evidence Plan Technical Panel meeting on 5 November 2019 (ON-HYD-2.1, ON-HYD-3.1, ON-HYD-3.2, ON-HYD-3.3, ON-HYD-3.4, ON-HYD-3.5, ON-HYD-3.6, ON-HYD-3.7, ON-HYD-3.8, ON-HYD-3.9, ON-HYD-3.10, ON-HYD-3.11, ON-HYD-3.12, ON-HYD-3.14, ON-HYD-3.15, ON-HYD-3.16).</p>

Summary of NPS EN-1, EN-3 and EN-5 provisions	How and where considered in the ES
<p><i>"Applicants should note that climate change is likely to increase risks to the resilience of infrastructure from flooding or at sites located near coasts and estuaries. Applicants should set out to what extent the proposed development is expected to be vulnerable, and, as appropriate, how it would be resilient to flooding (in particular for substations that are vital for the electricity transmission and distribution network) and earth movement caused by flooding (for underground cables)"</i> (paragraphs 2.4.1 and 2.4.2 of NPS-EN5).</p>	<p>Flood vulnerability and resilience in relation to Hornsea Four infrastructure are considered in the FRA, which is provided in Volume A6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment. This assesses the likely vulnerability of the onshore elements of Hornsea Four, including the OnSS to and from flooding. The likely increase in the risk of flooding due to climate change (i.e. future baseline) is also considered in Section 2.7.7.</p>

2.3.1.4 NPS EN-1 and NPS EN-3 also highlight several factors relating to the determination of an application and in relation to mitigation. These are summarised in [Table 2.2](#).

Table 2.2: Summary of NPS EN-1 and EN-3 policy on decision making relevant to Hydrology and Flood Risk.

Summary of NPS EN-1 and EN-3 provisions	How and where considered in the ES
<p><i>"The IPC [hereafter the Secretary of State (SoS)] should be satisfied that the applicant has applied the Sequential Test when undertaking the site selection exercise, the application is supported by a proportionate FRA, the proposal aligns with the national and local flood risk management strategy, sustainable drainage systems (SuDS) have been given priority and the project is appropriately flood resilient and resistant given the identified level of flood risk"</i> (paragraph 5.7.9 of NPS-EN1).</p>	<p>A FRA has been carried out, following the Sequential Test, and is set out in Section 2 of Volume A6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment, which shows that Hornsea Four satisfies the Sequential Test. Hornsea Four's commitment to incorporating SuDS and in relation to national and local flood risk management has been addressed in Volume F2, Chapter 6: Outline Onshore Infrastructure Drainage Strategy and Volume A6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment, and specific commitments (Co's) with regards to drainage, flood risk and flood resilience are outlined in Table 2.10 (Co13, Co14, Co18, Co19, Co28, Co127, Co157, Co, 183, Co184, Co185, Co191, Co197).</p>
<p><i>"The SoS needs to be satisfied that any proposed drainage system complies with National Standards published by Ministers under Paragraph 5(1) of Schedule 3 to the Flood and Water Management Act 2010, and that the most appropriate body is being given the responsibility for maintaining any SuDS, taking into account the nature and security of the infrastructure on the proposed site"</i> (paragraph 5.7.10 of NPS-EN1).</p>	<p>A FRA has been carried out and is set out in Volume A6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment. Hornsea Four's commitment to SuDS (Co191) has also been provided in Volume F2, Chapter 6: Outline Onshore Infrastructure Drainage Strategy.</p>
<p><i>"The SoS should not consent development in FZ2 in England unless it is satisfied that the sequential test requirements have been met. It should not consent development in FZ3 unless it is</i></p>	<p>A FRA has been carried out, following the Sequential and Exception Test, and is set out and</p>

Summary of NPS EN-1 and EN-3 provisions	How and where considered in the ES
<p><i>satisfied that the Sequential and Exception Test requirements have been met</i>" (paragraph 5.7.13 – 5.7.17 of NPS-EN1).</p> <p><i>"The SoS should give impacts upon the water environment more weight where a project would have an adverse effect on the achievement of the environmental objectives established under the WFD"</i> (paragraph 5.15.5 of NPS-EN1).</p>	<p>justified in Volume A6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment.</p> <p>The potential impacts of Hornsea Four on the water environment are discussed in detail in Section 2.8.1 of this document in Table 2.9. No impacts related to hydrology and flood risk have been considered in detail in this ES and are instead summarised in the 'Hydrology and Flood Risk' section of Volume A4, Annex 5.1: Impacts Register. In addition, a WFD Compliance Assessment has been produced, and is contained in Volume A6 Annex 2.3: Water Framework Directive Compliance Assessment which concludes that no adverse effects to WFD status are predicted to arise as a result of Hornsea Four.</p>
<p><i>"The SoS should consider whether the proposal has regard to the River Basin Management Plans and meets the requirements of the WFD (including Article 4.7) and its daughter directives, including those on priority substances and groundwater. The interactions of the proposed project with other such plans as Water Resource Management Plans and Shoreline/Estuary Management Plans shall also be considered by the SoS"</i> (paragraph 5.15.6 of NPS-EN1).</p>	<p>The potential impacts associated with the construction, operation and decommissioning of Hornsea Four on the water environment are discussed in Section 2.8.1 in Table 2.9. No impacts related to hydrology and flood risk have been considered in detail in this ES and are instead summarised in the 'Hydrology and Flood Risk' section of Volume A4, Annex 5.1: Impacts Register. The River Basin Management Plan is considered in Section 2.3.7 of this chapter. In addition, a WFD Compliance Assessment has been produced, and is contained in Volume A6, Annex 2.3: Water Framework Directive Compliance Assessment. Impacts on water resources, and hence the Water Resources Management Plan, are covered in Chapter 1: Geology and Ground Conditions, and interactions with the Shoreline/Estuary Management Plans are considered in Volume A2, Chapter 1: Marine Geology, Oceanography and Physical Processes.</p>
<p><i>"The SoS should consider whether appropriate requirements should be attached to any development consent and / or planning obligations entered into to mitigate adverse effects on the water environment"</i> (paragraph 5.15.7 of NPS-EN1).</p>	<p>The potential impacts of construction, operation and decommissioning on hydrology and the water environment are set out in Table 2.9 in Section 2.8.1. However, no impacts related to hydrology and flood risk have been considered in detail in the ES but are instead summarised in the 'Hydrology and Flood Risk' section of Volume A4, Annex 5.1: Impacts Register in impacts HFR-O-7, HFR-O-11 and HRF-O-13. Commitments related to the water environment are provided in Table 2.10. These</p>

Summary of NPS EN-1 and EN-3 provisions	How and where considered in the ES
	eliminate and/or reduce the likely significant effect (LSE) of a number of impacts. Commitments related to flood risk are provided in Section 2.12 of Volume A6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment .

2.3.1.5 There are several other pieces of legislation, policy and guidance applicable to water resources and flood risk. The following sections provide detail on key pieces of international and UK legislation, policy and guidance which are relevant to hydrology and flood risk and hence underpin this ES Chapter and its supporting assessments ([Volume A6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment](#) and [Volume A6, Annex 2.3: Water Framework Directive Compliance Assessment](#)). The requirement for this ES in the context of national legislation is detailed within [Volume A1, Chapter 2: Planning and Policy Context](#) of this ES.

2.3.2 Water Framework Directive (2000/60/EC)

2.3.2.1 The WFD (Council Directive 2000/60/EC which establishes a framework for community action in the field of water policy) was adopted by the European Commission (EC) in December 2000. The WFD requires that all European Union (EU) Member States must prevent deterioration and protect and enhance the status of aquatic ecosystems. This means that Member States must ensure that new schemes do not adversely affect the status of aquatic ecosystems, and that historical modifications that are already affecting aquatic ecosystems need to be addressed.

2.3.2.2 Unlike the EU Birds and Habitats Directives (European Commission (EC) Directive on the Conservation of Wild Birds (2009/147/EC) and EC Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC), which apply only to designated sites, the WFD applies to all water bodies (rivers, lakes, estuaries, coastal waters and groundwater) including those that are man-made.

2.3.2.3 The provisions of the WFD remain in force in England and Wales following the UK's departure from the European Union through the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 ([Section 2.3.3](#)).

2.3.3 Water Environment (Water Framework Directive) (England and Wales) Regulations 2017

2.3.3.1 The WFD is transposed into national law in the UK by means of the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017. The Regulations provide for the implementation of the WFD, including the designation of all surface waters (rivers, lakes, estuarine waters, coastal waters and ground waters) as water bodies, and set

objectives for the achievement of Good Ecological Status (GES) or Good Ecological Potential (GEP).

2.3.4 Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015

2.3.4.1 The standards used to determine the ecological or chemical status of a water body are provided in the WFD (Standards and Classification) Directions (England and Wales) 2015. This includes the thresholds for determining the status of the biological, hydromorphological, physico-chemical and chemical status of surface water bodies, and the quantitative and chemical status of groundwater bodies.

2.3.5 National Policy: National Planning Policy Framework (2019) and National Planning Practice Guidance

2.3.5.1 The National Planning Policy Framework (NPPF) sets out the UK Government planning policies for England. The NPPF seeks to ensure that flood risk is considered at all stages in the planning and development process, to avoid inappropriate development in areas at risk of flooding and to direct development away from areas at risk of flooding.

2.3.5.2 The National Planning Practice Guidance (NPPG) on Flood Risk and Coastal Change supports the NPPF with additional guidance on flood risk vulnerability classifications and managing residual risks. The NPPG makes use of the concepts of Flood Zones (paragraph 003), Vulnerability Classifications and Compatibility in order to assess the suitability of a specific site for a certain type of development (paragraphs 007 and 030).

2.3.5.3 The NPPF and associated guidance directs development away from areas at highest risk of flooding via the application of the Sequential Test (paragraphs 018 – 022 and 033 of the NPPG on Flood Risk and Coastal Change). If, following application of the Sequential Test, it is not possible for the project to be located in zones with a lower probability of flooding, the Exception Test can be applied if appropriate (paragraphs 023 – 028 and 035 of the NPPG on Flood Risk and Coastal Change).

2.3.6 Flood and Water Management Act 2010

2.3.6.1 The Flood and Water Management Act (FWMA) aims to improve both flood risk management and water resource management by creating clearer roles and responsibilities. This includes a lead role for local authorities in managing local flood risk (from surface water, ground water and ordinary watercourses) and a strategic overview role of all flood risk for the Environment Agency. The FWMA provides opportunities for a comprehensive, risk-based approach on land use planning and flood risk management by local authorities and other key partners.

2.3.7 Regional Policy: Humber River Basin District: River Basin Management Plan (2015)

2.3.7.1 The River Basin Management Plan (RBMP) sets out the objectives that have been set for implementation of the WFD at a regional (River Basin District (RBD)) level. The current

(second) RBMP (2015) for the Humber was produced by the Environment Agency and sets out the current state of the water environment according to WFD parameters, the statutory objectives for protected areas, the statutory objectives for water bodies and the summary programme of measures to achieve these statutory objectives. It provides a framework for action and future regulation. Since land-use planning, and water and land resources are closely linked, this plan also informs decisions on land-use and planning.

2.3.8 Regional Policy: Preliminary Flood Risk Assessment

2.3.8.1 The Hornsea Four hydrology and flood risk study area is located within the authority area of East Riding of Yorkshire Council (ERYC), which is a unitary authority. A Preliminary Flood Risk Assessment (PFRA) was last updated by the ERYC in 2017 for the Hull and Haltemprice Flood Risk Areas. The PFRA is used to inform the Local Flood Risk Management Strategy (LFRMS) and provides a high-level understanding of the potential risk of flooding from local sources and identifies areas at risk of significant flooding.

2.3.9 Regional Policy: Local Flood Risk Management Strategy

2.3.9.1 The LFRMS was adopted by ERYC in November 2015 as the Lead Local Flood Authority (LLFA) for the area. It sets out how ERYC intends to work with partners, including the Environment Agency, Yorkshire Water and Internal Drainage Boards, to manage the risk of flooding in the East Riding of Yorkshire up until 2027 and beyond. It aligns with the National Flood and Coastal Erosion Risk Management Strategy and sits within a wider policy framework of water resources management.

2.4 Consultation

2.4.1.1 Consultation is a key part of the DCO application process. Consultation regarding hydrology and flood risk (including all topics pertinent to the ES, FRA and WFD Compliance Assessment) has been conducted through Evidence Plan Technical Panel meetings, 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).

2.4.1.2 A summary of the key issues raised during consultation specific to hydrology and flood risk is outlined below in [Table 2.3](#), together with how these issues have been considered in the production of this ES.

Table 2.3: Consultation Responses.

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
Yorkshire Consortium of Drainage Boards	12 September 2018 Meeting 1 – Pre-scoping	<p>HDD under watercourses</p> <p>Concern was expressed by the Yorkshire Consortium of Drainage Boards regarding the depth of HDD under watercourses. It was agreed that the wording of the commitments would be altered to ensure that all IDB maintained watercourses will be HDD'd.</p>	Hornsea Four's approach to HDD, including the depth below watercourses, is provided in Co1 and Co18. Where surface watercourses are to be crossed by HDD (or other trenchless technologies) the export cables will be installed a minimum of 1.2 m below the hard bed, and the optimal clearance will be agreed with the relevant authorities prior to construction (Co18).
Planning Inspectorate	November 2018 – Scoping Opinion ID 4.14.1	<p>Impacts at Landfall</p> <p><i>The Inspectorate notes that Co1 in Table 7.7 of the Scoping Report does not specifically mention the landfall and therefore does not confirm the assumption made in Paragraph 7.2.4.1 of the Scoping Report that the landfall will be constructed using HDD. It is also noted that Co1 excludes flood defences, and therefore the Inspectorate does not agree to scope these matters out of the ES. It is advised that the Applicant should consider the effect of future coastal erosion on the Proposed Development and that the wording of embedded mitigation commitments applied to the ES should make it clear where these measures apply.</i></p>	<p>Although no impacts to hydrology and flood risk have been considered further in this ES, potential impacts at landfall are outlined in Table 2.9 in Section 2.8.2 of this chapter.</p> <p>Co187 has been made in relation to the use of HDD (or other trenchless technologies) at landfall. Potential flood risk related impacts are considered in detail in Volume A6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment.</p> <p>The effect of future coastal erosion on the proposed development is considered in Volume A2, Chapter 1: Marine Geology, Oceanography and Physical Processes.</p>
Planning Inspectorate	November 2018 – Scoping Opinion ID 4.14.2	<p>Impacts Associated with the Crossing Methodology for Watercourses and Minor Drainage Features</p> <p><i>The Inspectorate advises that the ES includes an assessment of the impact on watercourses, and on minor drainage features, where significant effects are likely to occur as a result of watercourse crossings and access track installations</i></p>	All identified hydrology and flood risk impacts associated with the construction of Hornsea Four are set out in Section 2.8.2 . Hydrology and flood risk impacts related to Hornsea Four have not been assessed in detail in this ES and are instead summarised in the 'Hydrology and Flood Risk' section of

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
		<p>and crossings. This is in view of the caveat of 'where technically practical' in Co1 regarding trenchless techniques and the embedded mitigation in Co34 which proposes open cut construction techniques.</p>	<p>Volume A4, Annex 5.1: Impacts Register and summarised in Table 2.9.</p> <p>Co1 provides the Hornsea Four commitment to HDD all Environment Agency Main Rivers and IDB maintained drains and no longer contains the caveat. The onshore Crossing Schedule which provides further detail and confirmation on the proposed crossing method for all crossings is provided in Volume A4, Annex 4.2: Onshore Crossing Schedule.</p>
<p>Planning Inspectorate</p>	<p>November 2018 – Scoping Opinion ID 4.14.4</p>	<p>Local land drainage and flood risk</p> <p><i>It is not clear from the Scoping Report whether the introduction of new, albeit temporary, impermeable areas during construction have been considered with respect to flood risk. The inspectorate is of the opinion that significant effects may arise in particular with regard to construction compounds and access haul roads. This matter cannot be scoped out of the ES based on the information provided, and therefore the ES should provide an assessment of flood risk associated with construction of the cable corridor.</i></p>	<p>An FRA has been carried out and is provided as an annex in Volume A6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment. It includes consideration of flood risk associated with temporary infrastructure including construction compounds and access haul roads.</p> <p>An outline drainage strategy is also provided in Volume F2, Chapter 6: Outline Onshore Infrastructure Drainage Strategy.</p>
<p>Planning Inspectorate</p>	<p>November 2018 – Scoping Opinion ID 4.14.</p>	<p>Effects associated with the operational phase</p> <p><i>The standard protocols referred to in Paragraph 7.2.4.1 should be included in the commitment register and CoCP and appropriately secured in the draft DCO. Given the uncertainty that remains over the nature of standard protocols and how they will be secured, the Inspectorate does not agree to scope these matters out and the ES should</i></p>	<p>All identified hydrology and flood risk impacts associated with the operation of Hornsea Four are set out in Section 2.8.2. Hydrology and flood risk impacts related to Hornsea Four have not been considered in detail in this ES and are instead summarised in the 'Hydrology and Flood Risk' section of Volume A4, Annex 5.1: Impacts Register and summarised in Table 2.9. The impacts relating to operation are HYD-O-7, HYD-O-11 and HYD-O-13. This approach was agreed with the IDB and the EA at a</p>

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
		<p><i>assess the impacts of operation where significant effects could occur.</i></p>	<p>Hornsea Four evidence plan technical meeting on 5 November 2019 (ON-HYD-3.14). The updated chapter has been sent to EYRC for review prior to submission, however a response has yet to be received.</p>
<p>Planning Inspectorate</p>	<p>November 2018 – Scoping Opinion ID 4.14.10</p>	<p>Impacts to minor drainage ditches</p> <p>The Inspectorate requires that the ES includes an assessment of the impacts to minor drainage ditches from access track installations and crossings where significant effects are likely to occur.</p>	<p>Hydrology and flood risk impacts have not been considered in detail in this ES and are instead summarised in the 'Hydrology and Flood Risk' section of Volume A4, Annex 5.1: Impacts Register and summarised in Table 2.9 in Section 2.8.2. This approach was agreed with the IDB and the EA at a Hornsea Four evidence plan technical meeting on 5 November 2019 (ON-HYD-3.6). The updated chapter has been sent to EYRC for review prior to submission, however a response has yet to be received. HFR-C-3 specifically addresses the impacts to minor drainage ditches. Co157, Co172, Co14, Co19, Co124, Co147 and Co186 will be implemented to prevent non-temporary effects.</p>
<p>Planning Inspectorate</p>	<p>November 2018 – Scoping Opinion ID 4.14.11</p>	<p>Potential impacts to designated sites</p> <p><i>This chapter of the Scoping Report makes no reference to the potential impacts from changes to hydrological function and water quality on designated sites. It is acknowledged that ecological and geological designations are proposed to be assessed in relevant other aspect chapters of the ES. However, the Inspectorate considers that these assessments should be informed by suitable hydrological assessment, and appropriate cross reference should be made accordingly within the ES.</i></p>	<p>Hydrology and flood risk impacts have not been considered in detail in this ES and are instead summarised in the 'Hydrology and Flood Risk' section of Volume A4, Annex 5.1: Impacts Register and summarised in Table 2.9 in Section 2.8.2. This approach was agreed with the IDB and the EA at a Hornsea Four evidence plan technical meeting on 5 November 2019 (ON-HYD-3., ON-HYD-3.17). The updated chapter has been sent to EYRC for review prior to submission, however a response has yet to be received. Impact HFR-C-12 specifically addresses designated sites. Co4, Co8, Co10, Co14, Co19, Co64 and Co77 will be implemented to control the</p>

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
			<p>supply of sediment and other contaminants into surface water.</p> <p>In addition, potential impacts to designated sites are discussed in Chapter 3: Ecology and Nature Conservation.</p>
<p>Yorkshire Consortium of Drainage Boards</p>	<p>15 January 2019 - Meeting 2 – Post Scoping / Pre-PEIR</p>	<p>Watercourse crossings</p> <p>It was questioned whether a list of crossings would be available, as the IDB is also responsible for ordinary watercourses in the project area and is the consenting authority as such. Although using HDD to cross IDB maintained watercourses may not cause too many issues, using open cut techniques may be more difficult.</p>	<p>Commitments relating to HDD including Co1, Co18 and Co41 are provided in Volume A4, Annex 5.2: Commitments Register and summarised in Table 2.10 with commitments to HDD beneath Environment Agency Main Rivers and IDB maintained drains (Co1) given in Volume A6, Annex 5.2: Commitments Register and reflected in Volume A4, Annex 4.2: Onshore Crossing Schedule.</p>
<p>Yorkshire Consortium of Drainage Boards</p>	<p>15 January 2019 - Meeting 2 – Post Scoping / Pre-PEIR</p>	<p>HDD entry and exit pits</p> <p>It was explained that tracked excavators are used on IDB (and Environment Agency) watercourses, and so it is preferable that a 9 m margin around these watercourses should be maintained for HDD entry and exit pits as well as link boxes. In addition, it was raised that methods of crossing the watercourses by the haul road such as bailey bridges and culverts will need to be consented and should be considered within the DCO application.</p>	<p>The commitment to locate HDD entry and exit pits 9 m away from IDB and Environment Agency watercourses is given in Co18 in Volume A6, Annex 5.2: Commitments Register.</p>
<p>Environment Agency</p>	<p>15 January 2019 - Meeting 2 – Post Scoping / Pre-PEIR</p>	<p>Flood risk permitting</p> <p>It was raised that methods of crossing the watercourses by the haul road such as bailey bridges and culverts will need to be consented and should be considered within the DCO application.</p>	<p>The proposed crossing methodology for the onshore export cables and any access which it being sought to date, is outlined in Volume A4, Annex 4.2: Onshore Crossing Schedule. Hornsea Four is in consultation with the Environment Agency and is seeking to include consent within the DCO for activities that would otherwise be</p>

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
			subject to the Environmental Permitting Regulations 2016.
Environment Agency	15 January 2019 - Meeting 2 – Post Scoping / Pre-PEIR	<p>WFD Compliance Assessment</p> <p>It was noted that some sort of WFD Compliance Assessment would be required even if using HDD, regardless of whether it would be provided with the view that nothing else would be required.</p>	A WFD Compliance Assessment is provided in Volume A6, Annex 2.3: Water Framework Compliance Assessment .
Environment Agency, Yorkshire Consortium of Drainage Boards and ERYC LLFA.	15 January 2019 - Meeting 2 – Post Scoping / Pre-PEIR	<p>Desk-Based Assessment</p> <p>It was agreed that desk-based assessments would be undertaken to determine impacts on hydrology, water quality and geomorphology, using freely available OS mapping, aerial photography, WFD status classification data and SSSI condition data. Desk-based assessments will also determine impacts on flood risk and inform the FRA; using Environment Agency flood risk data, historical flood incidents and local flood risk management strategy information from the LLFA and IDB.</p> <p>Fisheries/priority species records held by the Environment Agency will also be used to inform the definitions of receptor value if these are available. This assessment will inform the ES chapter and WFD compliance assessment.</p>	<p>A desk-based assessment has been carried out as part of this assessment, the results of which are included in Section 2.7.</p> <p>A FRA has been carried out, including a baseline environment section, and is provided as an annex in Volume A6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment.</p>
Environment Agency	5 April 2019 – Meeting 3 – Post Scoping / Pre- PEIR	<p>Types of flood risk considered in the FRA</p> <p>It was discussed that the FRA should assess all types of flood risk and consider changes to flood risk resulting from the proposed development as well as risks to the development (e.g. due to</p>	An FRA is provided in Volume A6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment . This includes consideration of all sources of potential flood risk including fluvial, coastal, surface water, groundwater and reservoir flooding. The assessment also considers potential flood risks to the project (i.e. on-site

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
		changes in runoff from the onshore substation (OnSS). Therefore, catchments and individual watercourses would have to be used for the assessment. Updated guidance on UKCP18 climate projection allowances published in Spring 2019 will be incorporated into the FRA when received.	flood risks) as well as potential flood risks resulting from the project (i.e. off-site flood risks). The most up to date guidance on climate projections has been used to inform the FRA ¹ .
York Consortium of Drainage Boards	5 April 2019 – Meeting 3 – Post Scoping / Pre-PEIR	<p>Crossing of IDB watercourses</p> <p>The IDB would prefer trenchless techniques such as HDD to be used for crossing of their watercourses based on experience from other projects.</p>	Co1 provides the Hornsea Four commitment to HDD all Environment Agency Main Rivers and IDB maintained drains and no longer contains the caveat. The onshore Crossing Schedule which provides further detail and confirmation on the proposed crossing method for all crossings identified to date, is provided in Volume A4, Annex 4.2: Onshore Crossing Schedule .
Environment Agency	5 April 2019 – Meeting 3 – Post Scoping / Pre-PEIR	<p>Integrity of flood defences</p> <p>The Environment Agency explained that there are raised flood defences around some of the watercourses. In order to maintain the integrity and access to the flood defences, reception pits must be a suitable distance away from the flood defences. In addition, the working area for crossings should allow the relevant responsible authority unrestricted access to the water where possible.</p>	An FRA is provided in Volume A6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment . Co18, Co175 and Co186 are relevant to Environment Agency flood defences. Hornsea Four has committed to locating the HDD entry and exit pits a minimum of 20 m away from EA Main River surface watercourses, and a minimum of 1.2 m vertical clearance will be maintained between the hard bed of the EA Main River and the landward toe of any associated flood defences (Co18).
ERYC LLFA	5 April 2019 – Meeting 3 – Post Scoping / Pre-PEIR	<p>Land drainage during construction</p> <p>It was questioned whether Hornsea Four would want to keep impacts resulting from changes to land drainage during construction scoped in until such</p>	Hornsea Four's approach to drainage for all onshore infrastructure is provided in Volume F2, Chapter 6: Outline Onshore Infrastructure Drainage Strategy (Co19). Co14, Co124, Co157 Co184,

¹ <https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/index>

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
		<p>time as we the drainage information is obtained.</p> <p>The inclusion of a comprehensive drainage strategy was discussed, incorporating measures to prevent changes to the volume and rate of runoff from the proposed development. This will be prepared and agreed in advance with the Environment Agency and LLFA. As a result, no significant effects are expected.</p>	<p>Co185 and Co191 have also been made in relation to drainage.</p> <p>An FRA is provided in Volume A6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment.</p>
<p>ERYC LLFA and Environment Agency</p>	<p>5 April 2019 – Meeting 3 – Post Scoping / Pre-PEIR</p>	<p>Flood risk due to coastal erosion</p> <p>The proposed approach to assessing impacts on flood risk due to coastal erosion at the landfall during construction was discussed. The value in Hornsea Four being aware that the landfall may interact with shoreline defences which might affect the shoreline management plan was also discussed.</p>	<p>An FRA is provided in Volume A6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment which explicitly considers the risk of flooding at landfall.</p>
<p>Environment Agency</p>	<p>5 April 2019 – Meeting 3 – Post Scoping / Pre-PEIR</p>	<p>Water quality during construction</p> <p>The potential use of bentonite was discussed due to experience on other projects where bentonite has leaked at HDD locations. It is assumed that bentonite will be used for the construction of Hornsea Four. This is proposed to be managed through the risk assessment.</p> <p>Potential impacts on water quality due to the remobilisation of existing contaminants in soils were proposed to be scoped out of the assessment. The location of contaminated land will be identified as part of a Phase 1 Preliminary Risk Assessment (PRA), and</p>	<p>The outline pollution prevention plan provided as an annex to Volume F2, Chapter 2: Code of Construction Practice (Co124) sets out the outline measures relating to the use of bentonite.</p> <p>No hydrology and flood risk impacts have been considered in detail in this ES and are instead summarised in the 'Hydrology and Flood Risk' section of Volume A4, Annex 5.1: Impacts Register and outlined in Table 2.9 in Section 2.8.2. Impact number HFR-C-8 relates to the mobilisation of pollutants in the event of disturbance on contaminated soils. Additionally, an assessment of potentially contaminated land has been assessed in Volume A6, Annex 1.1: Land</p>

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
		<p>associated risks will be considered in the Ground Conditions chapter.</p>	<p>Quality Preliminary Risk Assessment and the risks considered in Chapter 1: Geology and Ground Conditions.</p>
<p>ERYC LLFA and Environment Agency</p>	<p>5 April 2019 – Meeting 3 – Post Scoping / Pre-PEIR</p>	<p>Cottingham and Orchard Park Flood Alleviation Scheme (COPFAS)</p> <p>The ERYC LLFA enquired whether Hornsea Four is aware of COPFAS, which is being put in place to reduce flood risk in the area. The Environment Agency’s flood maps will not have been updated to take COPFAS into consideration, although the LLFA will have model data available from when the scheme was designed.</p> <p>The Environment Agency pointed out that in terms of available flood risk data there is likely to be one hydraulic model for Creyke Beck and another for the COPFAS project. Although COPFAS would be downstream of the project it would still need to be considered by Hornsea Four, as runoff from the project would have the potential to interact with and affect the COPFAS project.</p>	<p>An FRA, which includes consideration of COPFAS, has been carried out and is provided as an annex in Volume A6 Annex 2.2: Onshore Infrastructure Flood Risk Assessment. The approach and outcomes of this assessment were agreed with Environment Agency at a Hornsea Four water and flood risk evidence plan technical panel meeting on the 5th April 2019. Agreement was subsequently confirmed with the Environment Agency at an evidence plan technical panel meeting held on the 7th September 2021 (ON-HYD-7.9).</p>
<p>ERYC LLFA and Environment Agency</p>	<p>27 June 2019 - Meeting 4 - Post Scoping / Pre PEIR</p>	<p>Flood Modelling</p> <p>The Environment Agency noted that their flood modelling for the onshore substation site is out of date (approximately 15 years) and not considered to be robust based on broad-scale JFlow modelling. In addition, the flood risk in this area is significantly influenced by surface water flooding and the existing modelling does not take either COPFAS or wider surface water flood risk into consideration. They therefore suggested that Hornsea Four may want to undertake modelling to reduce</p>	<p>An FRA, which includes consideration of COPFAS, and modelling undertaken by the National Grid within its baseline section, has been carried out and is provided as an annex in Volume A6 Annex 2.2: Onshore Infrastructure Flood Risk Assessment.</p> <p>The approach and outcomes of this assessment were agreed with Environment Agency at a Hornsea Four water and flood risk evidence plan technical panel meeting on the 27th June 2019. Agreement was subsequently confirmed with the Environment Agency at an evidence plan technical panel</p>

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
		<p>uncertainty. The National Grid carried out some modelling approximately 3 years ago, but the Environment Agency does not hold this data.</p> <p>The ERYC LLFA also added that flooding does occur in the area of the proposed onshore substation, as in 2007 there was flooding across the golf course, approximately 300 mm deep. Some of the issues of flooding in these areas should be addressed upon completion of the COPFAS project.</p>	<p>meeting held on the 7th September 2021 (ON-HYD-7.9).</p>
<p>Environment Agency</p>	<p>27 June 2019 - Meeting 4 - Post Scoping / Pre PEIR</p>	<p>Topsoil storage</p> <p>The Environment Agency consider that topsoil storage should not be within 8 m of Environment Agency Main Rivers, and if possible, should also be located outside Flood Zones 2 and 3. The Environment Agency understood that Flood Zones 2 and 3 cover large areas of the Hornsea Four onshore cable route, and this may not always be achievable. It would be preferred that any topsoil stored in these flood zones is kept in minimal heaps and stacks with breaks in between to ensure that they can be bypassed by a flow route. Furthermore, if material is stored in a groundwater Source Protection Zone, it would be necessary to determine whether this poses an additional contamination risk. If it could pose a risk, then the material should be checked, covered and bunded for storage.</p>	<p>Commitments are provided in Table 2.10, with the relevant commitments being Co64 and Co197. These commitments and mitigation were discussed and agreed with the Environment Agency and IDB at a water and flood risk Evidence Plan Technical Panel meeting on 5 November 2019 (ON-HYD-4.16), and with the Environment Agency at a meeting on 15 May 2020 (ON-HYD-4.16).</p>
<p>ERYC (the LLFA) and Environment Agency</p>	<p>27 June 2019 - Meeting 4 - Post Scoping / Pre PEIR</p>	<p>Disruption of local land drainage during construction phase</p> <p>An overview of measures to be implemented to minimise effects of</p>	<p>Hornsea Four's approach to drainage for all onshore infrastructure is provided in Volume F2, Chapter 6: Outline Onshore Infrastructure Drainage Strategy (Co19), this will be developed in</p>

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
		<p>disruption to existing surface drainage network was given. These include pre-construction surveys of characteristics of affected watercourses, temporary drainage systems to manage runoff during construction and post-construction reinstatement plans informed by the pre-construction surveys.</p> <p>The LLFA stated that the pre-construction and post-construction drainage system would need to be developed in consultation with the IDB.</p> <p>The Environment Agency noted that the NPPF refers to betterment in terms of surface water flood risk i.e. a reduction in surface water runoff from the haul road.</p>	<p>consultation with key stakeholders including the IDB. Co14, Co124, Co157 Co184, Co185 and Co191 have also been made in relation to drainage.</p> <p>A FRA is provided in Volume A6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment.</p>
Environment Agency	27 June 2019 - Meeting 4 - Post Scoping / Pre PEIR	<p>Thermal effects on surface waters</p> <p>The Environment Agency questioned whether thermal effects on surface waters, and in particular fish, would be considered. It was agreed that agreeing the depths of the HDD would be instrumental.</p>	<p>Commitments are given in, Volume A4, Annex 5.2: Commitments Register and summarised in Table 2.10. Specifically, Co13 details measures to prevent thermal effects on groundwater, and therefore also surface waters.</p>
Environment Agency	5 November 2019 – Meeting 5 – Post PEIR / pre-Environmental Statement	<p>Flood risk at OnSS</p> <p>The Environment Agency stated that it would be preferable to design the permanent access track for the onshore substation in such a way that it does not impound or reduce the floodplain storage. For example, keeping it as close to existing ground levels as much as possible, or incorporating drainage to allow the water to flow in the same way across the floodplain. The south-eastern corner of the onshore substation (where the attenuation pond</p>	<p>Co184 and Co185 specifically relate to the permanent access track at the OnSS, and are detailed in Volume A4, Annex 5.2: Commitments Register and summarised in Table 2.10.</p> <p>The FRA provided in Volume A6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment incorporates the modelling provided by the National Grid into the assessment and considers freeboard and modelling relating to flood zones at the OnSS.</p>

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
		<p>would most likely be located) is partially located in Flood Zone 3. As such Hornsea Four should be considering fluvial flood risk.</p> <p>The modelling carried out by the National Grid was also discussed. It was determined that it includes surface water flood risk which the Environment Agency does not include in their mapping.</p> <p>The Environment Agency noted that substations may be considered 'essential infrastructure' according to the Planning Practice Guidance Table 2 (Paragraph 066) and should therefore be "designed and constructed to remain operational and safe in times of flood" (Table 3 of PPG Paragraph 067) in areas of Flood Zone 3a. They recommended that appropriate mitigation should be provided commensurate with the assessment of flood risk, taking into account any uncertainties and including freeboard to account for the uncertainties.</p>	
Environment Agency	5 November 2019 – Meeting 5 – Post PEIR / pre-Environmental Statement	<p>Logistics compounds</p> <p>The Environment Agency stated that where logistics compounds are located in Flood Zone 3 Hornsea Four should aim to limit their use to be as temporary as possible during construction. Similarly, the use of storage mounds should be avoided.</p>	The outline CoCP is provided in Volume F2, Chapter 2: Outline Code of Construction Practice (Co124). It includes measures relating to appropriate stockpiling mitigation comprising timescales, dimensions, spacing, maintaining flow routes, requirements for pollution control, measures to secure materials and procedures in extreme events.
Environment Agency	5 November 2019 – Meeting 5 – Post PEIR / pre-Environmental Statement	<p>Disruption of local land drainage (construction phase) and alteration in run-off characteristics at the OnSS (operational phase)</p>	Commitments are given in Volume A4, Annex 5.2: Commitments Register and summarised in Table 2.10 . Co64 has been worded in line with the Environment Agency's recommendations. Co197 specifies that

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
		<p>The Environment Agency suggested wording for Co64 which has been implemented. In addition, it was recommended that detailed modelling is undertaken considering fluvial and surface water risks allowing the development to be designed with flood risk mitigated. The use of a freeboard (a way of mitigating flood risk) about existing modelled and observed historic flood levels is recommended to ensure suitable mitigation is incorporated. The Environment Agency also does not want materials to be stockpiled in Flood Zone 2 and 3 where possible.</p> <p>In relation to freeboard, Hornsea Four should recommend and satisfy the Environment Agency that the freeboard is sufficient. Taking into consideration that there is better modelling information out there and that the site is subject to multiple sources of flood risk, they would be pushing for higher numbers.</p>	<p>stockpiling will be avoided in Flood Zones 2 and 3 at the OnSS.</p> <p>The FRA provided in Volume A6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment considers freeboard and modelling relating to flood zones at the OnSS.</p> <p>Hornsea Four's approach to drainage for all onshore infrastructure is provided in Volume F2, Chapter 6: Outline Onshore Infrastructure Drainage Strategy (Co19) and in Volume F2, Chapter 13: Outline Design Plan.</p> <p>The outcomes and justification to the approach taken to the use of freeboard at the OnSS were agreed with Environment Agency at a Hornsea Four water and flood risk evidence plan technical panel meeting on 15th May 2020 (ON-HTD-7.1).</p>
Environment Agency	5 November 2019 – Meeting 5 – Post PEIR / pre- Environmental Statement	<p>Culvert and temporary crossings</p> <p>The Environment Agency recommend that it would be more beneficial to use clear span bridge crossings to temporarily cross watercourses than culverts.</p> <p>Alternatives must have been considered before culverting of any Main Rivers will be accepted by the Environment Agency.</p>	<p>Commitments are given in Volume A4, Annex 5.2: Commitments Register and summarised in Table 2.10. Co172 commits to using clear span/bailey bridges where the temporary access track crosses Environment Agency Main Rivers. Culverts will not be used on any Environment Agency Main Rivers or IDB maintained drains, unless otherwise agreed with the relevant responsible authority.</p>
Environment Agency	5 November 2019 – Meeting 5 – Post PEIR / pre-	<p>Access tracks</p> <p>Hornsea Four explained that the onshore ECC had been reviewed and that access tracks had been reviewed</p>	<p>Commitments are given in Volume A4, Annex 5.2: Commitments Register and summarised in Table 2.10. Co18 states that HDD entry and exit points will be at least 9 m away from IDB and Ordinary</p>

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
	Environmental Statement	alongside the flood risk. Where the locations of the access tracks conflicted with flood zones, or where watercourses were located within 9 m buffer zones watercourses (and where possible, drains), the access tracks were reviewed and re-located. The Environment Agency stated that that an 8 m buffer is sufficient for EA Main Rivers and 16 m from tidal rivers, to allow the EA maintenance access along the banks.	surface watercourses and 20 m from Environment Agency Main Rivers.
York Consortium of Drainage Boards	5 November 2019 – Meeting 5 – Post PEIR / pre- Environmental Statement	<p>Site drainage</p> <p>Hornsea Four explained that ERYCs best practice guidance, which does not diverge from the IDB’s guidance, will be followed, and greenfield run-off rates will be adhered to. The IDB stated that the greenfield discharge rate should be equivalent to approximately the 1 in 1 year runoff rate and that the IDB will be seeking the same as that set out in the ERYC guidance.</p>	An FRA is provided in Volume A6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment .
Environment Agency	15th May 2020 – Environment Agency meeting	<p>Site freeboard</p> <p>The Environment Agency stated that they are content that there is sufficient natural freeboard within the site levels, and therefore no additional consideration freeboard is required. Surface water risk runs from west to east at the south of the OnSS site and the project should avoid these areas where flow paths exist or use the freeboard to mitigate these risks.</p>	<p>A FRA is provided in Volume A6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment which includes consideration of freeboard in relation to flood risk.</p> <p>The outcomes and justification to the approach taken to the use of freeboard at the OnSS were agreed with Environment Agency at a Hornsea Four water and flood risk evidence plan technical panel meeting on 15th May 2020 (ON-HYD-7.1).</p>
Environment Agency	7 th September 2021 – Environment Agency meeting	<p>Flood defence investment</p> <p>Environment Agency advised that timings of the flood defence works are unknown and are unlikely to be known</p>	A FRA is provided in Volume A6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment which includes consideration of peak flow allowance and freeboard in relation to flood risk.

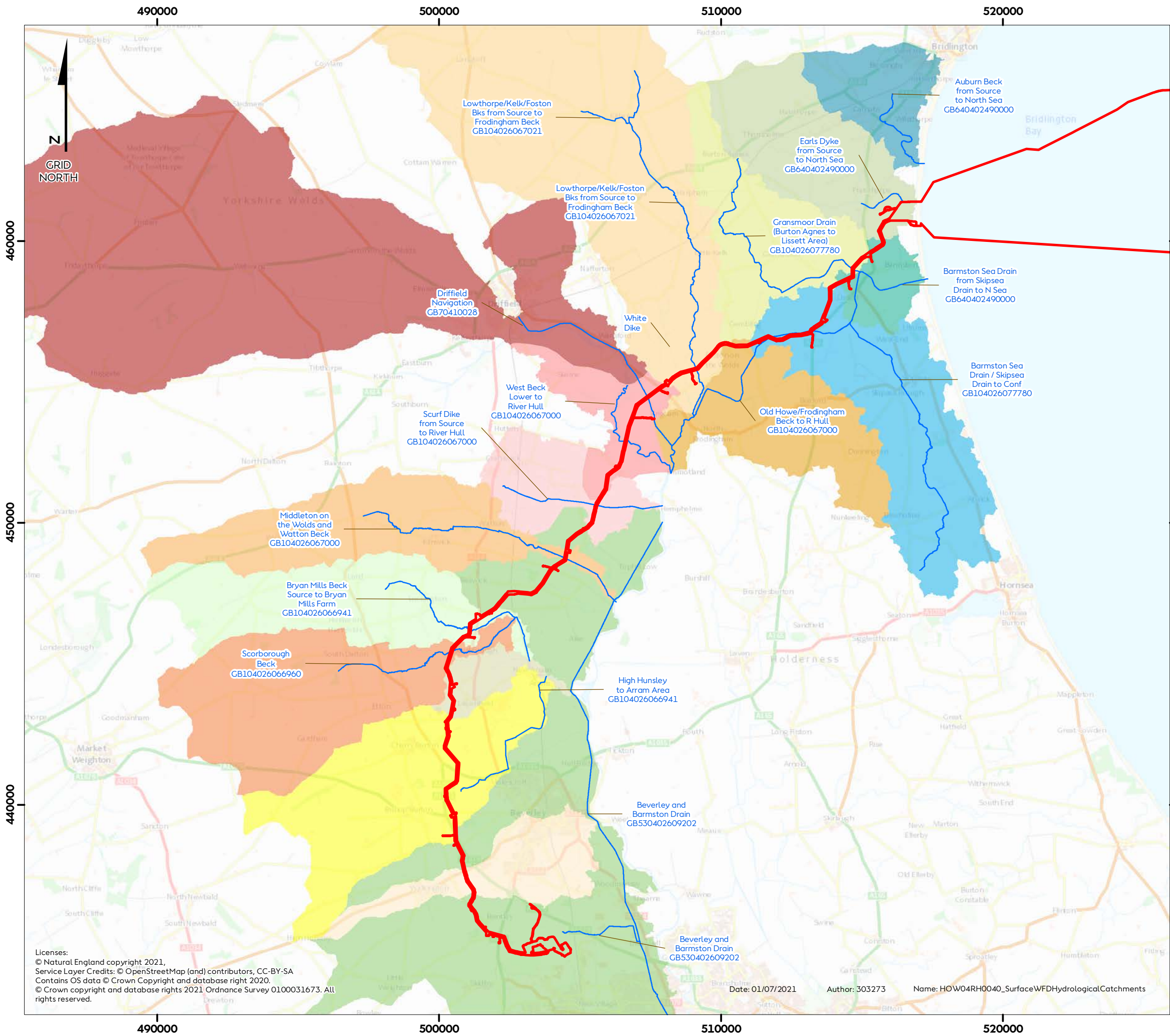
Consultee	Date, Document, Forum	Comment	Where addressed in the ES
		<p>in the short-term – funding constraints were raised as a principal factor. It was acknowledged that piling is not the only construction method available to facilitate the flood defence works; however, this is dependent on ground conditions. Environment Agency advised that at a similar location, piles were installed to approximately 0 m AOD (4 m under existing ground level).</p> <p>Maximum depth of OnSS excavation</p> <p>The Environment Agency advised that excavations associated with a similar project within the area had been deeper than anticipated and therefore requiring a substantial basement. The Environment Agency highlighted that groundwater impacts must be considered adequately during the pre-construction phase.</p> <p>Peak flow allowances</p> <p>The Applicant confirmed that a review of the Environment Agency Flood Map for Planning has been undertaken and the flood risk around the Hornsea Four OnSS has not changed. There remains an area at risk of flooding along the southern boundary and in the south-east corner, which is in line with the information previously discussed with the Environment Agency in previous evidence plan technical panel meetings.</p> <p>The Applicant confirmed that there had been no additional modelling undertaken by the Environment Agency in this area and that the 2016 modelling for the Creyke Beck substation remains the most detailed modelling for this area. Applicant advised that only the</p>	<p>The FRA (and its conclusions) was agreed with the Environment Agency at an evidence plan technical panel meeting held on the 7th September 2021 (ON-HYD-7.9).</p> <p>The Environment Agency agreed with the values being used for peak flows and climate change variance at the evidence plan technical panel meeting held on the 7th September 2021 (ON-HYD-7.7).</p> <p>The Environment Agency confirmed that the surrounding area around the OnSS is very flat and low-lying and therefore the freeboard that is detailed in the FRA is considered sufficient to ensure flood risk associated with climate change is unlikely to affect the OnSS (ON-HYD-7.8).</p> <p>Hornsea Four’s approach to drainage for all onshore infrastructure is provided in Volume F2, Chapter 6: Outline Onshore Infrastructure Drainage Strategy (Co19) and in Volume F2, Chapter 13: Outline Design Plan.</p>

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
		<p>modelling report / summary is available; however, the report confirms that the climate change allowance utilised in the modelling is 20%.</p> <p>Applicant clarified the peak flow values applicable to this location, in light of the recent update to NPPF and the supporting guidance on climate change (varies between 9%, 17% and 37%, although 37% should be assessed as a sensitivity test). Applicant highlighted that the 2016 Creyke Beck modelling utilises a more conservative scenario than the 17% 2050s High Central allowance, which should be applied to the design.</p> <p>The Applicant advised that on the basis of the above, despite updates to the information available, there is no change to the present and future flood risk in this location.</p> <p>Withdrawal of flood defences and flood defence investment</p> <p>Environment Agency explained the funding issues (notably the lack of funding for flood defences that do not protect residential properties).</p> <p>Environment Agency advised that it cannot be guaranteed that flood defences will not fail.</p> <p>Environment Agency noted that there are multiple abstraction points in the area surrounding the OnSS and that Hornsea Four should be cautious of springs.</p> <p>Environment Agency agreed that no changes are required to the impact</p>	

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
		assessment presented in the Hydrology & Flood Risk chapter of the ES.	

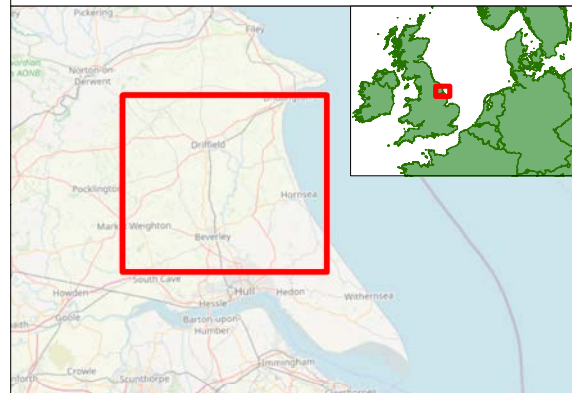
2.5 Study Area

- 2.5.1.1 The study area for this hydrology and flood risk assessment has been determined based on the boundaries of the surface hydrological catchments which contain or are hydrologically connected (i.e. upstream or downstream) to the Hornsea Four onshore Order Limits which includes the landfall, the 80 m wide onshore ECC, the OnSS and the 400 kV National Grid Electricity Transmission (NGET) connection area ([Figure 2.1](#)).
- 2.5.1.2 This study area was agreed with stakeholders, including the LLFA, Environment Agency and the York Consortium of Drainage Boards, during the second and third evidence plan meetings, on 15 January 2019 and 5 April 2019 (ON-HYD-1.2 and ON-HYD-2.1) as summarised in [Table 2.3](#).
- 2.5.1.3 The boundaries of each catchment are based on the Environment Agency's WFD river water body catchments, which each represent discrete surface water drainage catchments with an area of greater than 5 km² (on average). The combined boundaries of each catchment represent the overall boundary of the study area.
- 2.5.1.4 The study area incorporates all watercourses landward of MHWS that have the potential to be crossed or otherwise impacted by the construction, operation and decommissioning of Hornsea Four. Impacts to water resources seaward of MHWS are considered within [Volume A2, Chapter 1: Marine Geology, Oceanography and Physical Processes](#).



Hornsea Four
Figure 2.1
 Study Area based on WFD
 Waterbody Catchments

- Order Limits
- Water body
- Water body Catchment**
- Auburn Beck from Source to North Sea
- Barmston Sea Drain / Skipsea Drain to Conf
- Barmston Sea Drain from Skipsea Drain to N Sea
- Beverley and Barmston Drain
- Bryan Mills Beck Source to Bryan Mills Farm
- Earls Dyke from Source to North Sea
- Ella Dyke
- Gransmoor Drain (Burton Agnes to Lissett Area)
- High Hunsley to Arram Area
- High Hunsley to Woodmansey Area
- Lowthorpe/Kelk/Foston Bks from Source to Frodingham Beck
- Middleton on the Wolds and Watton Beck
- Old Howe/Frodingham Beck to R Hull
- Scarborough Beck
- Scurf Dike from Source to River Hull
- West Beck Lower to River Hull
- West Beck Upper




Coordinate system: British National Grid
 Scale@A3: 1:130,000
 0 1.25 2.5 5 Kilometres
 0 1,250 2,500 5,000 Yards

REV	REMARK	DATE
	First Issue for PEIR	10/05/2019
A	Updated following PEIR consultations, for DCO	01/07/2021

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Date: 01/07/2021 Author: 303273 Name: HOW04RH0040_SurfaceWFDHydrologicalCatchments

Title: Surface WFD Hydrological Catchments defining the Study Area
 Document no: HOW04RH0040
 Created by: AZ
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 Approved by: CS



2.6 Methodology to inform baseline

2.6.1.1 The assessment methodology and the scope of baseline data and field surveys was agreed with stakeholders including the LLFA, Environment Agency and the York Consortium of Drainage Boards during the second and third water and flood risk evidence plan meetings, on 15 January 2019 and 5 April 2019 respectively (ON-HYD-2.1, ON-HYD-1.2), as summarised in **Table 2.3**. It was also agreed that the WFD operational and watercourse catchments would be used as the basic receptors and as a means of systematically and representatively assessing impacts.

2.6.2 Desktop Study

2.6.2.1 A desk study was undertaken to obtain baseline information on hydrology and flood risk. Data were acquired within the Hornsea Four hydrology and flood risk study area, which comprises surface hydrological catchments that contain, or are hydrologically connected to, the Hornsea Four Order Limits. This desk study consisted of a detailed desktop review of existing studies and datasets as detailed in **Table 2.4**.

Table 2.4: Key Sources of Hydrology and Flood Risk Data.

Source	Summary	Coverage of Hornsea Four Order Limits
British Geological Survey (BGS)	1:50,000 geological mapping 55/65 Flamborough and Bridlington, 64 Great Driffield and 72 Beverley. BGS onshore geoindex map (http://mapapps2.bgs.ac.uk/geoindex/home.html)	Full coverage of the Hornsea Four onshore Order Limits.
Department for Environment, Food and Rural Affairs (DEFRA)	MAGIC map (www.magic.defra.gov.uk)	Full coverage of the Hornsea Four onshore Order Limits.
Natural England	UK Designated Site citations (www.designatedsites.naturalengland.org.uk) (http://publications.naturalengland.org.uk/category/6490068894089216)	Full coverage of the Hornsea Four onshore Order Limits.
Joint Nature Conservation Committee (JNCC)	International Designated Site citations https://sac.jncc.gov.uk/	Full coverage of the Hornsea Four onshore Order Limits.
Environment Agency Catchment Data Explorer	Provides information on WFD River Basin Districts Management Catchments, Operational Catchments and WFD water bodies. https://environment.data.gov.uk/catchment-planning/ManagementCatchment/3039	Full coverage of the Hornsea Four onshore Order Limits.
Environment Agency Product 4, 5 and 8 flood risk information	This includes Flood Map for Planning and detailed modelling reports (River Hull and Holderness Drain Flood Mapping Study 2017 and Hornsea Flood Mapping Study 2007)	Full coverage of the Hornsea Four onshore Order Limits.

Source	Summary	Coverage of Hornsea Four Order Limits
Environment Agency	Flood Map for Planning	Full coverage of the Hornsea Four onshore Order Limits.
Environment Agency	Risk of Flooding from Surface Water	Full coverage of the Hornsea Four onshore Order Limits.
Environment Agency	Risk of Flooding from Rivers and Sea	Full coverage of the Hornsea Four onshore Order Limits.
Environment Agency	Habitat and species data (detailed macrophyte, invertebrate, diatom and fisheries data) for WFD water bodies	Full coverage of the Hornsea Four onshore Order Limits.
LLFA – ERYC	Historical flood incident information relating to highway, surface water and / or drainage flooding and detailed information on COPFAS	Full coverage of the Hornsea Four onshore Order Limits.

2.6.3 Site Specific Surveys

2.6.3.1 To inform the EIA, site-specific geomorphological walkover surveys were undertaken, as agreed with the Environment Agency, LLFA and Beverley and North Holderness IDB during the Evidence Plan processes (ON-HYD-1.2). A summary of the surveys is outlined in [Table 2.5](#), the locations of which can be found in [Volume A6, Annex 2.1: Geomorphological Baseline Survey Report](#).

Table 2.5: Summary of site-specific survey data.

Title, year and reference	Summary	Coverage of Hornsea Four Order Limits
Hornsea Four Hydrology and Flood Risk Geomorphological Walkover March 2019 Volume A6, Annex 2.1: Geomorphological Baseline Survey Report	Characterising the baseline geomorphology of the Environment Agency Main Rivers crossed by the Hornsea Four Order Limits where survey access was possible.	Ten Environment Agency Main Rivers to be crossed by the Hornsea Four Order Limits.

2.7 Baseline environment

2.7.1.1 The existing baseline environment of the Hornsea Four Order Limits is characterised in this section with respect to surface water, groundwater and water-dependent designated sites. The baseline status is described within the following subsections, using the desk-based sources listed in [Table 2.4](#) and the geomorphological walkover survey described in [Table 2.5](#).

2.7.1.2 Considering the delayed submission of the Hornsea Four DCO to September 2021, a review of the validity of all baseline data underpinning the Environmental Statement (ES) has been undertaken to ensure that it remains a robust and valid baseline used to inform and support a rigorous Environmental Impact Assessment (EIA). For hydrology and flood risk, the review concluded that there would be no concerns in relation to data validity. This conclusion was agreed with the Environment Agency during the evidence plan technical panel meeting held on the 7th September 2021 (ON-HYD-7.9).

2.7.2 Surface water drainage

2.7.2.1 The Hornsea Four onshore infrastructure would be located within two main surface water drainage catchments ([Figure 2.1](#)):

- **Barmston Sea Drain:** This catchment drains the coastal zone located to the south of Bridlington. The Barmston Sea Drain rises near Gembling and flows eastwards until it flows into the North Sea. Major tributaries include Skipsea Drain, which flows northwards from its source near Hornsea until it meets the Barmston Sea Drain near Lissett, and Gransmoor Drain, which flows south and eastwards from Burton Agnes before also joining Barmston Sea Drain. Approximately 8.5 km of the onshore ECC, including the landfall, would be located in this catchment.
- **River Hull:** This larger catchment drains the area to the north of the Humber Estuary, to the west of the Barmston Sea Drain. The catchment is sub-divided into two operational catchments for management purposes by the Environment Agency:
 - **The Upper Hull** catchment drains the Yorkshire Wolds which are located to the north, east and west of the town of Driffield. The river rises as a series of chalk streams, including West Beck and the Driffield Trout Stream, which coalesce to form the River Hull downstream of Driffield. Other major tributaries include Nafferton Beck and Lowthorpe / Kelk / Foston Beck, which drain the area to the east of Driffield and flow southwards into the River Hull, and Skerne Beck and Scurf Dike. These are located to the south of Driffield, at the downstream end of the catchment. Approximately 9.5 km of the onshore cable route would be located in this catchment.
 - **The Lower Hull** catchment drains the low-lying area between the upper catchment and the Humber Estuary. The river flows in a southerly direction until it joins the Humber in Kingston on Hull. Major tributaries include Watton Beck, Bryan Mills Beck, Scarborough Beck and Ella Dyke, which drain the area to the north and west of Beverley, and the Beverley and Barmston Drain, which drains the area to the

north east of Beverley. Approximately 21 km of the onshore ECC, and the OnSS and 400 kV NGET connection area, would be located in this catchment.

- 2.7.2.2 Each of the main catchments are divided into a series of smaller sub-catchments, which are described in [Table 2.6](#) and shown in [Figure 2.2](#) to [Figure 2.8](#). There are also a number of IDB channels of importance which are also shown on [Figure 2.2](#) to [Figure 2.8](#). The Hornsea Four hydrology and flood risk study area incorporates the Beverley and North Holderness IDB area as the Hornsea Four Order Limits crosses several watercourses and drains that are managed by the IDB. Furthermore, there are a large number of ordinary watercourses and agricultural drainage channels that are unnamed and not listed individually here.

Table 2.6: Surface watercourses within the Hornsea Four hydrology and flood risk study area (see Figure 2.2 to Figure 2.8).

Catchment	Watercourse	Catchment area (ha)	WFD water body reference	Description	Associated ordinary watercourses
Barmston Sea Drain	Auburn Beck	1278.65	GB104026066650	This river is designated as heavily modified. It flows over 4.24 km from northeast of Carnaby and joins the sea at Auburn Sands.	Not applicable
	Earl's Dike	2554.61	GB104026066640	This is an artificial river which flows over a length of 2.38 km from just north of Low Stonehills to the west of the Bridlington Road (A165) in an easterly direction to meet the sea where it flows into the sea via an outfall.	<ul style="list-style-type: none"> • Watermill Grounds North Drain • Watermills Drain • Conygarth Hill Drain
	Gransmoor Drain	2406.75	GB104026066630	This is an artificial river of 10.47 km which is designated as a WFD water body, but not a main river. It rises near Burton Agnes and flows due south past Gransmoor from where it flows east towards Lisset and joins the Barmston Sea Drain before flowing into the sea.	<ul style="list-style-type: none"> • Spring Hill Drain
	Barmston Sea Drain	670.79	GB104026077780	This is an artificial river of which 4.57 km is designated as a WFD water body but not a main river. It begins near Brougham Hill and flows north through Mill Hill where it joins the Gransmoor Drain to flow sharply south east then east to drain into the North Sea.	Not applicable
	Skipsea Drain	3864.29	GB104026077770	The river flows over 15.55 km from its source northwest of Hornsea Mere, meandering north to meet the Skipsea Drain at the confluence with downstream Barmston Sea Drain from Skipsea to the North Sea.	<ul style="list-style-type: none"> • Hoe Carr Drain • North Field Drain • Northpasture Drain • Beck Hill Drain North Field Drain
River Hull (upper)	Frodingham Beck	2541.75	GB104026067021	This is a river which is designated as heavily modified under the WFD. It flows over 6.74 km from old Howe House following a sharply turning route to meet the River Hull from West Beck to Arram Beck water course.	<ul style="list-style-type: none"> • School Drain
	Lowthorpe/Kelk/Foston Beck	9299.20	GB104026067101	This river is designated as a WFD water body from Kilham, where it meanders south to Bridge Farm where it joins the Frodingham Beck which flows into the River Hull.	<ul style="list-style-type: none"> • East Field Drain • White Dike • Fisholme Drain

Hornsea 4

Catchment	Watercourse	Catchment area (ha)	WFD water body reference	Description	Associated ordinary watercourses
	Driffield Navigation	N/A	GB70410028	This is an artificial canal with a length of 8.10km which runs from just northwest of Driffield and flows east, then south past Wansford and Brigham to join the Frodingham Beck.	Not applicable
	West Beck	1221.00	GB104026067040	This is heavily modified river of 5.54 km in length from Copper Hall, where it meanders south and east to join the Frodingham Church Drain.	<ul style="list-style-type: none"> • Nafferton Drain • Rotsea Drain
	Scurf Dike	1309.91	GB104026067010	This is an artificial watercourse which flows over a length of 5.89 km from west to east, from just south of Hutton Cranswick to where it meets the River Hull (from West Beck to Arram Beck) at Struncheonhill Farm.	Not applicable
River Hull (lower)	Beverley and Barmston Drain	10,494.56	GB104026067211	This is an artificial watercourse which flows over 26.23 km from Struncheonhill Farm in a straight, south-westerly direction, then south to flow through Kingston Upon Hull into the Humber Middle transitional water body.	<ul style="list-style-type: none"> • Throstle Main Drain • Spring Dike • Kirby Drain • Kilnwick Arm • Beswick New Cut • Wilfholme Darm Drain • Beswick to Barfill Drain • Carr House Drain • Station Drain • Atkin's Keld • Birkhill Wood Drain • Cottingham Parks drain • Poplar South Drain • Wanlass Beck • Wanlass Drain • Signal Drain • Park Drain • Burn Park Farm Drain • Wilson Drain

Hornsea 4

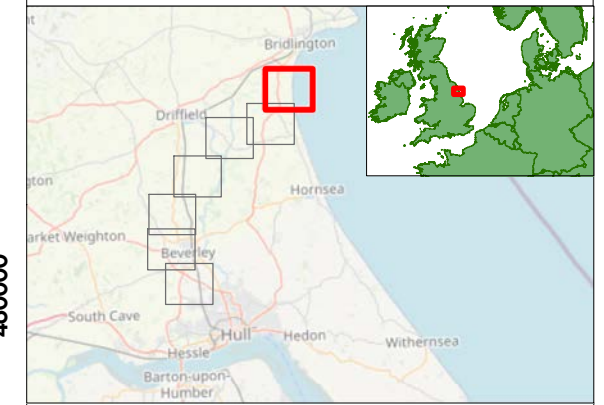
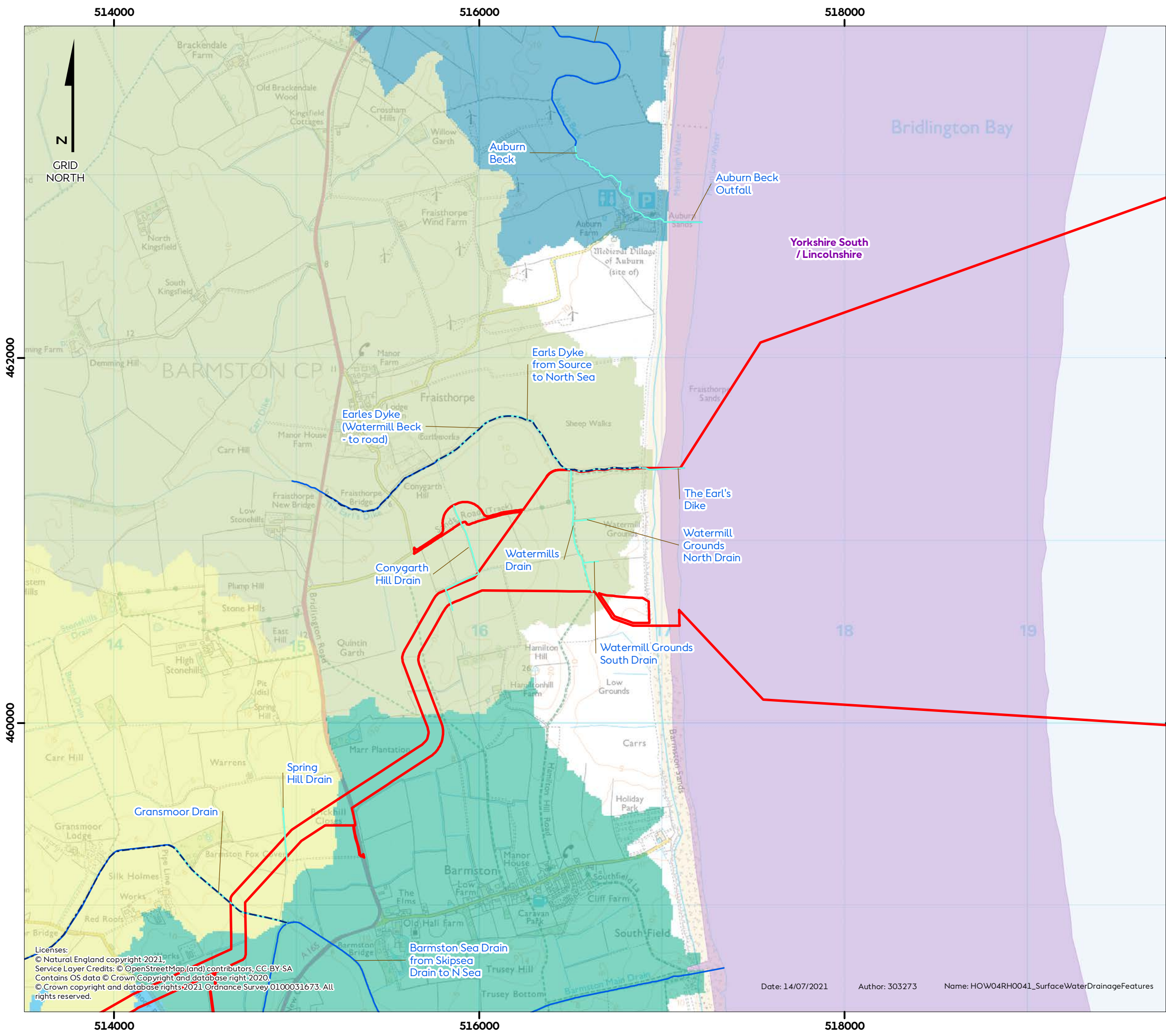
Catchment	Watercourse	Catchment area (ha)	WFD water body reference	Description	Associated ordinary watercourses
	Watton Beck	3169.45	GB104026066980	A river that is not designated artificial or heavily modified. However, it appears to be aligned with flood embankment along both channel banks and is predominantly straight. It flows over a length of 11.30 km from near Middleton-on-the-Wolds to meet the River Hull; appearing to cross over the Barmston Drain.	<ul style="list-style-type: none"> • Carr Drain
	Bryan Mills Beck	2982.29	GB104026066960	A river designated as artificial, flowing over a length of 8.05 km, rising to the west of Lockington before meandering in a south easterly direction and flowing into Ella Dyke.	Not applicable
	Scorborough Beck	3955.81	GB104026066901	This river has not been designated artificial or heavily modified. It flows over 8.11 km in a westerly direction from south of South Dalton to Scarborough where it bears northwest to meet the Bryan Mills Beck.	<ul style="list-style-type: none"> • Bealey's Beck
	Ella Dyke	518.50	GB104026066941	Ella Dyke is designated as heavily modified. It flows over 6.74 km from just south west of Leconfield in a north-easterly direction before curving south-east to join the River Hull.	Not applicable
	High Hunsley to Arram Area	4079.58	GB104026066841	This river is designated as artificial and flows over 6.46 km from east of Bishop Burton in a north-easterly direction to meet the Arram Beck to the north of Arram.	<ul style="list-style-type: none"> • North Drain • Washdike Drain
	High Hunsley to Woodmansey Area	1520.67	GB104026066820	This river is designated as artificial and flows over 6.97 km from just north of Bentley, meandering north-east to meet the River Hull at Weel.	<ul style="list-style-type: none"> • Autherd Drain

Hornsea Four

Figure 2.2

Surface Water Drainage Features
- Sheet 1 of 7

- Order Limits
 - IDB drain
 - Watercourse
 - WFD water body
 - Coastal water body
- Water body catchment**
- Auburn Beck from Source to North Sea
 - Barmston Sea Drain / Skipsea Drain to Conf
 - Barmston Sea Drain from Skipsea Drain to N Sea
 - Earls Dyke from Source to North Sea
 - Gransmoor Drain (Burton Agnes to Lissett Area)



Coordinate system: British National Grid
Scale@A3: 1:20,000

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Barmston Sea Drain from Skipsea Drain to N Sea

Date: 14/07/2021 Author: 303273 Name: HOW04RH0041_SurfaceWaterDrainageFeatures










Title: Surface watercourses affected by the proposed development
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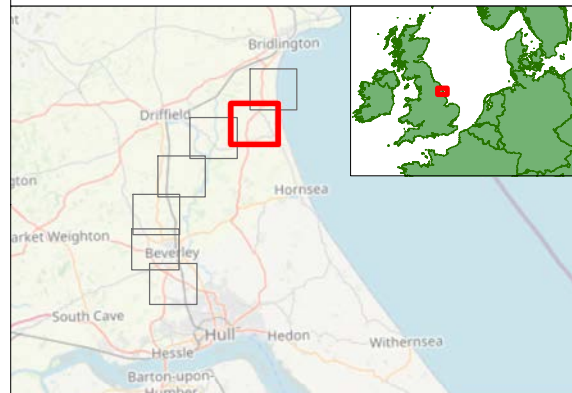
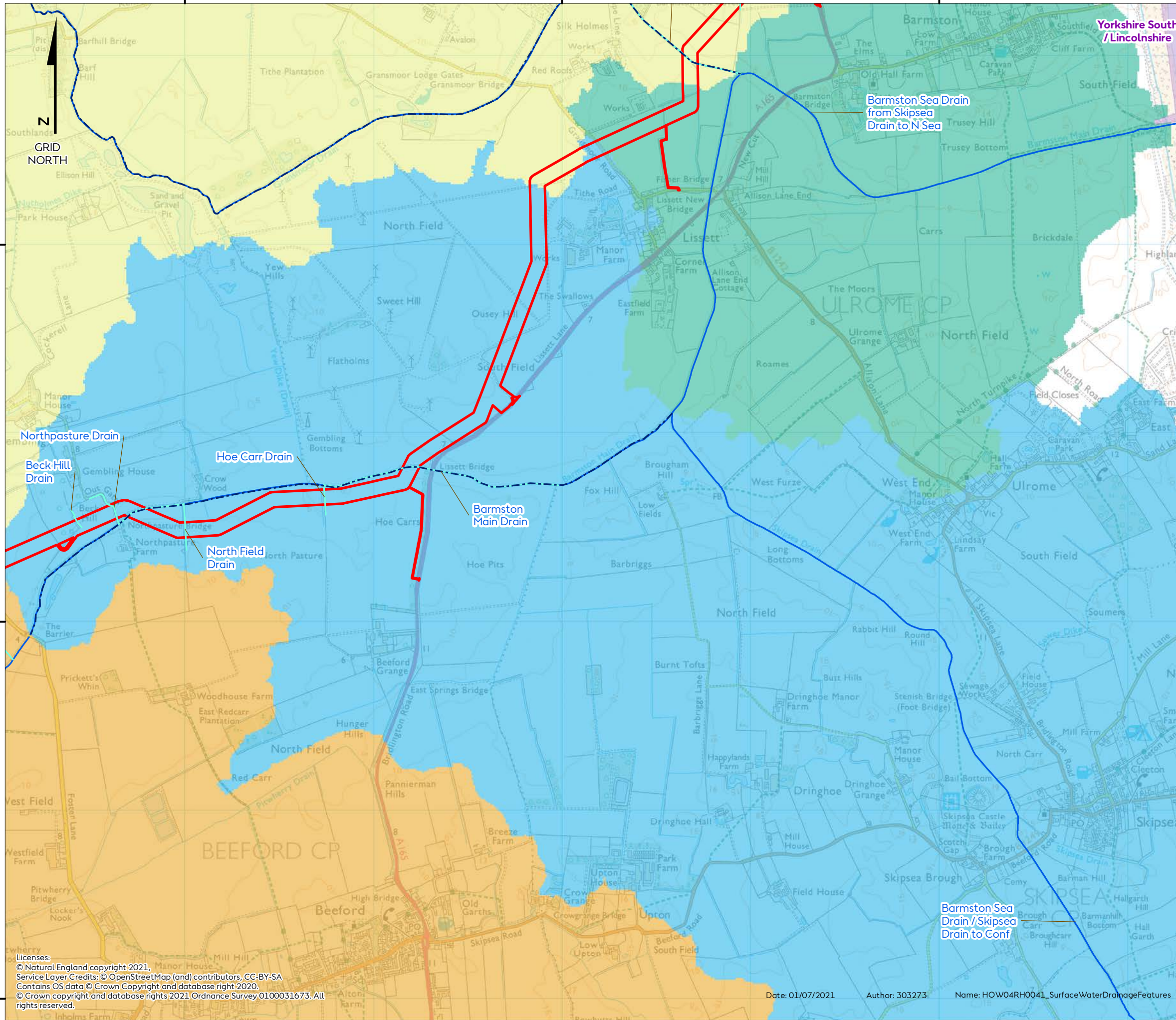


Hornsea Four

Figure 2.3

Surface Water Drainage Features
- Sheet 2 of 7

-  Order Limits
 -  IDB drain
 -  Watercourse
 -  WFD water body
 -  Coastal water body
- Water body catchment**
-  Barmston Sea Drain / Skipsea Drain to Conf
 -  Barmston Sea Drain from Skipsea Drain to N Sea
 -  Gransmoor Drain (Burton Agnes to Lissett Area)
 -  Old Howe/Frodingham Beck to R Hull





Coordinate system: British National Grid
Scale@A3: 1:20,000

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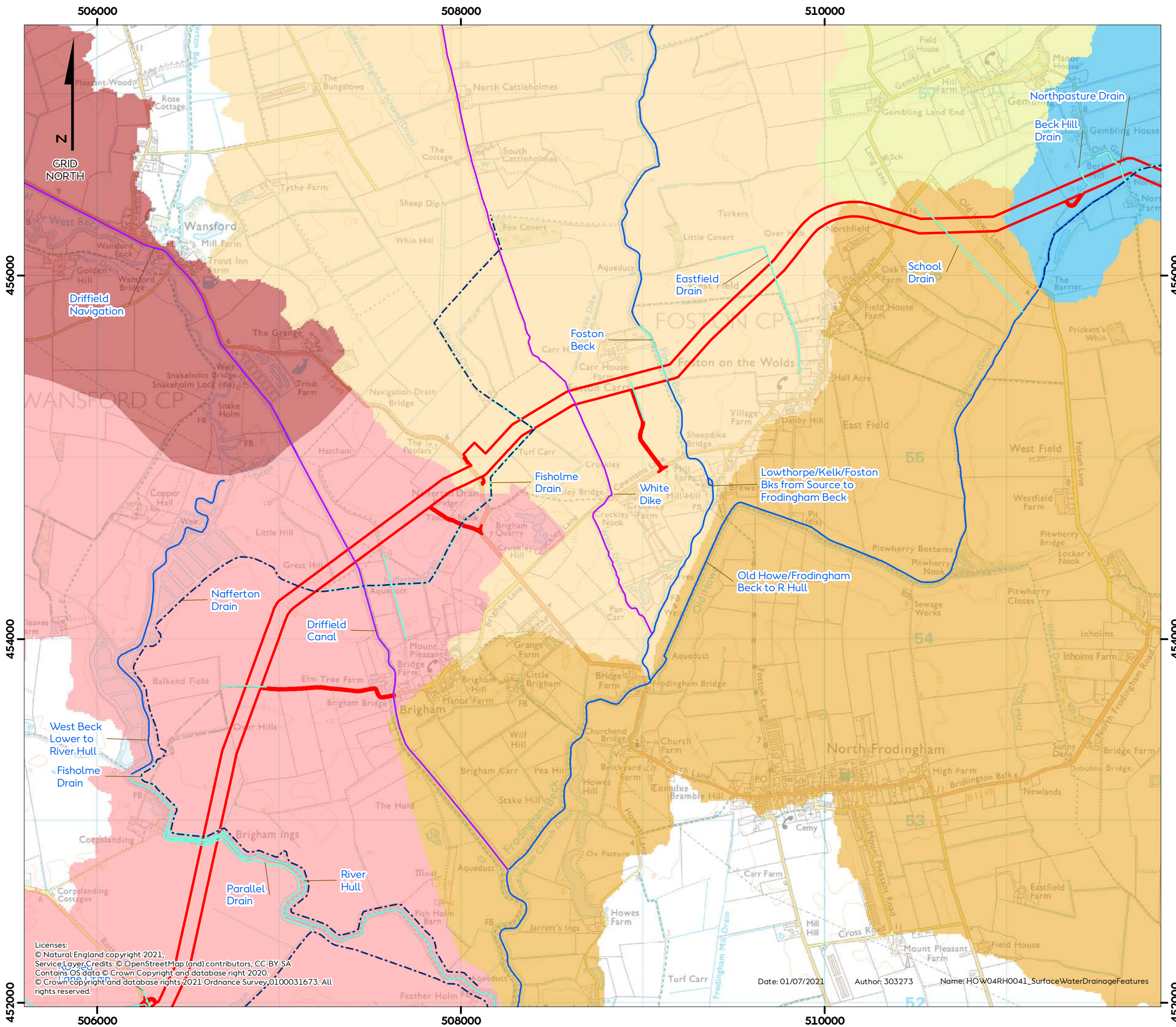
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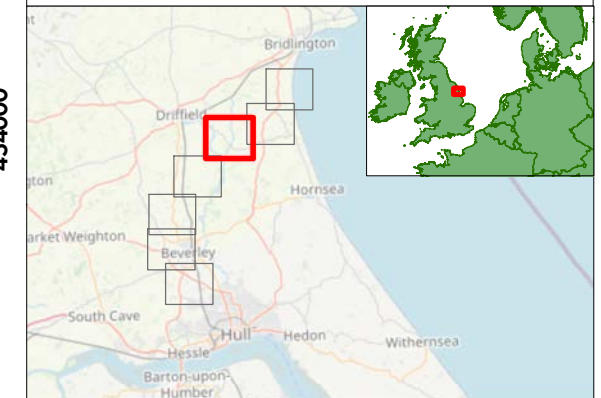


Hornsea Four

Figure 2.4

Surface Water Drainage Features
- Sheet 3 of 7

- Order Limits
 - IDB drain
 - Watercourse
 - WFD water body
 - Main river
- Water body catchment**
- Barmston Sea Drain / Skipsea Drain to Conf
 - Gransmoor Drain (Burton Agnes to Lissett Area)
 - Lowthorpe/Kelk/Foston Bks from Source to Frodingham Beck
 - Old Howe/Frodingham Beck to R Hull
 - West Beck Lower to River Hull
 - West Beck Upper



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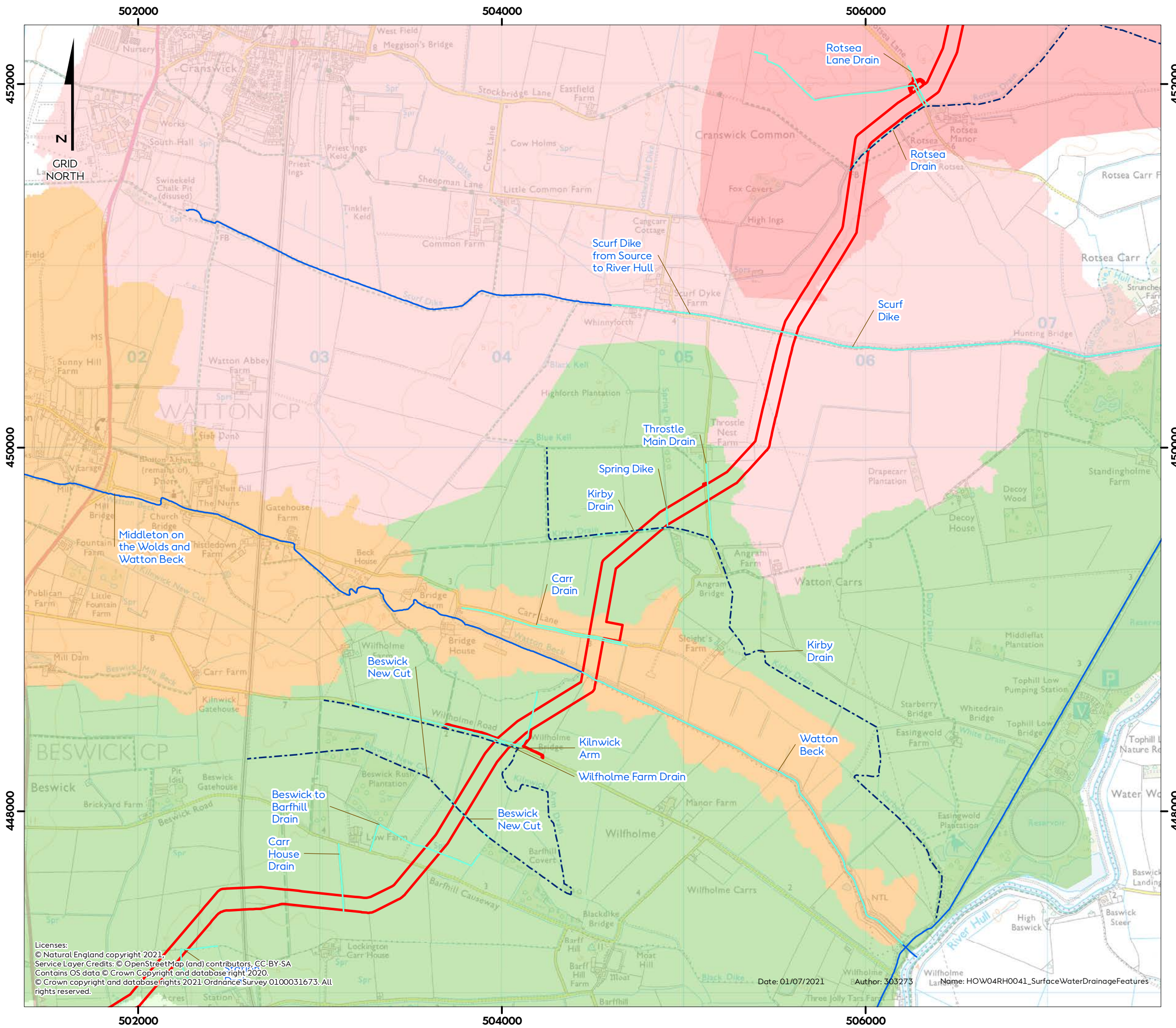
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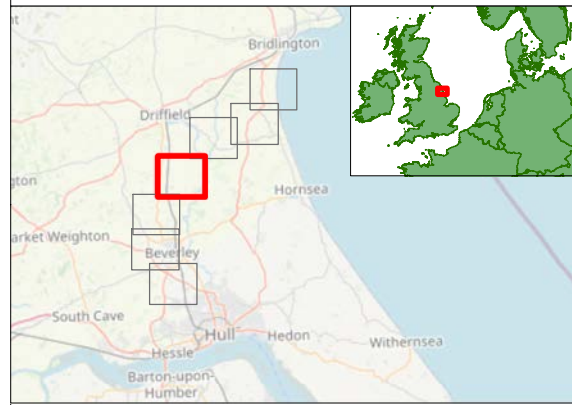
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Hornsea Four

Figure 2.5
Surface Water Drainage Features
- Sheet 4 of 7

- Order Limits
 - IDB drain
 - Watercourse
 - WFD water body
- Water body catchment**
- Beverley and Barmston Drain
 - Bryan Mills Beck Source to Bryan Mills Farm
 - Middleton on the Wolds and Watton Beck
 - Scurf Dike from Source to River Hull
 - West Beck Lower to River Hull




Coordinate system: British National Grid
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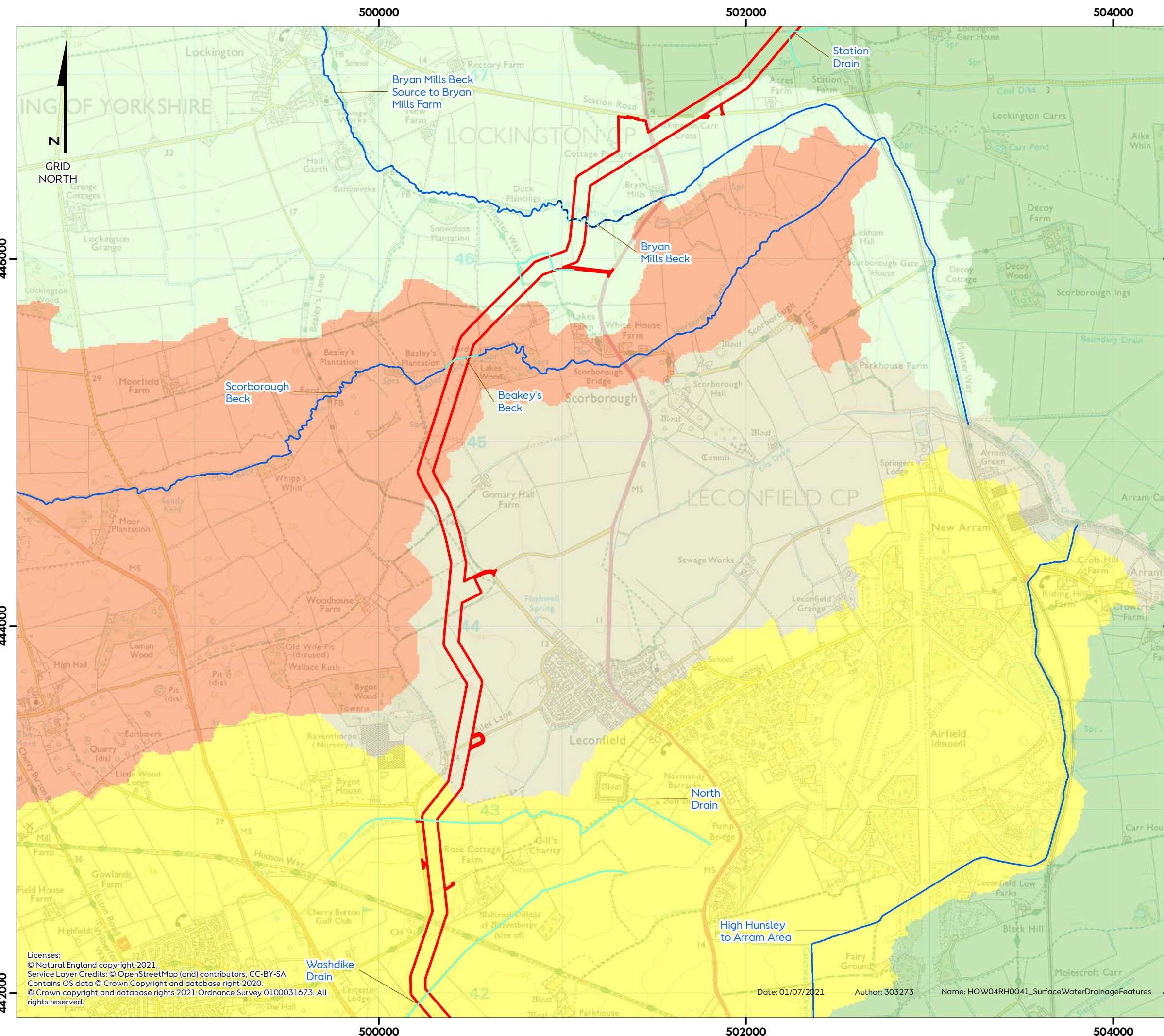
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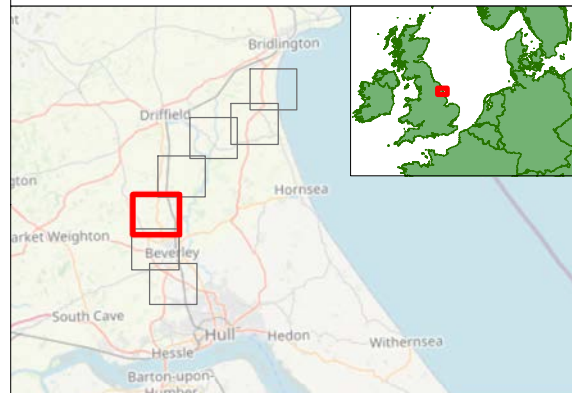




Hornsea Four

Figure 2.6
Surface Water Drainage Features
- Sheet 5 of 7

- Order Limits
 - IDB drain
 - Watercourse
 - WFD water body
- Water body catchment**
- Beverley and Barmston Drain
 - Bryan Mills Beck Source to Bryan Mills Farm
 - Ella Dyke
 - High Hunsley to Arram Area
 - Scarborough Beck



Coordinate system: British National Grid
 Scale@A3: 1:20,000
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 0 500 1,000 Yards

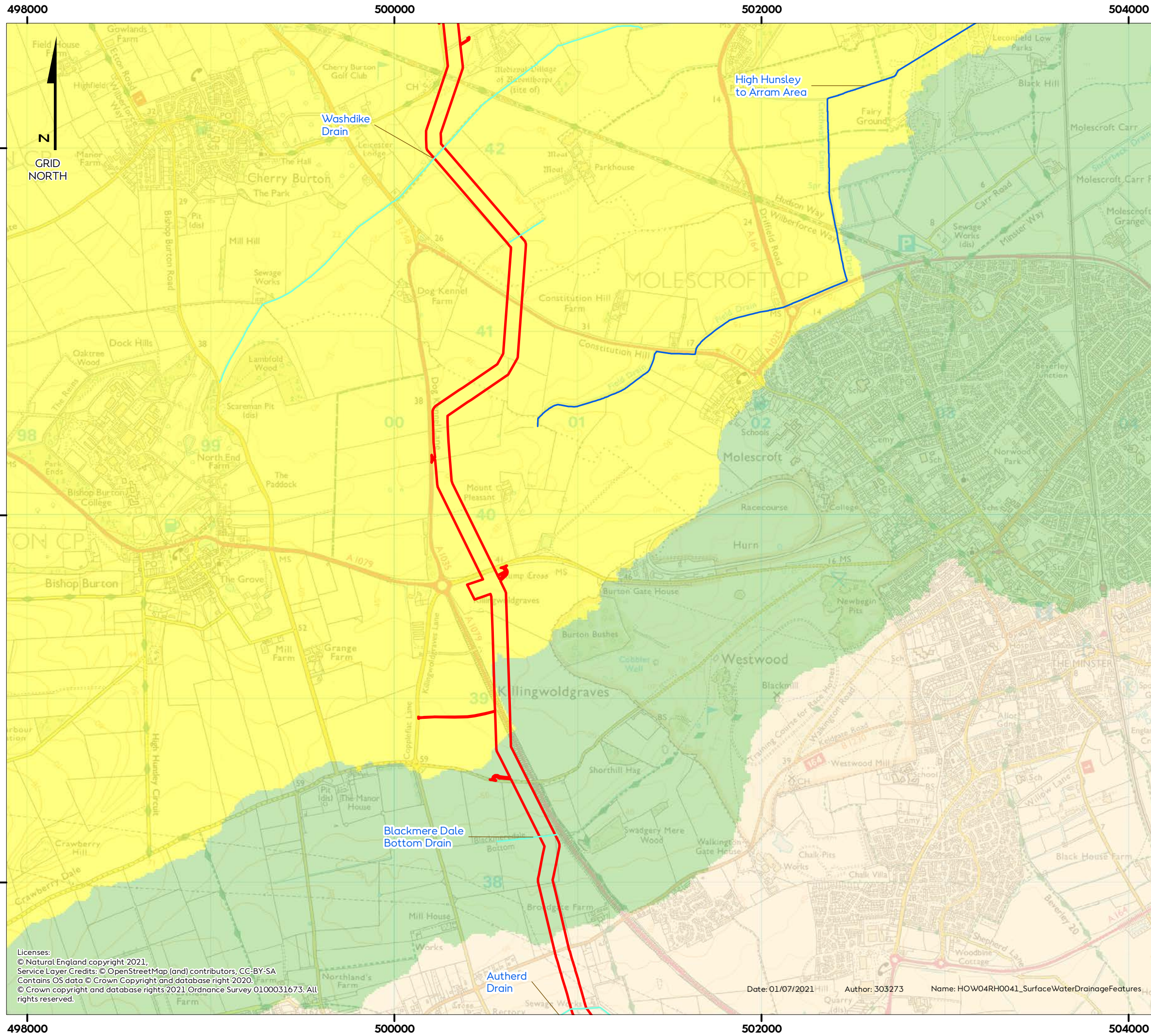
REV	REMARK	DATE
	First Issue for PEIR	17/07/2019
A	Updated following PEIR consultations, for DCO	01/07/2021

Title: Surface watercourses affected by the proposed development
 Document no: HOW04RH0041
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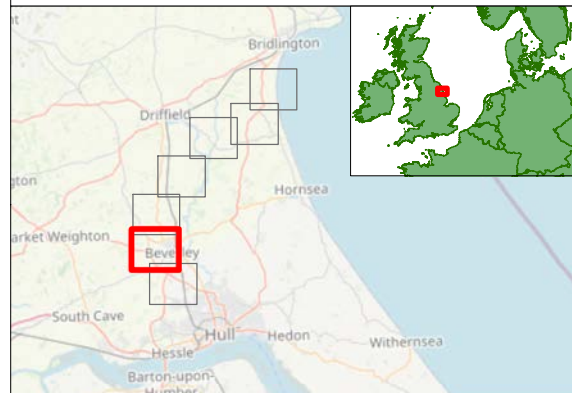
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Hornsea Four

Figure 2.7
Surface Water Drainage Features
- Sheet 6 of 7


- Order Limits
 - Watercourse
 - WFD water body
- Water body catchment**
- Beverley and Barmston Drain
 - High Hunsley to Arram Area
 - High Hunsley to Woodmansey Area



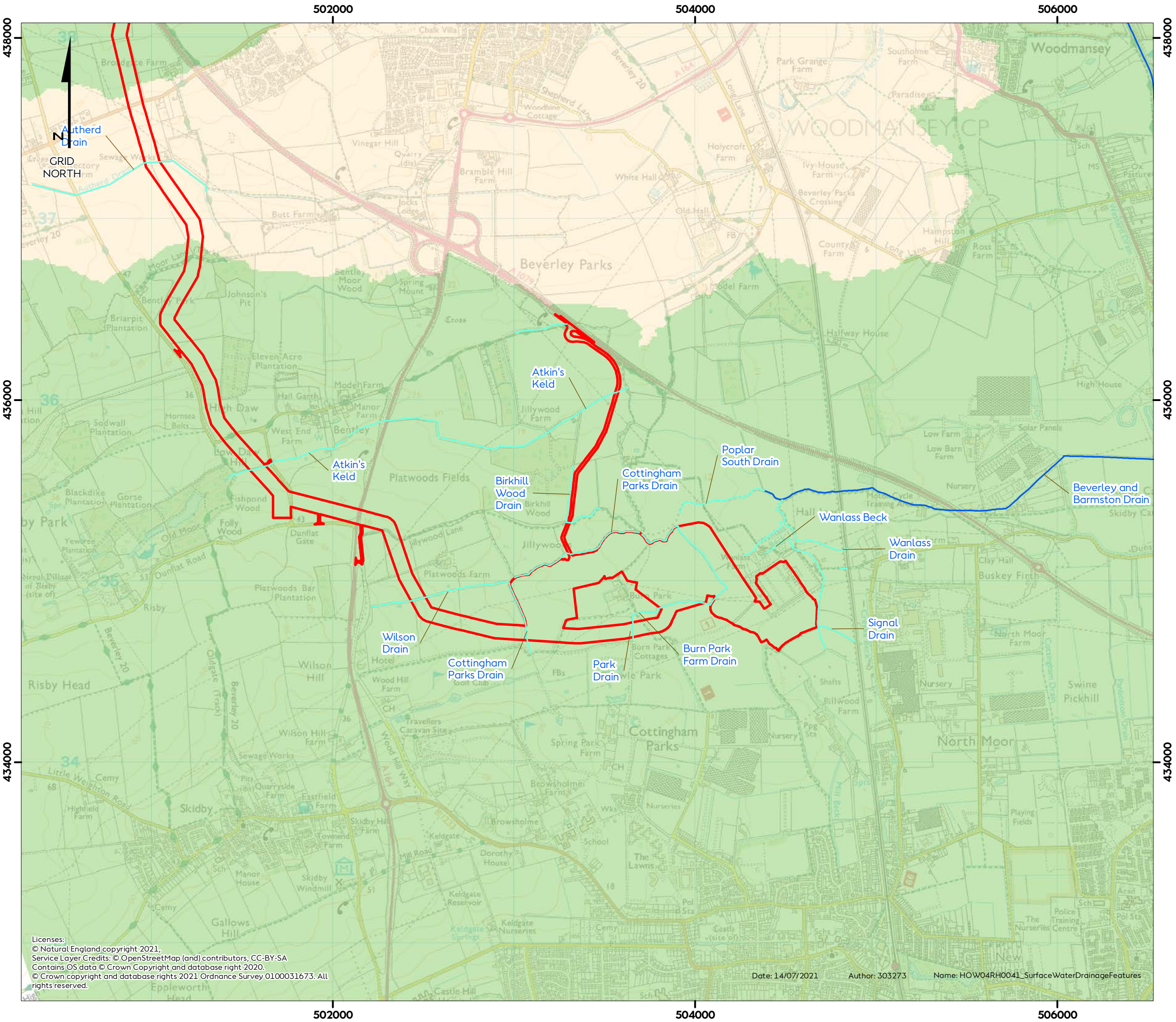
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	First Issue for PEIR	17/07/2019
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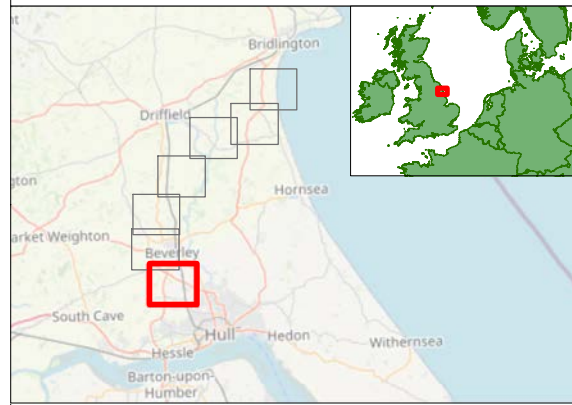
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Hornsea Four

Figure 2.8
Surface Water Drainage Features
- Sheet 7 of 7

- Order Limits
- Watercourse
- WFD water body
- Water body catchment**
- Beverley and Barmston Drain
- High Hunsley to Woodmansey Area



Coordinate system: British National Grid
 Scale@A3: 1:20,000
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 0 500 1,000 Yards

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	First Issue for PEIR	17/07/2019
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2.7.3 Geomorphology

- 2.7.3.1 A walkover survey to identify the main geomorphological characteristics of the main rivers and WFD water bodies which directly intersect with the Hornsea Four Order Limits was undertaken in March 2019. This considered factors such as flow conditions, channel form, floodplain characteristics and evidence of channel modification. The findings of the survey are detailed in [Volume A6, Annex 2.1: Geomorphological Baseline Survey Report](#) and summarised in [Table 2.7:](#).
- 2.7.3.2 The surveys found that a large number of watercourses surveyed across the Hornsea Four hydrology and flood risk study area are either entirely artificial or have been extensively modified, with uniform, incised channels and limited geomorphological diversity. These watercourses are typically characterised by low energy conditions, with depositional processes dominant.
- 2.7.3.3 Parts of the Upper River Hull catchment, including Lowthorpe / Kelk / Foston Beck and West Beck, are designated as part of the River Hull Headwaters SSSI because they retain the natural characteristics of a chalk river (e.g. shallow banks, clear flows and coarse substrates with a low proportion of silts and clays). However, most of the chalk rivers have been historically widened and deepened and as such are in sub-optimal condition. This is reflected in the River Hull Headwaters SSSI Condition Assessment (Natural England 2010-2012a) which states that at the most recent assessment, most of the SSSI units were considered to be in unfavourable condition. Further information on designated sites is provided in [Section 2.7.6](#) and also in [Chapter 3: Ecology and Nature Conservation](#).
- 2.7.3.4 The low-energy conditions observed in the majority of the watercourses surveyed in the Hornsea Four hydrology and flood risk study area, including the chalk rivers, reflect the naturally low gradient of the systems and the extensive modifications that were undertaken to improve land drainage, facilitate milling and navigation, and improve flood defences during the 18th and 19th centuries (Royal HaskoningDHV 2010). These modifications include channel enlargement and straightening, the installation of weirs and locks, and the construction of flood embankments (often on both sides of the channel). As a result of these modifications and the prevailing low energy conditions, the watercourses in the Hornsea Four hydrology and flood risk study area are largely stable and do not display significant evidence of lateral instability (i.e. changes in channel planform) since the First Edition OS mapping was produced in 1851. This is only with the exception of the West Beck to the west of the village of Wansford, where meanders have widened as a result of localised bank erosion (Royal HaskoningDHV 2010). Moreover, no significant evidence of vertical instability (i.e. incision) has been observed (Royal HaskoningDHV 2010).

Table 2.7: Geomorphological characteristics of surface water bodies which intersect with the Hornsea Four Hydrology and Flood Risk Study Area.

Catchment	Watercourse	Geomorphological conditions at time of geomorphological walkover survey
Barmston Sea Drain	Gransmoor Drain	The Gransmoor Drain is a uniform incised channel with a straight planform which has been artificially straightened along some stretches. Flow conditions characterised by low energy glide flows were observed as well as moderate water clarity showing some turbidity. Connectivity to the surrounding floodplain, which consists largely of arable land, is constrained due to the deep incised channel which is potentially dredged as part of water control management, although is well vegetated in places.
	Barmston Sea Drain	The Barmston Sea Drain is predominantly straight in planform with little diversity in flow or geomorphology, although large wetland features are evident to the north of the drain suggesting floodplain connectivity. It is typical of a large drainage system that is incised in response to water management control of the drainage system. The substrate is largely composed of sands and silts.
River Hull (upper)	Lowthorpe/ Kelk/ Foston Beck	These chalk rivers are predominantly straight in planform with little diversity in flow or geomorphology, showing features typical of a large drainage system including uniform channel shape, lined with embankments, and with potential evidence of dredging. The banks and margins are well vegetated with rushes, sedges and reeds. Fine and coarse channel deposits are present and limited floodplain connectivity was observed.
	White Dyke	White Dyke is a uniform, artificially straightened, incised channel which is aligned with flood embankments and surrounded predominantly by arable land. There is potential that it is dredged as part of water control management. Run-off pipes from adjacent fields were observed which may provide a source of sediment. The substrate is dominated by silts and the banks are well vegetated with some in-channel aquatic vegetation. It appears that there is limited floodplain connectivity.
	Driffield Navigation	The Driffield Navigation Canal has a predominantly straight to sinuous planform with a uniform flow, medium gradient and gravelly bed with localised silt and bank material predominantly fine grained. The bed is dominated by sandy clay, and the banks have vegetated graded profiles.
	West Beck	This chalk river is predominantly meandering and has historically been over-deepened and over-widened for navigation purposes. It is therefore very deep with steep banks and uniform flow conditions. The channel is largely bordered by flood embankments with large parts of the bank exposed, although there is localised wet woodland and back waters. The surrounding land is largely arable agricultural land. The bed of the river is silty with occasional fine and coarse gravel, whilst the bank material is fine grained and predominantly vegetated. Floodplain connectivity is limited.
	Scurf Dike	Scurf Dike is a uniform incised channel that has been artificially straightened and aligned with flood embankments. The channel is dominated by glide flows and silt deposition, with the silt being supplied by land and catchment management. The substrate is dominated by sands and silts which settle out to form a flat bed with little geomorphological complexity. Little floodplain connectivity was

Catchment	Watercourse	Geomorphological conditions at time of geomorphological walkover survey
		observed, and the banks and margins were well vegetated with rushes, sedges and reeds.
River Hull (lower)	Watton Beck	The Watton Beck also comprises a predominantly straight planform with little diversity in flow or geomorphology, showing typical features of a large drainage system including a uniform channel shape aligned with embankments. The substrate is dominated by sands and silts, and slow flows and low gradients appear to form a typical sediment deposition zone. The banks and margins are well vegetated, and there is little flood plain connectivity.
	Bryan Mills Beck	The Bryan Mills Beck displays a sinuous planform, although it is deeply incised with a 2 – 3 m bank base which appears to constrain connectivity to the flood plain; comprising predominantly arable agricultural land. In places, a variety of geomorphic processes are evident within the channel such as deposition and erosion and a variety of flow habitats such as deep riffles and glides are displayed. The banks are well vegetated, with vegetation encroaching up to 2 m into the channel, which shows signs of historical enlargement.
	Scorborough Beck	The Beck has a straight sinuous planform but does display flow and geomorphological diversity in places particularly through Bealey's Plantation and Lakes Wood where springs are a dominant feature. As a result of the springs, the water is crystal clear through this area. The banks are well vegetated, with substrates being dominated by sands, gravels and organic matter. No direct evidence of channel modification was observed.

2.7.4 Water quality

2.7.4.1 The Environment Agency's WFD water quality data for all WFD surface water bodies in the Hornsea Four hydrology and flood risk study area (i.e. in those catchments in which construction, operation and decommissioning of Hornsea Four would take place) as presented on the Catchment Data Explorer (Environment Agency 2020) are summarised in [Table 2.8](#). The water quality data demonstrates that 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 polybrominated diphenyl ethers (PBDE) and mercury are elevated in a large proportion of the Hornsea Four hydrology and flood risk study area.

Table 2.8: Water quality characteristics of surface watercourses within the Hornsea Four hydrology and flood risk study area.

Catchment	Watercourse	Water quality (Source: Environment Agency 2020)
Barmston Sea Drain	Auburn Beck	Low invertebrate populations are recorded by the Environment Agency in this catchment. Elevated levels of PBDE and mercury are also recorded.
	Earls Dyke	The watercourse contains low dissolved oxygen concentrations which appears to have resulted in low invertebrate populations. This is attributed by the Environment Agency to point source discharges from trade and industry discharges and the supply of nutrients from both point and diffuse sources. Elevated levels of PBDE and mercury are also recorded.
	Gransmoor Drain	Water quality is adversely affected by sewage discharges which result in elevated concentrations of phosphate. Fish populations are poor in this water body. Elevated levels of PBDE and mercury are also recorded.
	Barmston Sea Drain	Water quality is adversely affected by sewage discharges which result in elevated concentrations of phosphate. Elevated levels of PBDE and mercury are also recorded.
	Skipsea Drain	Water quality is adversely affected by sewage discharges which result in elevated concentrations of phosphate and ammonia and low dissolved oxygen concentrations. The environment agency records pressures to Macrophytes, Phytobenthos and invertebrates. Elevated levels of PBDE and mercury are also recorded.
River Hull (upper)	Frodingham Beck	Elevated levels of PBDE and mercury are recorded by the Environment Agency in this catchment.
	Lowethorpe / Kelk / Foston Beck	Low fish population are recorded by the Environment Agency in this catchment. Elevated levels of PBDE and mercury are also recorded.
	Driffield Navigation	Elevated levels of PBDE and mercury are recorded by the Environment Agency in this catchment.
	West Beck	Low fish population are recorded by the Environment Agency in this catchment. Elevated levels of PBDE and mercury are also recorded.
	Scurf Dike	Elevated levels of PBDE and mercury are recorded by the Environment Agency in this catchment.
River Hull (lower)	Beverley and Barmston Drain	High concentrations of phosphate and low concentrations of dissolved oxygen are recorded by the Environment Agency. Elevated levels of PBDE and mercury are also recorded.
	Watton Beck	Low fish population are recorded by the Environment Agency in this catchment. Elevated levels of PBDE and mercury are also recorded.
	Bryan Mills Beck	High concentrations of phosphate are recorded by the Environment Agency and attributed to sewage discharges and poor soil management. Elevated levels of PBDE and mercury are also recorded.
	Scorborough Beck	Water quality is adversely affected by sewage discharges and poor soil management, which has resulted in pressures to Macrophytes and Phytobenthos. Elevated levels of PBDE and mercury are also recorded.

Catchment	Watercourse	Water quality (Source: Environment Agency 2020)
	Ella Dyke	Water quality is adversely affected by sewage discharges, which result in elevated concentrations of phosphate and low dissolved oxygen concentrations. Elevated levels of PBDE and mercury are also recorded.
	High Hunsley to Arram Area	Water quality is adversely affected by sewage discharges, which result in elevated concentrations of phosphate and ammonia. Elevated levels of PBDE, Benzo(b)fluoranthene, Benzo(g-h-i)perylene, Benzo(k)fluoranthene and mercury are also recorded.
	High Hunsley to Woodmansey Area	Low fish population are recorded by the Environment Agency in this catchment. Elevated levels of PBDE and mercury are also recorded.

2.7.5 Flood risk

- 2.7.5.1 The Environment Agency online Flood Map for Planning (Environment Agency, undated) and Product 4, 5 and 8 data package obtained in April 2019 show that the landfall is largely located within Flood Zone 1 which is defined as land which has a less than 1 in 1000 annual probability of river flooding (< 0.1%). Small parts of the landfall site fall within Flood Zones 2 and 3 due to the proximity of Earl's Dike (Figure 3, [Volume A6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment](#)). Flood Zone 2 is an area that has a medium (between a 1 in 100 and 1 in 1,000 annual) probability of flooding and Flood Zone 3 is an area that has a high probability (a 1 in 100 or greater annual) probability of flooding. The onshore ECC will be required to pass through Flood Zones 2 and 3. However, as the cables are below-ground infrastructure they will not themselves be at risk from flooding. Potential risks during construction will be avoided through the use of trenchless crossing techniques (Co1) and measures to maintain river flows and contain drainage in the cable corridor (Co14 and Co124). Further information is provided in outlined [Table 2.10, Volume A4, Annex 5.2 Commitments Register](#) and [Volume A4, Annex 4.2: Onshore Crossing Schedule](#). The landfall logistics compound is temporary in nature and therefore would not be affected by the managed coastal retreat proposed for this area. The risk of flooding from groundwater or sewers at the landfall site is considered low.
- 2.7.5.2 The onshore ECC will pass primarily through Flood Zone 1, although some locations are located in Flood Zone 2 and 3 (Figure 3, Figure 5, Figure 7, Figure 8, Figure 11, Figure 12 and Figure 13, [Volume A6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment](#)). Whilst undertaking watercourse crossings the construction areas may be at risk of flooding, as well as posing an increased risk of flooding elsewhere. Therefore, the design of the temporary water crossings will be developed to prevent impoundment and maintain flows (e.g. by ensuring that any culverts have sufficient capacity to prevent impoundment up to the bank-full capacity of the channel, ensuring that a suitable flow rate is maintained whilst crossings are installed through the use of pumps, flumes or equivalent, and ensuring that the temporary works remain safe and operational in times of flood), as detailed in [Volume F2, Chapter 2: Outline Code of Construction Practice \(Co124\)](#). Once operational there will be no flood risk posed to the onshore ECC from fluvial, tidal, surface or sewer flooding. A residual risk to buried infrastructure within the onshore ECC of flooding from groundwater

shall be mitigated through the use of suitable waterproofing of the cables, link boxes and transition joint bays (see [Volume A1, Chapter 4](#) for further details).

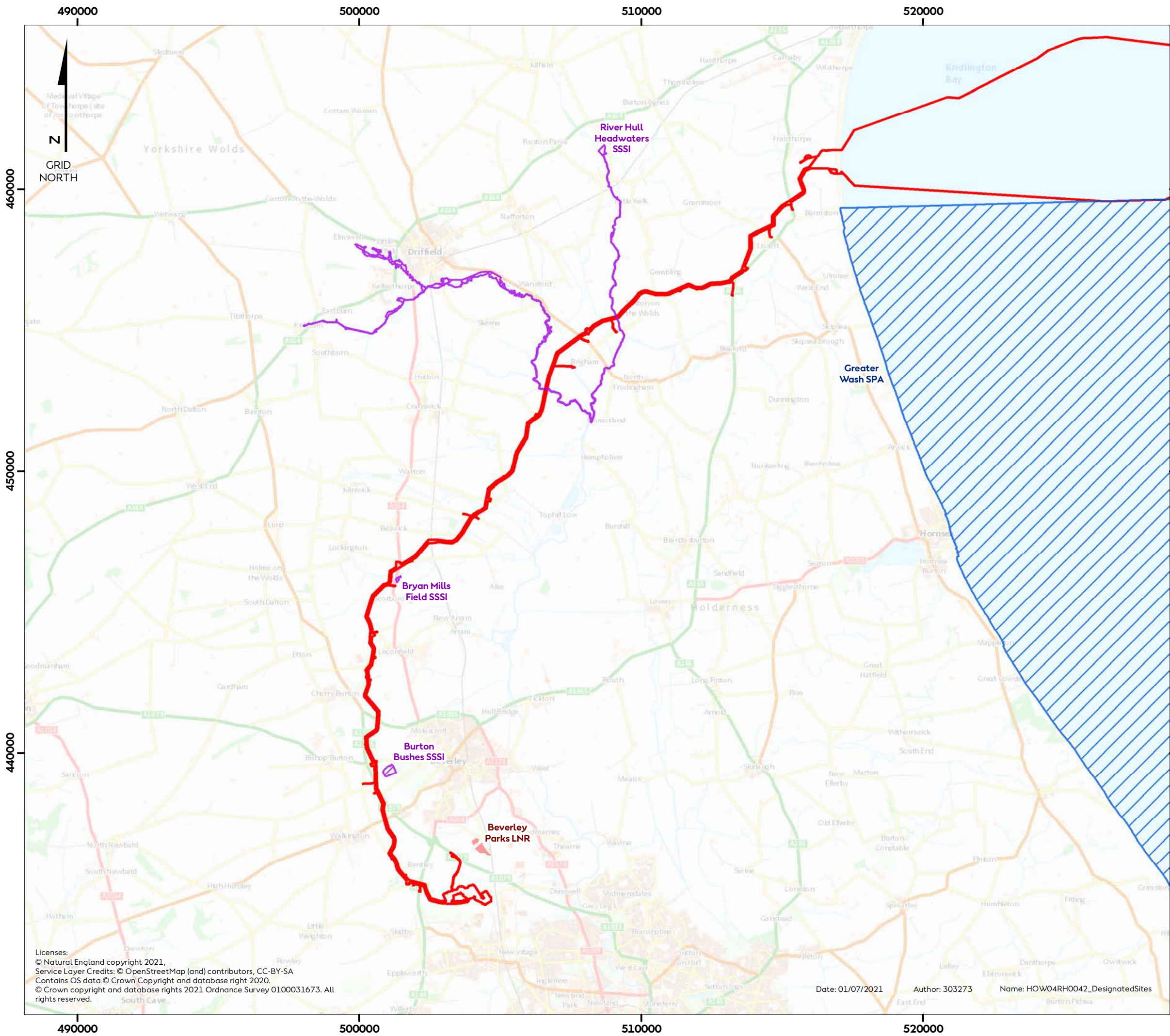
- 2.7.5.3 The OnSS is primarily located within Flood Zone 1 (80% of the total area), and at low risk of flooding from fluvial sources. The OnSS is also located primarily within areas of very low and low surface water flood risk. An area of high surface water flood risk is located to the south-east of the OnSS (Figure 18, [Volume A6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment](#)).
- 2.7.5.4 The 400 kV NGET connection area intersects two Flood Zone 3 extents and is also located over bedrock designated as a Principal Aquifer. However, the majority of the area is in Flood Zone 1 and therefore at 'Very Low' risk of flooding from surface water, and is at no risk from IDB maintained watercourses, the sea, sewers, reservoirs, canals or other artificial sources (see Figure 18, [Volume A6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment](#)).
- 2.7.5.5 A more detailed description of the baseline flood risk associated with the Hornsea Four hydrology and flood risk study area is provided in [Volume A6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment](#). A review of the modelling carried out by National Grid for the adjacent Creyke Beck site, which extends to the permanent OnSS area, found that the flood extent is similar to the Environment Agency modelled flood extent. It also found that the permanent OnSS intersects one Flood Zone 3 extent at the south-east corner associated with Cottingham Parks Drain Ordinary Watercourse. Overall, it is concluded that although there are sections of the landfall, onshore ECC and OnSS which are located in Flood Zones 2 and 3, it is predominantly located in Flood Zone 1. As such, the key infrastructure associated with the permanent OnSS is not considered to be at risk of fluvial flooding during an extreme event and has a significant natural freeboard above maximum modelled water levels (See Section 4.9; [Annex 6.2.2](#) for further details). This is further mitigated by Co197. Following construction there will therefore be no risk to the onshore infrastructure associated with the onshore ECC.

2.7.6 Designated sites





- 2.7.6.1 A summary of the main characteristics of water-dependent designated sites (as shown in [Figure 2.9](#)) is provided below. Further details sites are provided in [Chapter 3: Ecology and Nature Conservation](#).
- 2.7.6.2 The River Hull Headwaters SSSI comprises several tributaries of the River Hull, including Eastburn Beck from Kirkburn, Elmswell Beck from Elmswell through to West Beck, and Lowthorpe / Kelk / Foston Beck which flows from Harpham into Frodingham Beck and subsequently the River Hull. This site is designated due to the national importance of the headwaters of the River Hull as the most northerly chalk stream system in Britain. The upper tributaries originate on the edge of the chalk Yorkshire Wolds, where the surface geology influences the character of the river and its ecological species composition; with gravel, sand and silt sediments deposited on the riverbed. The river valley supports a diverse breeding bird community, including several waders as well as being home to several areas of wet woodland with alder (*Alnus glutinosa*) and willow (*Salix spp.*) carr, and areas of riverside

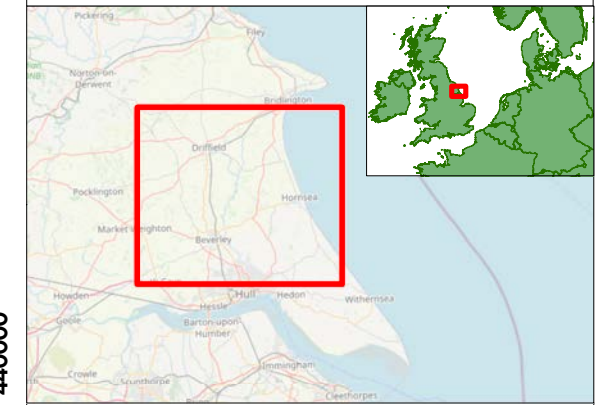
grassland and fen (Natural England 2010-2012b). This SSSI is proposed to be crossed at two locations, on Lowthorpe / Kelk / Foston Beck and West Beck ([Figure 2.9](#)).

- 2.7.6.3 The River Hull, which is crossed by the onshore ECC, flows into the Humber Estuary which is designated as a Special Area of Conservation (SAC), Special Protection Area (SPA) and a Ramsar Site. The primary reason for the selection of the site as a SAC is its status as the second-largest coastal plain estuary in the UK (Natural England 2019a). It incorporates habitats including mud flats, sand flats, lagoons, salt marshes, salt pastures, bogs and water fringed vegetation. Sediment concentrations are high and are derived from a variety of sources including marine sediments and eroding boulder clay from the Holderness Coast. The Ramsar site and SPA are designated for the internationally important numbers of waterfowl the estuary supports in winter, and nationally important breeding populations of a variety of bird species (Natural England 2019b; JNCC 2007).
- 2.7.6.4 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 hydrology and flood risk usually occur over an extended period of time (considered in [Section 2.7.7](#)). 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. The baseline environment for operational/decommissioning impacts is expected to evolve as described in the next section, with the additional consideration that any changes during the construction phase will have altered the baseline environment to a degree (as set out in this chapter).



Hornsea Four
 Figure 2.9
 Designated Sites within the Onshore Study Area

-  Order Limits
-  Sites of Special Scientific Interest (SSSI)
-  Special Protection Areas (SPA)
-  Local Nature Reserves (LNR)




Coordinate system: British National Grid
 Scale@A3: 1:130,000
 0 1.25 2.5 5 Kilometres
 0 0.75 1.5 3 Miles

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Date: 01/07/2021 Author: 303273 Name: HOW04RH0042_DesignatedSites

Title: Designated Sites within the Onshore Study Area
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2.7.7 Evolution of the Baseline

- 2.7.7.1 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 hydrology and flood risk.
- 2.7.7.2 The baseline review presented in [Section 2.7](#) demonstrates that the majority of the surface watercourse catchments within which the Hornsea Four hydrology and flood risk study area interacts, currently have moderate or poor water quality. This is due, in many cases, to the discharge of high concentrations of nutrients from sewage discharges and agricultural sources, and a variety of chemical pollutants from industrial sources. Continued efforts by the Environment Agency and partner organisations to achieve Good Ecological Status and Good Chemical Status over the next River Basin Management Planning cycles are likely to deliver improvements to water quality in the future. However, it is acknowledged that increasing pressures for greater agricultural production, coupled with the long residence times of chemical pollutants such as phosphates in the environment, could potentially limit the speed in which improvements are achieved as a result of projects led by the Environment Agency, Natural England and their partners within the lifetime of Hornsea Four. The activities proposed as part of Hornsea Four will not themselves prevent the implementation of these improvement measures or affect their outcomes, given the commitments included in the project design that will prevent the supply of fine sediment and contaminants into the surface drainage network during construction (e.g. Co4, Co6, Co8, Co10, Co14, Co18 and Co77) and operation (e.g. Co19 and Co191) (see [Section 2.8.2](#) for further details of these commitments). Natural England have agreed that these measures are appropriate, provided that specific details are agreed during the post-DCO permitting process (ON-HYD-4.11, ON-HYD-4.18, ON-HYD-4.19, ON-HYD-4.20).
- 2.7.7.3 Predicted climate changes are likely to result in wetter winters, drier summers with increased incidence of drought and a greater number of convectional rain storms. This means that the hydrology of the surface drainage network could change, with higher winter flows, lower summer flows and a greater number of storm-related flood flows. This in turn could result in changes to the geomorphology of the river systems, with increased geomorphological activity (e.g. channel adjustment) occurring in response to larger storm events (e.g. Longfield and Macklin 1999). However, with the exception of a reach of the West Beck upstream of the village of Wansford, the river planform has been largely stable since at least 1851 ([Section 2.7.3](#)). Furthermore, Natural England have confirmed that no evidence of significant adjustment in response to the removal of Broady's Weir (upstream of the potential crossing point) has been observed (ON-HYD-4.17). It is therefore unlikely that significant

geomorphological changes (such as lateral planform migration or channel incision) in the surface drainage network, including the River Hull Headwaters SSSI, will occur during the operational life of Hornsea Four.

2.7.7.4 Ongoing initiatives to improve the geomorphology and in-channel habitats of the surface drainage network are being undertaken by the Environment Agency, Natural England and partner organisations such as the East Yorkshire Rivers Trust (EYRT). These initiatives include works to restore the geomorphological functionality and in-channel habitats in Lowthorpe Beck and the Driffield Trout Stream (EYRT 2019) to meet WFD status targets. These works will also ensure that designated sites reach their target condition. Localised geomorphological conditions are therefore likely to improve in the future, within the constraints presented by the low energy, low gradient nature of the drainage network. It was agreed with Natural England that any future river restoration measures, including measures to address the pressures associated with Foston Mill Weir, are unlikely to interact with buried cable infrastructure that is offset from the bed and banks of the river channel (ON-HYD-7.4). Hornsea Four will not constrain the implementation of these initiatives as a result of the commitments (i.e. Co1 and Co18) that have been made to avoid impacts on the river channel.

2.7.7.5 The risk of flooding will be amplified as a result of the predicted increase in rainfall associated with climate change (e.g. Longfield and Macklin 1999), with an increase in peak river flows and an increase in the magnitude of surface water flooding. Additional information on climate-related impacts on flood risk is provided in [Volume A6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment](#).

2.7.8 Data limitations

2.7.8.1 The data used to inform this assessment has largely been obtained from archive sources ([Table 2.4](#)) with the exception of the results of the Hornsea Four geomorphological walkover survey ([Table 2.5](#)) ([Volume A6, Annex 2.1: Geomorphological Baseline Survey Report](#)). Since this geomorphological walkover was undertaken in March 2019, the Hornsea Four Order Limits have been refined (as detailed in [Volume A1, Chapter 3: Site Selection and Consideration of Alternatives](#)). However, this refinement has had no impact on the location of watercourse crossings and as such the baseline information used to inform this assessment is also unaffected.

2.7.8.2 The results of the geomorphological walkover survey ([Volume A6, Annex 2.1: Geomorphological Baseline Survey Report](#)) represent the findings of a single site visit which considered a limited reach of each watercourse rather than the entire system. However, a desk-based assessment of high-resolution aerial photography and current and historical Ordnance Survey mapping of each area was undertaken prior to the field survey. This was to provide broader contextual information and ensure that each survey reach was sufficiently broad (i.e. 200 m upstream and downstream of the area that could be directly

affected by the proposed project) to provide an accurate representation of prevailing geomorphological characteristics.

- 2.7.8.3 The baseline assessment is therefore considered to characterise current conditions within the Hornsea Four hydrology and flood risk study area to an acceptable level of certainty. Consultation with key stakeholders ([Section 2.4](#)) has confirmed that they agree that the data used to inform the assessment are suitable and accurately reflect baseline conditions (ON-HYD-1.1).
- 2.7.8.4 It is acknowledged that a proportion of the data derived from archive sources was published several years ago (e.g. Environment Agency flood risk data and WFD classification data) and that there is therefore a possibility that baseline conditions may have changed since the data was published. However, the most up-to-date data sets that have been published by the relevant authorities and regulators such as the Environment Agency have in all instances been consulted in order to minimise the potential for any significant changes in baseline conditions. Furthermore, although verification of the quality of third-party data is beyond the scope of this assessment, data have only been used if they have been obtained from published sources with clear quality control procedures (e.g. national datasets from government bodies).

2.8 Project basis for assessment

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

- 2.8.1.1 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, all potential impacts on hydrology and flood risk receptors are “Not considered in detail in the ES”. These impacts are outlined, together with a justification why they are not considered further, in [Table 2.9](#), which should be read in conjunction with [Volume A4, Annex 5.1: Impacts Register](#).
- 2.8.1.2 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 2.9](#).

Table 2.9: Hydrology and flood risk impact register – Impacts not considered in detail in the ES and justification.

Project activity and impact	Likely significance of effect	Approach to assessment	Justification
<p>Changes in water quality: Construction phase</p> <p>Works associated with cable installation leading to impacts on the water quality of watercourses and drainage systems local to the works. (HFR-C-6)</p>	No likely significant effects	Scoped out	As a result of the commitments embedded within the project design (Co4, Co6 Co8, Co10, Co14, Co19, Co64, Co77 and Co124), the potential for changes in water quality during construction was scoped out of the PEIR because no likely significant effects were identified at the scoping stage (with agreement achieved during EIA Scoping (PINS Scoping Opinion, November 2018, ID:4.14.5)). This was agreed with the Environment Agency and Beverley and North Holderness IDB during the Hornsea Four Water and Flood Risk Evidence Plan Technical Panel Meeting on 5 November 2019 (ON-HYD-3.1), and with the LLFA, Environment Agency and Beverley and North Holderness IDB via the consultation process and therefore this impact has not been considered further in the ES.
<p>Impacts associated with decommissioning of the cable route: Decommissioning phase</p> <p>Decommissioning activities along the cable route could disturb watercourses and affect water quality. (HFR-D-9)</p>	No likely significant effects	Scoped out	As a result of the Co127 (in Volume A4, Annex 5.2: Commitments Register) impacts associated with decommissioning the onshore ECC were scoped out of the PEIR because no likely significant effects were identified at the scoping stage (with agreement achieved during EIA Scoping (PINS Scoping Opinion, November 2018, ID:4.14.7)). This was agreed with the Environment Agency and Beverley and North Holderness IDB during the Hornsea Four Water and Flood Risk Evidence Plan Technical Panel Meeting on 5 November 2019 (ON-HYD-3.15), and with the Environment Agency and Beverley and North Holderness IDB via the consultation process and therefore this impact has not been considered further in the ES.
<p>Disturbance of watercourses: Construction phase</p> <p>Works associated with cable crossings Main Rivers and IDB maintained watercourses may result in a reduction in</p>	No likely significant effects	Not considered in detail in the ES.	<p>Disagreement from PINS (PINS Scoping Opinion, November 2018, ID:4.14.2).</p> <p>Trenchless techniques will be adopted to cross all major watercourses along the onshore ECC i.e. Main Rivers and IDB maintained drains (Co1). The entry and exit points will be located at least 20 m away from Environment Agency Main Rivers and 9 m away from all other surface watercourses and the cabling will be installed at least 1.2 m beneath the hard bed of</p>

Project activity and impact	Likely significance of effect	Approach to assessment	Justification
water quality and channel hydro-morphology. (HFR-C-1)			<p>watercourses being cross by HDD (Co18) to minimise the likelihood of interaction. HDD will be undertaken by non-impact methods (Co41) to minimise construction vibration and therefore preserve bank stability. Further details of all identified crossings can be found in Volume A4, Annex 4.2: Onshore Crossing Schedule.</p> <p>Joint bays and link boxes will be located a minimum of 20 m away from Environment Agency Main Rivers (Co170) to minimise the likelihood of disturbance.</p> <p>Where Hornsea Four may cross sites of particular sensitivity (e.g. SSSIs) a pre-construction hydrogeological risk assessment will be undertaken to inform a site-specific risk assessment (Co18). As such, there will therefore be no mechanisms for the direct disturbance of these watercourses during construction. Furthermore, the stability of the watercourses (as described in Section 2.7.2) means that rates of lateral or vertical adjustment are unlikely to be sufficient to result in direct interactions with buried cable infrastructure in the future. Further details of all identified crossings can be found in Volume A4, Annex 4.2: Onshore Crossing Schedule.</p> <p>As a result of the commitments Co1, Co18, Co41, Co124, Co143, Co147 and Co186 the direct disturbance of Environment Agency Main River and IDB-maintained watercourses during construction was not assessed in the PEIR or ES because no likely significant effects were identified at the scoping stage. This was agreed with the Environment Agency and Beverley and North Holderness IDB during the Hornsea Four Water and Flood Risk Evidence Plan Technical Panel Meeting on 5 November 2019 (ON-HYD-3.4), and with the LLFA, Environment Agency and Beverley and North Holderness IDB via the consultation process and therefore this impact has not been considered further in the ES.</p>
Disturbance of minor drainage ditches: Construction phase	No likely significant effects	Not considered in detail in the ES.	Disagreement from PINS (PINS Scoping Opinion, November 2018, ID:4.14.3 and ID.4.14.10).

Project activity and impact	Likely significance of effect	Approach to assessment	Justification
<p>Works associated with cable crossings of minor drainage ditches (as defined in the watercourses crossing schedule and agreed with EA, IDB and LLFA) may result in a reduction in water quality and channel hydro-morphology. (HFR-C-3)</p>			<p>Minor drainage features are likely to be crossed using an open trench technique following a methodology agreed in advance with the relevant consenting authority and developed in consultation with landowners once detailed land drainage surveys have been undertaken (Co14). This will include details of the temporary works, including measures to maintain flows and reinstate the bed and banks of the watercourse. This is secured through the outline Code of Construction Practice (CoCP) (Co124) (Volume F2, Chapter 2: Outline Code of Construction). All ditches and drainage outfalls will be retained where possible, and where it is not possible to retain them, they will be repaired and reinstated (Co157). The bed and banks of watercourses will be reinstated to their pre-construction condition (Co172). These will prevent non-temporary effects on minor drainage features. Further details of all identified crossings can be found in Volume A4, Annex 4.2: Onshore Crossing Schedule.</p> <p>As a result of the commitments Co14, Co19, Co124, Co147, Co157, Co172 and Co186 (set out in Volume A4, Annex 5.2: Commitments Register and Table 2.10), the direct disturbance of minor ordinary watercourses during construction was not assessed in the PEIR or ES because no likely significant effects were identified at the scoping stage. This was agreed with the Environment Agency and Beverley and North Holderness IDB during the Hornsea Four Water and Flood Risk Evidence Plan Technical Panel Meeting on 5 November 2019 (ON-HYD-3.6) and with the LLFA via the consultation process, and therefore this impact has not been considered further in the ES.</p>
<p>Disruption of local land drainage: Construction phase</p> <p>Works associated with cable installation leading to impacts on the integrity of the local land drainage systems and potential flooding. (HFR-C-5)</p>	<p>No likely significant effects</p>	<p>Not considered in detail in the ES.</p>	<p>Disagreement from PINS (PINS Scoping Opinion, November 2018, ID:4.14.4)</p> <p>A construction phase drainage strategy will be prepared to support the DCO application, setting out the performance requirements of a temporary site drainage system to ensure there are no changes to surface runoff during the construction of the substation and cable route (Co14). The Outline Onshore Infrastructure Drainage Strategy (Co19) can be found in Volume F2, Chapter 6: Outline Onshore</p>

Project activity and impact	Likely significance of effect	Approach to assessment	Justification
			<p>Infrastructure Drainage Strategy). All ditches and drainage outfalls will be retained where possible, and where it is not possible to retain them they will be repaired and reinstated (Co157). The construction drainage strategy will be agreed in advance with the LLFA and the Environment Agency as necessary (Co14) and appropriate liaison will be undertaken with the IDB during construction (Co147).</p> <p>As a result of commitments Co10, Co13, Co14, Co19, Co157, Co170, Co183 and Co186 (set out in Volume A4, Annex 5.2: Commitments Register and Table 2.10) the disruption of land drainage during construction were not assessed in the PEIR or ES because no likely significant effects were identified at the scoping stage. This was agreed with the Environment Agency and Beverley and North Holderness IDB during the Hornsea Four Water and Flood Risk Evidence Plan Technical Panel Meeting on 5 November 2019 (ON-HYD-3.8), and with the LLFA via the consultation process and therefore this impact has not been considered further in the ES.</p>
<p>Mobilisation of pollutants in the event of disturbance of contaminated soils: Construction phase</p> <p>Works associated with construction of the cable and substation may mobilise contaminants into surface water runoff from the site. (HFR-C-8)</p>	<p>No likely significant effects</p>	<p>Not considered in detail in the ES.</p>	<p>Disagreement from PINS (PINS Scoping Opinion, November 2018, ID:4.14.6).</p> <p>Impacts relating to disturbance of contaminated ground (the location of which would be identified through an investigation an assessment report undertaken under DCO Regulation 14 (Contaminated land and groundwater scheme) (Co77)) have been considered in detail in Chapter 1: Geology and Ground Conditions. Impact pathways will then be evaluated on the basis of proximity to proposed ground disturbance (Co77); and specific measures will be included in the CoCP (Co124) to prevent the ingress of soils and sediment whether contaminated or uncontaminated. Guidance on pollution prevention will also be adhered to (Co6) and a Pollution Prevent Plan will also be developed, to include adherence to good practice guidance (Co4). The outline CoCP (Volume F2, Chapter 2: Outline Code of Construction Practice) also includes measures to:</p> <ul style="list-style-type: none"> • Implement protection of groundwater during construction, including good environmental

Project activity and impact	Likely significance of effect	Approach to assessment	Justification
			<p>practices based on legal responsibilities and guidance on good environmental management in: CIRIA C532 Control of Water Pollution from Construction Sites – Guidance for Consultants and Contractors (Masters-Williams 2001); and CIRIA C648 Control of Water Pollution from Linear Construction Projects (Murnane, Heap, and Swain 2006) will be followed;</p> <ul style="list-style-type: none"> • Avoidance of oil storage within 50 m of a spring, well or borehole; • Not store oil where it could run over hard ground into a watercourse; • Use a secondary containment system that can hold at least 110% of the oil volume stored; • In accordance with The Control of Pollution (Oil Storage) (England) Regulations 2001. Refuelling of machinery would be undertaken within designated areas where spillages can be easily contained; • Machinery would be routinely checked to ensure it is in good working condition; and any tanks and associated pipe work containing oils and fuels would be double skinned and be provided with intermediate leak detection equipment. Measures will be employed to intercept and treat run-off from the working width. After treatment, discharge of any waters will be carried out so as to minimise physical impacts on channel morphology. Discharges will not be made without prior agreement and appropriate consents and approvals from the Environment Agency and relevant IDB. Further details on Co4, Co6 and Co124 are provided in Volume A4, Annex 5.2: Commitments Register. <p>As a result of commitments Co4, Co6, Co77 and Co124) (set out in Volume A4, Annex 5.2: Commitments Register and Table 2.10) the mobilisation of pollutants through the disturbance of contaminated soils during construction was not assessed in the PEIR and ES because no likely significant effects were identified at the scoping stage. This was agreed with the Environment Agency and Beverley and North Holderness IDB during the</p>

Project activity and impact	Likely significance of effect	Approach to assessment	Justification
			<p>Hornsea Four Water and Flood Risk Evidence Plan Technical Panel Meeting on 5 November 2019 (ON-HYD-3.10), and with the LLFA via the consultation process and therefore this impact has not been considered further in the ES.</p>
<p>Hydrological and water quality effects on designated sites: Construction phase</p> <p>Ground disturbance during construction could increase the supply of sediment and contaminants to the River Hull SSSI and change its hydrology. (HFR-C-12)</p>	<p>N/A</p>	<p>Not considered in detail in the ES.</p>	<p>Impact not identified at EIA Scoping but introduced at PEIR due to PINS scoping opinion (PINS Scoping Opinion, November 2018, ID:4.14.11).</p> <p>HDD (or other trenchless techniques) will be used to cross all Environment Agency Main River and IDB maintained drains, including the River Hull Headwaters SSSI. The entry and exit points will be located at least 20 m from Environment Agency Main Rivers and 9 m from all other surface watercourses being crossed by HDD (or other trenchless techniques) (Co18) and the cables will be installed a minimum of 1.2 m below the hard bed of any watercourse being crossed by HDD to minimise the likelihood of interaction. Suitable clearance distances from SSSI watercourses will be informed by a site-specific hydrogeological risk assessment (Co18) and agreed with Natural England and the Environment Agency in advance of construction. There will therefore be no mechanisms for the disturbance of the SSSI watercourses during construction. Furthermore, the stability of the watercourses (as described in Section 2.7.3) means that rates of lateral or vertical adjustment are likely to be insufficient to result in direct interactions with buried cable infrastructure in the future. This was agreed with Natural England during the Hornsea Four Water and Flood Risk Evidence Plan Technical Panel Meeting on 16th September 2020 (ON-HYD-3.17). Because trenchless cable crossings will not themselves directly interact with surface watercourses, they are proposed to be scoped out. Further information regarding crossing techniques is provided in Volume A4, Annex 4.2: Crossings Schedule.</p> <p>It is also proposed that, due to the measures set out in the CoCP (Co124) and associated commitments (Co4, Co8, Co10, Co14, Co19 Co64, and Co77) to control the supply of fine sediment and other contaminants</p>

Project activity and impact	Likely significance of effect	Approach to assessment	Justification
			<p>into surface watercourses and groundwaters, potential impacts on water quality in designated sites will also be scoped out.</p> <p>As a result of commitments Co1, Co4, Co8, Co10, Co14, Co18, Co19, Co64, Co77 and Co124, impacts on the hydrology and water quality of designated sites during construction were scoped out of assessment in the PEIR and ES because no likely significant effects were identified at the scoping stage. This was agreed with the Environment Agency and Beverley and North Holderness IDB during the Hornsea Four Water and Flood Risk Evidence Plan Technical Panel Meeting on 5 November 2019 (ON-HYD-3.2), and with the LLFA via the consultation process and therefore this impact has not been considered further in the ES.</p>
<p>Alteration in run-off characteristics at substation site: Operational phase</p> <p>The operational presence of the substation may alter surface run-off characteristics from the site and could lead to increased flood risk elsewhere. (HFR-O-7)</p>	<p>Likely significant effects without secondary mitigation</p> <p>Increase in flood risk from surface water has the potential to affect the substation itself, and increase flood risk to sensitive receptors downstream which could have a significant effect if not mitigated.</p>	<p>Not considered in detail in the ES.</p>	<p>This potential impact is not considered in detail because an operational drainage strategy in accordance with the Outline Onshore Infrastructure Drainage Strategy (Volume F2, Chapter 6) ((Co19). This sets out the principles of the sustainable drainage systems that will be provided to ensure that drainage will be restricted to the greenfield run-off rate (including a 30% allowance for climate change prescribed by the LLFA) (Co191).</p> <p>The Onshore Infrastructure Drainage Strategy will be agreed with the LLFA and the Environment Agency where appropriate.</p> <p>As a result of the commitments embedded within the scheme design (Co19, Co68, Co184, Co185, Co186, Co191 and Co197), the alteration of surface run-off characteristics at the substation site during operation was not assessed in the PEIR or ES. Although likely significant effects were identified at the scoping stage, these would be managed with the proposed mitigation. This was agreed with the Environment Agency and Beverley and North Holderness IDB during the Hornsea Four Water and Flood Risk Evidence Plan Technical Panel Meeting on 5 November 2019 (ON-HYD-3.12), and with the LLFA via the consultation process and therefore this impact has not been considered further in the ES.</p>

Project activity and impact	Likely significance of effect	Approach to assessment	Justification
<p>Impacts associated with operation: Operational phase</p> <p>Operational activities at the substation site and along the cable route could disturb watercourses and affect water quality. (HFR-O-11)</p>	<p>No likely significant effect</p>	<p>Not considered in detail in the ES.</p>	<p>Disagreement from PINS (PINS Scoping Opinion, November 2018, ID:4.14.9).</p> <p>Potential impacts on water quality during operation are not considered in detail in this assessment because there will be minimal requirements for routine maintenance along the cable corridor or at the onshore substation. Further information on the nature of any proposed operation and maintenance activities are provided in Section 4.11.3 of Volume A1, Chapter 4: Project Description. Necessary measures will be undertaken to ensure that there are no changes to surface runoff and adherence to SuDS hierarchies. This is secured through Volume F2, Chapter 6: Outline Onshore Infrastructure Drainage Strategy (Co19) (as provided in Volume A4, Annex 5.2: Commitments Register and Table 2.10)</p> <p>As a result of commitments Co19 and Co191, impacts associated with the operation of the Hornsea Four OnSS, landfall and onshore ECC were scoped out assessment in the PEIR and ES because no likely significant effects were identified at the scoping stage. This was agreed with the Environment Agency and Beverley and North Holderness IDB during the Hornsea Four Water and Flood Risk Evidence Plan Technical Panel Meeting on 5 November 2019 (ON-HYD-3.14), and with the LLFA via the consultation process and therefore this impact has not been considered further in the ES.</p>
<p>Thermal impacts on water resources: Operational Phase</p> <p>Thermal effects of the underground power cables along the cable route could lead to potential impacts on groundwater quality and associated species / habitats. For example, a reduction</p>	<p>No likely significant effect</p>	<p>Not considered in detail in the ES.</p>	<p>Impact not identified at EIA scoping but introduced at PEIR following consultation with the Environment Agency during the Hornsea Four Water and Flood Risk Evidence Plan Technical Panel Meeting on 5 November 2019 (ON-HYD-3.13).</p> <p>Potential impacts on water temperature during operation are not considered in this assessment because cables will be buried at least 1.2 m beneath watercourses, and effects on the temperature of flowing water is therefore considered to be negligible. The optimal clearance depth beneath watercourses will be agreed with the relevant authorities prior to construction. Further details are provided in Co13 and</p>

Project activity and impact	Likely significance of effect	Approach to assessment	Justification
<p>in WFD status. (HFR-O-13)</p>			<p>Co18 in Volume A4, Annex 5.2: Commitments Register. Note that potential effects on aquatic biota resulting from changes to water temperature are considered in Chapter 3: Ecology and Nature Conservation.</p> <p>As a result of commitments Co18 and Co13 (including thermal insulation of the cables), thermal impacts on water resources during operation were scoped out of the assessment in the PEIR and ES because no likely significant effects were identified at the scoping stage. This was agreed with the Environment Agency and Beverley and North Holderness IDB during the Hornsea Four Water and Flood Risk Evidence Plan Technical Panel Meeting on 5 November 2019 (ON-HYD-3.13), and with the LLFA via the consultation process and therefore this impact has not been considered further in the ES.</p>
<p>Impacts associated with the decommissioning of the Hornsea Four substation:</p> <p>Decommissioning phase</p> <p>Works associated with decommissioning of substation. (HFR-D-10)</p>	<p>No likely significant effect</p>	<p>Not considered in detail in the ES.</p>	<p>Disagreement from PINS (PINS Scoping Opinion, November 2018, ID:4.14.8).</p> <p>Potential impacts resulting from decommissioning of the OnSS are considered to be equal to, or less than construction-stage impacts. Decommissioning of the OnSS for Hornsea Four will comprise:</p> <ul style="list-style-type: none"> The removal of the OnSS above ground electrical equipment and infrastructure, along with the building of foundations and security fencing. Any waste arising from the decommissioning will be disposed of in accordance with the relevant regulations. The site will be returned to its previous condition. <p>Decommissioning practices will incorporate measures to prevent pollution, to include emergency spill response procedures, and clean up and remediation of contaminated soils. The measures will follow a similar approach to those set out for the construction phase.</p> <p>A decommissioning plan will be developed in line with the latest relevant available guidance (Co127). Further details on decommissioning are provided in Section 4.13 of Volume 1, Chapter 4: Project Description.</p>

Project activity and impact	Likely significance of effect	Approach to assessment	Justification
			<p>As a result of commitment Co127, impacts associated with decommissioning the Hornsea Four OnSS were scoped out of assessment in the PEIR and ES because no likely significant effects were identified at the scoping stage. This was agreed with the Environment Agency and Beverley and North Holderness IDB during the Hornsea Four Water and Flood Risk Evidence Plan Technical Panel Meeting on 5 November 2019 (ON-HYD-3.16), and with the LLFA via the consultation process and therefore this impact has not been considered further in the ES.</p>
<p>Access across watercourses: Construction phase</p> <p>Works associated with access track crossings of Main Rivers and IDB maintained watercourses may result in a reduction in water quality and channel hydro-morphology. (HFR-C-2)</p>	<p>No likely significant effects</p>	<p>Not considered in detail in the ES.</p>	<p>As a result of the commitments Co13, Co124, Co147, Co172, Co175 and Co186 (as set out in Volume A4, Annex 5.2: Commitments Register and Table 2.10) no likely significant effects resulting from temporary access across watercourses during construction were identified as part of the EIA assessment, as set out in the PEIR (Orsted 2019) and confirmed in the impact register . This was agreed with the Environment Agency and Beverley and North Holderness IDB during the Hornsea Four Water and Flood Risk Evidence Plan Technical Panel Meeting on 5 November 2019 (ON-HYD-3.5), and with the LLFA via the consultation process and therefore this impact has not been considered further in the ES.</p>
<p>Access across minor drainage ditches: Construction phase</p> <p>Works associated with access track crossings of minor drainage ditches (as defined in the watercourses crossing schedule and to be agreed with Environment Agency, IDB and LLFA) may result in a reduction in water quality and channel hydro-morphology. (HFR-C-4)</p>	<p>No likely significant effects</p>	<p>Not considered in detail in the ES.</p>	<p>Scoped into assessment based on PINS scoping opinion (PINS Scoping Opinion, November 2018, ID:4.14.10).</p> <p>As a result of the commitments Co13, Co124, Co147, Co172 and Co186 (set out in Volume A4, Annex 5.2: Commitments Register and Table 2.10) no likely significant effects resulting from temporary access across minor ordinary watercourses during construction were identified as part of the EIA assessment, as set out in the PEIR (Orsted 2019) and confirmed in the impact register. This was agreed with the Environment Agency and Beverley and North Holderness IDB during the Hornsea Four Water and Flood Risk Evidence Plan Technical Panel Meeting on 5 November 2019 (ON-HYD-3.7), and with the LLFA via the consultation process and therefore this impact has not been considered further in the ES.</p>

Project activity and impact	Likely significance of effect	Approach to assessment	Justification
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.			

2.8.2 Commitments

2.8.2.1 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 2.10](#), 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.

2.8.2.2 The commitments adopted by Hornsea Four in relation to hydrology and flood risk are presented in [Table 2.10](#).

Table 2.10: Relevant hydrology and flood risk commitments.

Commitment ID	Measure Proposed	How the measure will be secured
Co1	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.	DCO Requirement 17 (CoCP)
Co4	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.	DCO Requirement 17 (CoCP)
Co6	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.	DCO Requirement 17 (CoCP)

Commitment ID	Measure Proposed	How the measure will be secured
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 (CoPC)
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 20m 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 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	DCO Requirement 17 (CoCP)

Commitment ID	Measure Proposed	How the measure will be secured
	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)
Co25	Primary: The onshore export cable corridor (inclusive of the 400kV export cables) will be completely buried underground for its entire length. No overhead pylons will be installed as part of the consented works for Hornsea Four.	DCO Schedule 1, Part 1 Authorised Development
Co28	Primary: Joint Bays will be completely buried, with the land above reinstated except where access will be required from ground level, e.g. via link box chambers and manholes.	DCO Requirement 17 (CoCP) DCO Requirement 20 (Restoration of land used temporarily for construction)
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)
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 (Code of construction practice)
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
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)
Co143	Secondary: The landfall site will avoid the Barmston Main Drain.	DCO Works Plan - Onshore
Co147	Tertiary: Appropriate liaison will take place with the Internal Drainage Board during construction.	DCO Requirement 17 (CoCP)
Co157	Secondary: Fences, walls, ditches and drainage outfalls will be retained along the onshore export cable corridor and landfall, where possible. Where it is not reasonably practicable to retain them, any damage will be repaired and reinstated as soon as reasonably practical. The Environment Agency must be notified if damage occurs to any EA Main river or related flood infrastructure.	DCO Requirement 17 (CoCP)
Co170	Secondary: Joint bays and link boxes will be located a minimum of 20 m away from Environment Agency (EA) Main rivers.	DCO Requirement 17 (CoCP)
Co172	Secondary: The bed and banks of watercourses will be reinstated to their pre-construction condition following the removal of any temporary structures. Culverts will not be used for temporary access track crossings across EA Main Rivers. Where a temporary access track crossing across an EA Main River may be required, clear span/ bailey bridges will be used. There will be no loss of cross-sectional area to Environment Agency (EA) Main rivers.	DCO Requirement 17 (CoCP)
Co175	Secondary: A pre and post construction condition survey will also be undertaken at each Environment Agency (EA) Main river crossings, including any flood defences to be crossed. The scope and methodology of the survey will be agreed in advance with the EA. On completion of the project, details of the surveys under each Main River and flood defence will be submitted to the EA.	DCO Requirement 17 (CoCP)
Co183	Secondary: Where reasonably practicable the design of all temporary access tracks within the floodplain of EA Main rivers (defined as areas of Flood Zone 2 and 3, as shown on the Environment Agency Flood Map for Planning), areas at risk of surface water flooding (as shown on the Risk of	DCO Requirement 17 (CoCP)

Commitment ID	Measure Proposed	How the measure will be secured
	Flooding Surface Water maps), or in areas included on the historic flood map (from any source) will replicate or be as consistent with existing ground levels as possible, to limit any effects on future flood risk.	
Co184	Secondary: Where the permanent access track to the OnSS may be required to pass over an existing watercourse, the crossing will be appropriately designed to maintain floodplain capacity and/or flow conveyance, where reasonably practicable. This shall include an allowance for the predicted effects of climate change.	DCO Requirement 17 (CoCP)
Co185	Secondary: Where the permanent access track to the OnSS is within areas of flood risk (as shown on the Environment Agency Flood Map for Planning) it will be appropriately designed to maintain existing ground elevations to ensure continued floodplain capacity and/or flow conveyance, where reasonably practicable.	DCO Requirement 17 (CoCP)
Co186	Tertiary: Where works to an EA Main river or ordinary watercourse are necessary, the appropriate permits and consents will be sought from the relevant authority as required. Details of the locations and work undertaken on any EA Main river or associated flood defences, including any reports or records, will be submitted to the Environment Agency.	DCO Requirement 17 (CoCP)
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)
Co191	Secondary: The drainage design at the onshore substation will include Sustainable Drainage System (SuDS) measures including filter drains, swales, attenuation and flow control structures for the operational drainage of the Onshore Substation. Surface water will be discharged from the site at a controlled rate which will be determined during the detailed design stage. Appropriate consideration will be given to maintaining the existing floodplain capacity and / or flow conveyance during extreme rainfall events. These principles are provided in the Outline Onshore Infrastructure Drainage Strategy with which the Onshore Infrastructure Drainage Strategy will be developed.	DCO Requirement 15 (Surface water)
Co197	Secondary: Where reasonably practicable, topsoil & subsoil stockpiling within the floodplain (defined as areas of Flood Zone 2 or 3 as identified on the Environment Agency Flood Map for Planning) of any EA Main River will be avoided at the Onshore Substation	DCO Requirement 17 (CoCP)

2.9 Maximum Design Scenario

2.9.1.1 The Maximum Design Scenario (MDS) 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](#). As all potential impacts associated with hydrology and flood risk have either been scoped out (at Scoping and not assessed at PEIR) or are not considered in detail within the ES (as no LSE identified at PEIR), no MDS have been presented within the chapter. Should Hornsea Four be constructed within the MDS provided in the 'Hydrology and Flood Risk' section of [Volume A4, Annex 5.1: Impacts Register](#), then impacts would not be

any greater than those also summarised in [Volume A4, Annex 5.1: Impacts Register](#). All potential hydrology and flood risk impacts identified in relation to Hornsea Four are summarised in the 'Hydrology and Flood Risk' section of [Annex A4.5.1](#).

2.10 Assessment methodology

2.10.1.1 The assessment methodology for hydrology and flood risk is consistent with that presented in Annex C of the Scoping Report (Orsted 2018). Individual assessment methodologies have also been prescribed for the FRA and the WFD Compliance Assessment appended to this Chapter. The assessment methodologies of these exercises are detailed within the respective appendices:

- [Volume A6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment](#); and
- [Volume A6, Annex 2.3: Water Framework Directive Compliance Assessment](#).

2.10.1.2 Two key groups of impacts have been identified for the purpose of defining impact significance:

- Water resources: the potential effects on the physical (including hydrology and geomorphology), biological or chemical character of surface waters or groundwater. Potentially impacting on secondary receptors such as wetlands or abstractions and WFD water body status; and
- Flood risk: the potential impacts of Hornsea Four on site drainage, conveyance and surface water flooding.

2.10.1.3 Whilst there is a relationship between the two impact groups, the assessment of receptor sensitivity and the magnitude of impacts may differ, as set out in [Section 2.10.2](#).

2.10.1.4 For the purposes of this assessment, each discrete surface drainage catchment identified within the study area in [Section 2.5](#) has been treated as a separate receptor. Any parts of the surface drainage network that are not included in Ordnance Survey datasets are therefore considered to be part of the nearest downstream watercourse. The value and sensitivity of each of these receptors has been set at a catchment level and applied to all watercourses within that catchment.

2.10.2 Impact assessment criteria

2.10.2.1 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 determine the sensitivity of receptors ([Table 2.11](#)) and the magnitude of potential impacts ([Table 2.12](#)). The terms used to define sensitivity and magnitude are based on those used in the DMRB methodology, which is described in further detail in [Volume A1, Chapter 5: Environmental Impact Assessment Methodology](#). Reference has also been made to guidance on the assessment of impacts on water provided by the Department of Transport (2015).

Table 2.11: Definition of terms relating to receptor sensitivity.

Sensitivity	DMRB definition	Definition used in this chapter
Very High	Very high importance and rarity, international scale and very limited potential for substitution	<p>Receptor has very limited capacity to tolerate changes to hydrology, geomorphology, and water quality or flood risk.</p> <p><i>Water resources</i> Controlled waters with an unmodified, naturally diverse hydrological regime, a naturally diverse geomorphology with no barriers to the operation of natural processes, and very good water quality. Supports habitats or species that are highly sensitive to changes in surface hydrology, geomorphology or water quality. Supports Principal Aquifer with public water supply abstractions for a large population. Site is within Inner Source Protection Zones.</p> <p><i>Flood risk</i> Highly Vulnerable Land Use, as defined by PPG Table 2 (Ministry of Housing, Communities and Local Government 2014). Land with more than 100 residential properties (after DMRB 2009).</p>
High	High importance and rarity, national scale and limited potential for substitution	<p>Receptor has limited capacity to tolerate changes to hydrology, geomorphology, and water quality or flood risk.</p> <p><i>Water resources</i> Controlled waters with an almost unmodified, naturally diverse hydrological regime, a naturally diverse geomorphology with few barriers to the operation of natural processes, and good water quality. Supports habitats or species that are highly sensitive to changes in surface hydrology, geomorphology or water quality. Supports Principal Aquifer with public water supply abstractions for a small population. Site is within Outer Source Protection Zones.</p> <p><i>Flood risk</i> More Vulnerable Land Use, as defined by PPG Table 2 (Ministry of Housing, Communities and Local Government 2014). Land with between 1 and 100 residential properties or more than 10 industrial premises (after DMRB 2009).</p>
Medium	Medium importance and rarity, regional scale, limited potential for substitution	<p>Receptor has moderate capacity to tolerate changes to hydrology, geomorphology, and water quality or flood risk.</p> <p><i>Water resources</i> Controlled waters with hydrology that sustains natural variations, geomorphology that sustains natural processes, and water quality that is not contaminated to the extent that habitat quality is constrained.</p>

Sensitivity	DMRB definition	Definition used in this chapter
		<p>Supports or contributes to habitats or species that are sensitive to changes in surface hydrology, geomorphology and/or water quality. Supports Secondary A or Secondary B Aquifer. Site is within a Catchment Source Protection Zone.</p> <p><i>Flood risk</i> Less Vulnerable Land Use, as defined by PPG Table 2 (Ministry of Housing, Communities and Local Government 2014). Land with 10 or fewer industrial properties (after DMRB 2009).</p>
Low	Low importance and rarity, local scale	<p>Receptor has high capacity to tolerate changes to hydrology, geomorphology, and water quality or flood risk.</p> <p><i>Water resources</i> Controlled waters with hydrology that supports limited natural variations, geomorphology that supports limited natural processes and water quality that may constrain some ecological communities. Supports or contributes to habitats that are not sensitive to changes in surface hydrology, geomorphology or water quality. Non-productive strata that does not support groundwater resources.</p> <p><i>Flood risk</i> Water Compatible Land Use, as defined by PPG Table 2 (Ministry of Housing, Communities and Local Government 2014). Land with limited constraints and a low probability of flooding of residential and industrial properties (after DMRB 2009).</p>

2.10.2.2 The criteria for defining magnitude in this chapter are outlined in [Table 2.12](#).

Table 2.12: Definition of terms relating to magnitude of an impact.

Magnitude of impact	Definition used in this chapter
Major	<p>Fundamental, permanent / irreversible changes, over the whole receptor, and / or fundamental alteration to key characteristics or features of the particular receptor's character or distinctiveness.</p> <p><i>Water resources</i> Permanent changes to geomorphology and/or hydrology that prevent natural processes operating. Permanent and/or wide scale effects on water quality or availability. Permanent loss or long-term (>5 years) degradation of a water supply source. Permanent or wide scale degradation of habitat quality.</p> <p><i>Flood risk</i> Permanent or major change to existing flood risk.</p>

Magnitude of impact	Definition used in this chapter
	<p>Reduction in on-site flood risk by raising ground level in conjunction with provision of compensation storage.</p> <p>Increase in off-site flood risk due to raising ground levels without provision of compensation storage.</p> <p>Failure to meet either sequential or exception test (if applicable).</p>
Moderate	<p>Considerable, permanent / irreversible changes, over the majority of the receptor, and / or discernible alteration to key characteristics or features of the particular receptors character or distinctiveness.</p> <p><i>Water resources</i></p> <p>Medium-term (1-5 years) effects on water quality or availability.</p> <p>Medium-term (1-5 years) degradation of a water supply source.</p> <p>Habitat change over the medium-term (1-5 years).</p> <p><i>Flood risk</i></p> <p>Medium-term (1-5 years) or moderate change to existing flood risk.</p> <p>Possible failure of sequential or exception test (if applicable).</p> <p>Reduction in off-site flood risk within the local area due to the provision of a managed drainage system.</p>
Minor	<p>Discernible, temporary (throughout project duration) change, over a minority of the receptor, and / or limited but discernible alteration to key characteristics or features of the particular receptors character or distinctiveness.</p> <p><i>Water resources</i></p> <p>Short-term (<1 year) or local effects on water quality or availability.</p> <p>Short-term (<1 year) degradation of a water supply source.</p> <p>Habitat change over the short-term.</p> <p><i>Flood risk</i></p> <p>Short-term (<1 year), temporary or minor change to existing flood risk.</p> <p>Localised increase in on-site or off-site flood risk due to increase in impermeable area.</p> <p>Passing of sequential and exception test.</p>
Negligible	<p>Discernible, temporary (for part of the project duration) change, or barely discernible change for any length of time, over a small area of the receptor, and/or slight alteration to key characteristics or features of the particular receptors character or distinctiveness.</p> <p><i>Water resources</i></p> <p>Intermittent impact on local water quality or availability.</p> <p>Intermittent or no degradation of a water supply source.</p> <p>Very slight local changes to habitat that have no observable impact on dependent receptors.</p> <p><i>Flood risk</i></p> <p>Intermittent or very minor change to existing flood risk.</p>

Magnitude of impact	Definition used in this chapter
	Highly localised increase in on-site or off-site flood risk due to increase in impermeable area.
No change	No loss or alteration of characteristics features or elements; no observable impact (neither positive nor adverse).

2.10.2.3 The significance of the effect upon hydrology and flood risk 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 2.13](#). Where a range of significance of effect is presented in [Table 2.13](#), the final assessment for each effect is based upon expert judgement.

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

Table 2.13: 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)

2.11 Impact assessment

2.11.1 Construction

2.11.1.1 Following the scoping for hydrology and flood risk and the assessment presented in the PEIR, potential impacts of onshore construction activities (i.e. HFR-C-1, HFR-C-2, HFR-C-3, HFR-C-4, HFR-C-5, HFR-C-6, HFR-C-8, and HFR-C-12) are considered likely to be not significant in EIA terms due to project commitments and therefore have not been considered in detail in this ES, as summarised in [Table 2.9](#). Further details are provided in the 'Hydrology and Flood Risk' section of [Volume A4, Annex 5.1: Impacts Register](#).

2.11.2 Operation and Maintenance

2.11.2.1 Following mitigation, no potentially significant impacts have been identified in relation to operation and maintenance of Hornsea Four (i.e. HFR-O-7, HFR-O-11, and HFR-O-13) on hydrology and flood risk, and therefore these impacts have not been considered in detail in this ES, as summarised in [Table 2.9](#). Further details are provided in the 'Hydrology and Flood Risk' section of [Volume A4, Annex 5.1: Impacts Register](#).

2.11.3 Decommissioning

2.11.3.1 Following mitigation and commitments outlined in [Table 2.10](#), no LSE have been identified in relation to the decommissioning (i.e. HFR-D-9) of Hornsea Four on hydrology and flood risk. Additionally, no further impacts have been identified which have not been assessed for the construction phase that could result in LSE during decommissioning. Therefore, decommissioning has not been considered in detail in this ES as further justification was provided at PEIR, as summarised in [Table 2.9](#). These impacts (HFR-D-9 and HFR-D-10) have been summarised in the 'Hydrology and Flood Risk' section of [Volume A4, Annex 5.1: Impacts Register](#), as agreed with the IDB and the Environment Agency at a Hornsea Four water and flood risk evidence plan technical panel meeting on 5th November 2019 (ON-HYD-3.15, ON-HYD-3.16).

2.11.3.2 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).

2.12 Cumulative effect assessment (CEA)

2.12.1.1 Cumulative effects can be defined as effects upon a single receptor from Hornsea Four when considered alongside other proposed and reasonably foreseeable projects and developments. 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.

2.12.1.2 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 Effect Screening Matrix 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.

2.12.1.3 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**.

2.12.2 CEA Stage 2 Shortlist and Stage 3 Information Gathering

2.12.2.1 A short list 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 projects is provided in **Volume A4, Annex 5.5: Onshore Cumulative Effect Screening Matrix** and **Volume A4, Annex 5.6: Location of Onshore Cumulative Schemes**.

2.12.2.2 Twenty one projects have been identified for inclusion on the short list of projects to be assessed cumulatively for hydrology and flood risk. Any projects located outside of the surface water catchments within which construction or operational activities will take place have not been considered (for inclusion) as they do not have the potential to result in cumulatively significant effects on hydrology and flood risk receptors as there is no mechanism for impact.

2.12.2.3 None of the shortlisted projects were assessed as having any cumulative impact for hydrology and flood risk. Summary information is provided below in **Table 2.14**.

2.12.3 CEA Stage 3 Assessment

2.12.3.1 As stated in Table 2 of **Volume A4, Annex 5.5: Onshore Cumulative Effects**, the assessment is undertaken in two phases:

- Phase 1 - set out the potential impacts assessed in this chapter and identify the potential for cumulative effects to arise, providing a rationale for such determinations; and
- Phase 2 - set out the CEA for each of the projects/developments that have been identified on the short-list of projects screened.

2.12.3.2 It should be noted that 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 2.14**. As the first phase of CEA Stage 3 assessment did not identify any potential cumulative

effects (as set out in [Table 2.14](#)) the second phase assessment has therefore not been carried out.

Table 2.14: Potential Cumulative Effects.

Impact	Potential for Cumulative Effect?	Rationale
<i>Construction</i>		
There are unlikely to be any significant cumulative impacts from the construction of the project, because the commitments summarised in Table 2.10 will mean that the project activities do not result in any significant effects.		
<i>Operation</i>		
There are unlikely to be any significant cumulative impacts from the operation of the project. The onshore export cables will be monitored remotely, and any maintenance will be infrequent and corrective (Volume A1, Chapter 4: Project Description).		
<i>Decommissioning</i>		
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.		

2.12.3.3 The CEA for hydrology and flood risk does not identify any reasonably foreseeable projects or developments where significant cumulative effects could arise.

2.13 Transboundary effects

2.13.1.1 A screening of transboundary impacts 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 hydrology and flood risk from Hornsea Four upon the interests of other EEA States and this is not discussed further.

2.14 Inter-related effects

2.14.1.1 Inter-related effects consider impacts from the construction, operation or decommissioning of Hornsea Four on the same receptor (or group). 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 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.

2.14.1.2 A description of the process to identify and assess these effects is presented in Section 2 of [Volume A1 Chapter 5: EIA Methodology](#). Although several potential effects were identified in the inter-related effects screening report supplied as Annex J to the Hornsea Four Scoping Report (Orsted 2018), the breadth of project details now available mean that it has now

been possible to scope out all potential impact pathways considered in this assessment ([Table 2.9](#)).

2.14.1.3 No significant inter-related effects are forecast as any potential inter-related effects will be of no greater significance than those assessed in isolation. As all potential impacts associated with hydrology and flood risk have either been scoped out (at PEIR) or are no longer considered in detail within the ES (as no LSE identified) (please see [Volume A4, Annex 5.1: Impacts Register](#)), there are no opportunities for cumulative transboundary effects to occur.

2.15 Conclusion and summary

2.15.1.1 This chapter of the ES demonstrates that potential hydrology and flood risk impacts related to Hornsea Four have either been scoped out or not assessed in detail in this EA. These impacts are summarised in the 'Hydrology and Flood Risk' section of [Volume A4, Annex 5.1: Impacts Register](#). Overall, no LSE have been identified during the construction, operation and decommissioning stages following implementation of the project commitments set out in [Volume A4, Annex 5.2: Commitments Register](#).

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