Hornsea Project Four: Preliminary Environmental Information Report (PEIR)

Volume 3, Chapter 2 : Hydrology and Flood Risk

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Glossary

Term	Definition
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	A term used interchangeably with mitigation. Commitments are Embedded Mitigation Measures. Commitments are either Primary (Design) or Tertiary (Inherent) and embedded within the assessment at the relevant point in the EIA (e.g. at Scoping or PEIR). The purpose of Commitments is to reduce and/or eliminate Likely Significant Effects (LSE's) in EIA terms.
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 impact	Impacts 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 Regulations	The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (the 'EIA Regulations').
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.
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.
Orsted Hornsea Project Four Ltd.	The Applicant for the proposed Hornsea Project Four Ltd. offshore wind farm project.
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

Term	Definition
	construction works, including the offshore and onshore ECC, intertidal working area and landfall compound.
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 Hornsea Four. Mitigation measures (Commitments) are embedded within the assessment at the relevant point in the EIA (e.g. at Scoping or PEIR).
Onshore substation (OnSS)	Located as close as practical to the National Grid substation at Creyke Beck and will include all necessary electrical plant to meet the requirements of the National Grid. Specialists to use OnSS
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 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.

Acronyms

Acronym	Definition
BGS	British Geological Survey
CoCP	Code of Construction Practice
CMS	Construction Method Statement
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
EA	Environment Agency
EC	European Commission
ECC	Export Cable Corridor
EEA	European Economic Area
EIA	Environmental Impact Assessment
ERYC	East Riding of Yorkshire Council
EU	European Union
FWMA	Flood and Water Management Act
GEP	Good Ecological Potential
GES	Good Ecological Status
HDD	Horizontal Directional Drilling
IDB	Internal Drainage Board
LFRMS	Local Flood Risk Management Strategy
LLFA	Lead Local Flood Authority

Acronym	Definition
LSE	Likely Significant Effects
MDS	Maximum Design Scenarios
MHWS	Mean High-Water Springs
MLWS	Mean Low-Water Springs
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
TJBs	Transition Joint Bay
WFD	Water Framework Directive

Units

Unit	Definition
kV	Kilovolt (electrical potential)
K*m*	Kilometres (distance).

2.1 Introduction

2.1.1.1 This chapter of the Preliminary Environmental Information Report (PEIR) presents the results of the Environmental Impact Assessment (EIA) to date for the potential impacts of the Hornsea Project Four offshore wind farm (hereafter 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.

2.1.1.2 Orsted Hornsea Project Four Limited (the Applicant) is proposing to develop Hornsea Four which will be located approximately 65 km from the East Riding of Yorkshire in the Southern North Sea and will be the fourth project to be developed in the former Hornsea Zone (please see **Volume 1, Chapter 1: Introduction** for further details on 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 connection to the electricity transmission network (please see **Volume 1, Chapter 4: Project Description** for full details on the Project Design).

2.1.1.3 A Water Framework Directive (WFD) Compliance Assessment has been undertaken and is provided separately in **Volume 6, Annex 2.3: Water Framework Directive Compliance Assessment**. Baseline geomorphological surveys were also undertaken and are reported on in **Volume 6, Annex 2.1: Geomorphological Baseline Survey Report**. A flood risk assessment has also been completed for all onshore project elements and can be found in **Volume 6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment**.

2.1.1.4 This chapter should be read in conjunction with **Chapter 1: Geology and Ground Conditions** which summarised 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 This PEIR presents the preliminary environmental information for Hornsea Four and sets out the findings of the EIA to date to support the pre-DCO application consultation activities required under the Planning Act 2008.

2.2.1.2 The feedback from this consultation will be used to inform the final project design and the associated EIA (which will be reported in an Environmental Statement (ES)) that will accompany the DCO application to PINS.

2.2.1.3 This PEIR chapter:

- Presents the existing environmental baseline established from desk studies 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.

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 PEIR
Hydrology and Flood Risk	
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 (paragraph 5.7.4 of NPS-EN1).	An FRA which identifies and assesses the risks of flooding and to and from the project has been undertaken and is provided within **Volume 6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment**.
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 (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 Flood Risk Assessment and WFD Compliance Assessment are summarised in **Table 2.3**. Additional details are provided in **Volume 1, Chapter 6: Consultation Report**.

Summary of NPS EN-1, EN-3 and EN-5 provisions	How and where considered in the PEIR
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 (paragraph 5.15.2 of NPS-EN1).	The existing status of the water environment is outlined in Section 2.7, and the impacts on the water quality in relation to the Water Framework Directive (WFD) (Volume 5, Annex 2.2). Impacts from the proposed project on water quality and water resources water resources resulting from both the construction and operation are discussed in Table 2.9 or assessed in Section 2.11.
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 (paragraph 2.3.5 of NPS-EN3).	The predicted future baseline is considered in Section 2.8.1 which considers the future impact of climate change and increased risk of drought. The impact assessment in Section 2.11 concludes that there is little mechanism for operational impacts on water quality or resources resulting from Hornsea Four. Therefore, increased drought and higher temperatures will not act cumulatively with the project.
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 (paragraph 2.6.190 of NPS-EN3).	Construction impacts are examined in Section 2.11.1, Operational impacts are examined in Section 2.11.2, and Decommissioning impacts are addressed in Section 2.11.3.
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) (paragraphs 2.4.1 and 2.4.2 of NPS-EN5).	Flood vulnerability and resilience in relation to Hornsea Four infrastructure are considered in the FRA, which is provided in 6.2.2: Onshore Infrastructure Flood Risk Assessment. This addresses the likely vulnerability of the onshore substation (OnSS) to and from flooding.

2.3.1.3 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 PEIR
Hydrology and Flood Risk	
The [Secretary of State] 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	A flood risk assessment has been carried out, following the Sequential Test, and is set out in Section 2 of Volume 6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment, which

Summary of NPS EN-1 and EN-3 provisions	How and where considered in the PEIR
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 (paragraph 5.7.9 of NPS-EN1).	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 2, Chapter 6: Outline Onshore Infrastructure Drainage Strategy** and **Volume 6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment**, and specific commitments with regards to drainage, flood risk and flood resilience are outlined in **Table 2.10** (**Co14**, **Co18**, **Co19**, **Co28**, **Co157**).
The IPC 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 (paragraph 5.7.10 of NPS-EN1).	A flood risk assessment has been carried out and is set out in **Volume 6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment.** Hornsea Four's commitment to SuDS has also been provided in **Volume F2, Chapter 6: Outline Onshore Infrastructure Drainage Strategy**.
The IPC 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 satisfied that the Sequential and Exception Test requirements have been met (paragraph 5.7.13 – 5.7.17 of NPS-EN1).	A flood risk assessment has been carried out, following the Sequential and Exception Test, and is set out in **Volume 6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment**.
The IPC 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 (paragraph 5.15.5 of NPS-EN1).	The potential impacts of Hornsea Four on the water environment are discussed in detail in **Section 2.11**. In addition, a WFD Compliance Assessment has been produced, and is contained in **Annex 6, Annex 2.3: Water Framework Directive Compliance Assessment** which sets out that no adverse effects to WFD status are predicted to arise as a result of Hornsea Four.
The IPC 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 IPC (paragraph 5.15.6 of NPS-EN1).	The potential impacts of Hornsea Four on the water environment are discussed in detail **Table 2.9** in **Section 2.11** with the River Basin Management Plan considered in **Section 2.3.7**. In addition, a WFD Compliance Assessment has been produced, and is contained in **Volume 6, 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

Summary of NPS EN-1 and EN-3 provisions	How and where considered in the PEIR
	considered in **Volume 2, Chapter 1: Marine Geology, Oceanography and Physical Processes**.
The IPC 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 (paragraph 5.15.7 of NPS-EN1).	Further mitigation is outlined in the form of Commitments in **Table 2.10** and **Table 2.9** is also considered following the assessment of each impact in **Section 2.11** (**paragraph 2.11.1.14** and **2.11.1.15**).

2.3.1.4 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 Chapter and its supporting assessments (**Volume 6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment** and **Volume 6, Annex 2.3: Water Framework Directive Compliance Assessment**).The requirement for this PEIR in the context of national legislation is detailed within **Volume 1, Chapter 2: Planning and Policy Context** of this PEIR.

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.

2.3.3 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 directs development away from areas at highest risk of flooding via the application of the Sequential Test (paragraphs 018 – 022 and 033). 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).

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. Due to the fact that 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 onshore 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 Development Consent Order (DCO) application process. Consultation regarding Hydrology and Flood Risk (including all topics pertinent to the PEIR, Flood Risk Assessment and WFD Compliance Assessment) has been conducted through Hornsea Four Evidence Plan Meetings (attended by the Environment Agency, Lead Local Flood Authority (ERYC) and Internal Drainage Board), the Scoping Report (Ørsted, 2018), and consultation on the draft Report to Inform Appropriate Assessment (RIAA). An overview of the project consultation process are presented within **Volume 1, Chapter 6: Consultation**.

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 PEIR. A summary of consultation specific to hydrology and flood risk undertaken for the Hornsea Zone, which are applicable to Hornsea Project Four, are also set out below.

Table 2.3: Consultation Responses.

Consultee	Date, Document, Forum	Comment	Where addressed in the PEIR
ERYC Lead Local Flood Authority (LLFA); Yorkshire Consortium of	12 September 2018 Meeting 1 - Pre-scoping &	**Flood Risk Assessment and WFD Compliance Assessment** Representatives from the LLFA and the EA agreed with Hornsea Four that no FRA is required for the onshore	This position was updated following further consultation, and therefore a Flood Risk Assessment is provided in

Consultee	Date, Document, Forum	Comment	Where addressed in the PEIR
Internal Drainage Boards (IDB); Environment Agency (EA)	22 January 2019 Scoping Consultation Response & 15 January 2019 Meeting 2 – Post Scoping / Pre-PEIR	Export Cable Corridor (ECC) as watercourses will be avoided and no open cutting of IDB maintained drains will be undertaken. However, the area around the substation is of varied flood risk designation and there are significant areas of groundwater source protection zones around Cottingham. Therefore, it was agreed that an FRA is required for the substation area. Details of surface water management around the substation should be considered as early as possible and in accordance with the hierarchy of sustainable drainage. In addition, during initial consultation in 2018, the EA agreed with the principle of discounting a WFD compliance assessment, subject to future confirmation following further discussions. However, following further discussion the EA require some form of WFD compliance assessment to be completed even if using Horizontal Directional Drilling (HDD).	**Volume 6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment** and a WFD Compliance Assessment is provided in **Volume 6, Annex 2.3: Water Framework Compliance Assessment**. Hornsea Four's approach to drainage for all onshore infrastructure is considered in **Volume F2, Chapter 6: Outline Onshore Infrastructure Drainage Strategy** (Co19). Co14, Co124 and Co157 have also been made in relation to drainage.
PINS ERYC Lead Local Flood Authority; Yorkshire Consortium of Internal Drainage Boards; Environment Agency	23 November 2018 Scoping Opinion Section 4.14 15 January 2019 Meeting 2 – Post Scoping / Pre-PEIR & 5 April 2019 Meeting 3 – Post Scoping / Pre-PEIR	**Flood Risk Assessment** The Inspectorate and ERYC LLFA, Yorkshire Consortium of IDBs and the EA are not content to scope out the introduction of temporary impermeable areas during construction with respect to changes to land drainage and flood risk as significant effects may result from the construction compounds and access haul roads. Therefore, the ES should provide an assessment of flood risk associated with the construction of the cable corridor and changes to flood risk resulting from the proposed development. A comprehensive drainage strategy incorporating measures to prevent changes to volume and rate of run-off from the proposed development will be prepared and agreed in advance with the EA and LLFA and can be scoped out of the PEIR. It was recommended that an FRA should consider all potential sources of flood risk including fluvial, coastal, surface, groundwater and reservoir flooding alongside two key elements; (1) the sediment being washed in to watercourses, and (2) ensuring continued floodplain	A Flood Risk Assessment has been carried out and is provided as an annex in **Volume 6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment**. An outline drainage strategy is also provided in **Volume F2, Chapter 6: Outline Onshore Infrastructure Drainage Strategy.**

Consultee	Date, Document, Forum	Comment	Where addressed in the PEIR
		storage / conveyance during a flood event. Updated guidance on UKCP18 climate projection allowances published in Spring 2019 will be incorporated into the FRA when received.	
PINS	23 November 2018 Scoping Opinion Section 4.14 & 15 January 2019 Meeting 2 – Post Scoping / Pre-PEIR	***Impacts at Landfall*** *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.*	Impacts at landfall are addressed in **Table 2.9** of this chapter. Impacts from the landfall on flood risk include the use of open cut or HDD are considered in detail in the **Volume 6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment**. The effect of future coastal erosion on the proposed development is considered in **Volume 2, Chapter 1: Marine Geology, Oceanography and Physical Processes**.
PINS ERYC Lead Local Flood Authority; Yorkshire Consortium of Internal Drainage Boards; Environment Agency	23 November 2018 Scoping Opinion Section 4.14 & 15 January 2019 Meeting 2 – Post Scoping / Pre-PEIR & 22 January 2019 Scoping Consultation Response 5 April 2019 Meeting 3 – Post Scoping / Pre-PEIR	**Impacts Associated with the Crossing Methodology for Watercourses and Minor Drainage Features** *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 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.* *It is proposed that HDD should be used for all major watercourses to avoid significant effects as per Co1. Trenchless cable crossings can be scoped out of the PEIR as they do not directly impact on surface watercourses.* *The Inspectorate considers that if the proposed commitments are successfully implemented (including Co1), significant effects are unlikely, however*	All impacts are considered in **Section 2.11.Table 2.9** explains why certain impacts are scoped out. Co1 provides the Hornsea Four commitment to DD all main rivers and IDB maintained drains. The onshore Crossing Schedule which provides further detail and confirmation on the proposed crossing method for all crossings is provided in **Volume 4, Annex 4.2: Onshore Crossing Schedule**. Impacts to minor drainage features are scoped out as described in **Table 2.9**,

Consultee	Date, Document, Forum	Comment	Where addressed in the PEIR
		uncertainty remains regarding the design and successful implementation of the proposed mitigation. This is despite Co80 which states that a crossing schedule, including crossing methodology, will be defined and agreed with the relevant authorities. *Temporary crossing methods will be agreed with the appropriate consenting authority and agreed with landowners but will be avoided where possible. Yorkshire Consortium of IDBs noted that they would prefer trenchless crossings on all their water bodies.*	except for impacts associated with access track crossings which are discussed in **Section 2.11.1**. Further mitigation (Co124, Co172) is provided in **paragraphs 2.11.1.14** and **2.11.1.15**. Commitments are in, **Volume 4, Annex 5.2: Commitments Register** and summarised in **Table 2.10** with commitments to HDD beneath watercourses (Co1) given in **Volume 6, Annex 5.2: Commitments Register** and reflected in **Volume 4, Annex 4.2: Onshore Crossing Schedule**.
PINS ERYC Lead Local Flood Authority; Yorkshire Consortium of Internal Drainage Boards; Environment Agency	23 November 2018 Scoping Opinion Section 4.14 15 January 2019 Meeting 2 – Post Scoping / Pre-PEIR	**Impacts During Decommissioning** *The Inspectorate advises that the hydrological and flood risk effects associated with decommissioning of the substation cannot be scoped out of the ES due to uncertainty regarding the design and successful implementation of the proposed mitigation.* However. it was agreed that impacts associated with the onshore ECC decommissioning could be scoped out because the cables will be de-energised and left in-situ.	The effects related to decommissioning are scoped out, with a justification provided in **Table 2.9** (Co127). Decommissioning is also discussed in **Section 2.11.3** with further information provided in **Volume 1, Chapter 4: Project Description**.
PINS ERYC Lead Local Flood Authority; Yorkshire Consortium of Internal Drainage Boards; Environment Agency	23 November 2018 Scoping Opinion Section 4.14 15 January 2019 Meeting 2 – Post Scoping / Pre-PEIR &	**Impacts During Operation** *Although the Scoping Report does not request to scope operational impacts out, it is suggested in Paragraph 7.2.4.1 that 'standard protocols' can be implemented to control impacts. The Inspectorate suggests that these are included in the Commitment Register, the Code of Construction Practise (CoCP) and the draft DCO along with the reinstatement works that are identified in*	Standard protocols used as mitigation as provided in the Outline Code of Construction Practice (**Volume F2, Chapter 2**) (Co124). Related mitigation commitments have also

Consultee	Date, Document, Forum	Comment	Where addressed in the PEIR
	5 April 2019 Meeting 3 – Post Scoping / Pre-PEIR	*Co10. Due to the uncertainty remaining over the nature of the 'standard protocols' they cannot be scoped out, and operational impacts should be assessed where significant effects could occur.* In consultation with ERYC LLFA and Yorkshire Consortium of IDBs and EA it was proposed that operational impacts should be scoped out due to minimal operation and maintenance requirements. Impacts on flood risk associated with operational infrastructure are included in the FRA.	been provided in the form of Co4, Co6, Co10, Co13, Co64). Impacts during operation are discussed in **Table 2.9** and in **Section 2.11.2**. A Flood Risk Assessment has been carried out and is provided as an annex in **Volume 6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment**.
PINS ERYC Lead Local Flood Authority; Yorkshire Consortium of Internal Drainage Boards; Environment Agency	23 November 2018 Scoping Opinion Section 4.14 15 January 2019 Meeting 2 – Post Scoping / Pre-PEIR & 5 April 2019 Meeting 3 – Post Scoping / Pre-PEIR	**Designated Sites** *The Inspectorate notes that the Scoping Report makes no reference to the potential impacts, caused by changes to hydrological function and water quality, on designated sites. It is acknowledged that ecological and geological designations are proposed to be assessed in other relevant 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.* In addition, ERYC LLFA, Yorkshire Consortium of IDBs and the EA consider that potential impacts upon the hydrology, geomorphology and water quality of designated sites (including the River Hull Headwaters SSSI) should be given due consideration across all project phases. These impacts should be avoided through the use of trenchless crossing techniques. The Environment Agency offered advice on permitting certain activities that impact upon water bodies, and the requirement to consult with Natural England.	Designated Sites including the River Hull Headwaters SSSI with potential to be impacted are summarised in **Section 2.7** (**paragraphs 2.7.3.3** and **2.7.3.4**), with impacts being considered in **Section 2.11.1.** In addition, Designated Sites are discussed in **Chapter 3: Ecology and Nature Conservation.** Commitments are in **Volume 6**, **Annex 5.2: Commitments Register** and summarised in **Table 2.10.**
ERYC Lead Local Flood Authority; Yorkshire Consortium of Internal Drainage Boards;	22 January 2019 Scoping Consultation Response & 5 April 2019	**Other Flood Defence Works/COPFAS** There are currently no other flood defence works planned or LLA operated / maintained defences, other than those identified. ERYC LLFA noted that the Cottingham and Orchard Park Flood Alleviation Scheme (COPFAS) is still ongoing but is not within the	A Flood Risk Assessment, which includes consideration of COPFAS, has been carried out and is provided as an annex in **Volume 6, Annex 2.2:**

Consultee	Date, Document, Forum	Comment	Where addressed in the PEIR
Environment Agency	Meeting 3 – Post Scoping / Pre-PEIR	scoping boundary (although is close to the substation area) and will be complete in the timescales of the project (by the end of 2019). EA's flood risk maps have not been updated to reflect these yet and it is suggested that this information should be obtained.	**Onshore Infrastructure Flood Risk Assessment**.
ERYC Lead Local Flood Authority; Yorkshire Consortium of Internal Drainage Boards; Environment Agency	15 January 2019 Meeting 2 – Post Scoping / Pre-PEIR & 5 April 2019 Meeting 3 – Post Scoping / Pre-PEIR	**Impacts on Water Quality** It was agreed that potential impacts on water quality resulting from the mobilisation of soil and sediment and remobilisation of existing contaminants in the soil can be scoped out from further assessment provided that a commitment is made to adhere to relevant Pollution Prevention Guidance at the DCO stage.	These effects are scoped out, with justifications provided in **Table 2.9.** Contaminated land will be identified and addressed through **Volume 6, Annex 1.1: Land Quality Preliminary Risk Assessment** and the risks considered in **Chapter 1: Geology and Ground Conditions**. **Volume F2, Chapter 2: Code of Construction Practice** will set out measures to prevent contamination of water receptors.
ERYC Lead Local Flood Authority; Yorkshire Consortium of Internal Drainage Boards; Environment Agency	15 January 2019 Meeting 2 – Post Scoping / Pre-PEIR	**Assessment Methodology** The EA agreed with the proposed assessment methodology which proposed grouping receptors according to hydrological catchments (e.g. WFD river water body catchments) to carry out the impact assessment, rather than individual watercourses. Each watercourse will be assigned the highest value and sensitivity identified within its catchment. In addition, it was agreed that published guidance from the Ministry of Housing, Communities and Local Government and the Design Manual for Roads and Bridges (DMRB) would be used to define receptor value and sensitivity.	The Assessment Methodology is given in **Section 2.10.**
ERYC Lead Local Flood Authority; Yorkshire Consortium of	5 April 2019 Meeting 3 – Post Scoping / Pre-PEIR	**Code of Construction Practise (CoCP)** The Outline Code of Construction Practice will deal with soil generation and include mitigation measures such as soil capture. It will also include measures to	**Volume F2, Chapter 2: Code of Construction Practice** will aid in securing mitigation measures.

Consultee	Date, Document, Forum	Comment	Where addressed in the PEIR
Internal Drainage Boards; Environment Agency		control runoff and the supply of fine sediment and other contaminants.	
ERYC Lead Local Flood Authority; Yorkshire Consortium of Internal Drainage Boards; Environment Agency	15 January 2019 Meeting 2 – Post Scoping / Pre-PEIR	**Desk-Based Assessment** 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 EA flood risk data, historical flood incidents and local flood risk management strategy information from the LLFA and IDB. 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 PEIR chapter and WFD compliance assessment.	A desk-based assessment has been carried out as part of this assessment, the results of which are included in **Section 2.7**. A Flood Risk Assessment has been carried out, including a baseline environment section, and is provided as an annex in **Volume 6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment**.
ERYC Lead Local Flood Authority; Yorkshire Consortium of Internal Drainage Boards; Environment Agency	5 April 2019 Meeting 3 – Post Scoping / Pre-PEIR	**Field Based Assessment** It was agreed that a field-based assessment comprising a geomorphological walkover survey of all the main rivers and/or WFD water bodies along the cable route with confirmed land access should be undertaken with the aim of characterising the geomorphological form and function of watercourses and allowing the potential impacts of temporary crossings to be evaluated. Discussion took place about future surveys to survey, and verify the location of, land drainage features along the onshore project area (subject to landowner agreement) and provide basic information on physical characteristics.	The results of the geomorphological survey are summarised in **Section 2.7**. The Geomorphological Walkover Survey is detailed in **Volume 6, Annex 2.1: Geomorphological Baseline Survey Report**. Future surveys are addressed in the commitments in **Table 2.10** (Co14 and Co19).
ERYC Lead Local Flood Authority; Yorkshire Consortium of	15 January 2019 Meeting 2 – Post Scoping / Pre-PEIR	**Construction Method** The Yorkshire Consortium of Internal Drainage Boards explained that it is preferable that a 9m margin around	The construction method is included in **Volume 1, Chapter 3: Project Description** and Co18

Consultee	Date, Document, Forum	Comment	Where addressed in the PEIR
Internal Drainage Boards; Environment Agency		watercourses be maintained for HDD entry and exit pits, as well as link boxes. This is to allow tracked excavators undertaking works for the IDB and/or EA to access the watercourses. 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.	stipulates 9m entry and exist pit set backs. Bailey bridges and culverts used to cross watercourses are discussed in construction impacts in **Section 2.11.1** and the relevant commitments are provided in Co124 and Co127.

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 onshore components of the proposed development, including the landfall, the 80 m wide onshore Export Cable Corridor (ECC), the onshore substation (OnSS) and the 400 kV grid connection (**Figure 2.1**).

2.5.1.2 This study area was agreed with stakeholders, including the LLFA, Environment Agency and the Yorkshire Consortium of Drain Boards, during the second and third evidence plan meetings, in January and April 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 km^2 (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 the onshore project area. Impacts to water resources seaward of MHWS are considered within **Volume 2, Chapter 6: Marine Geology, Oceanography and Physical Processes**.

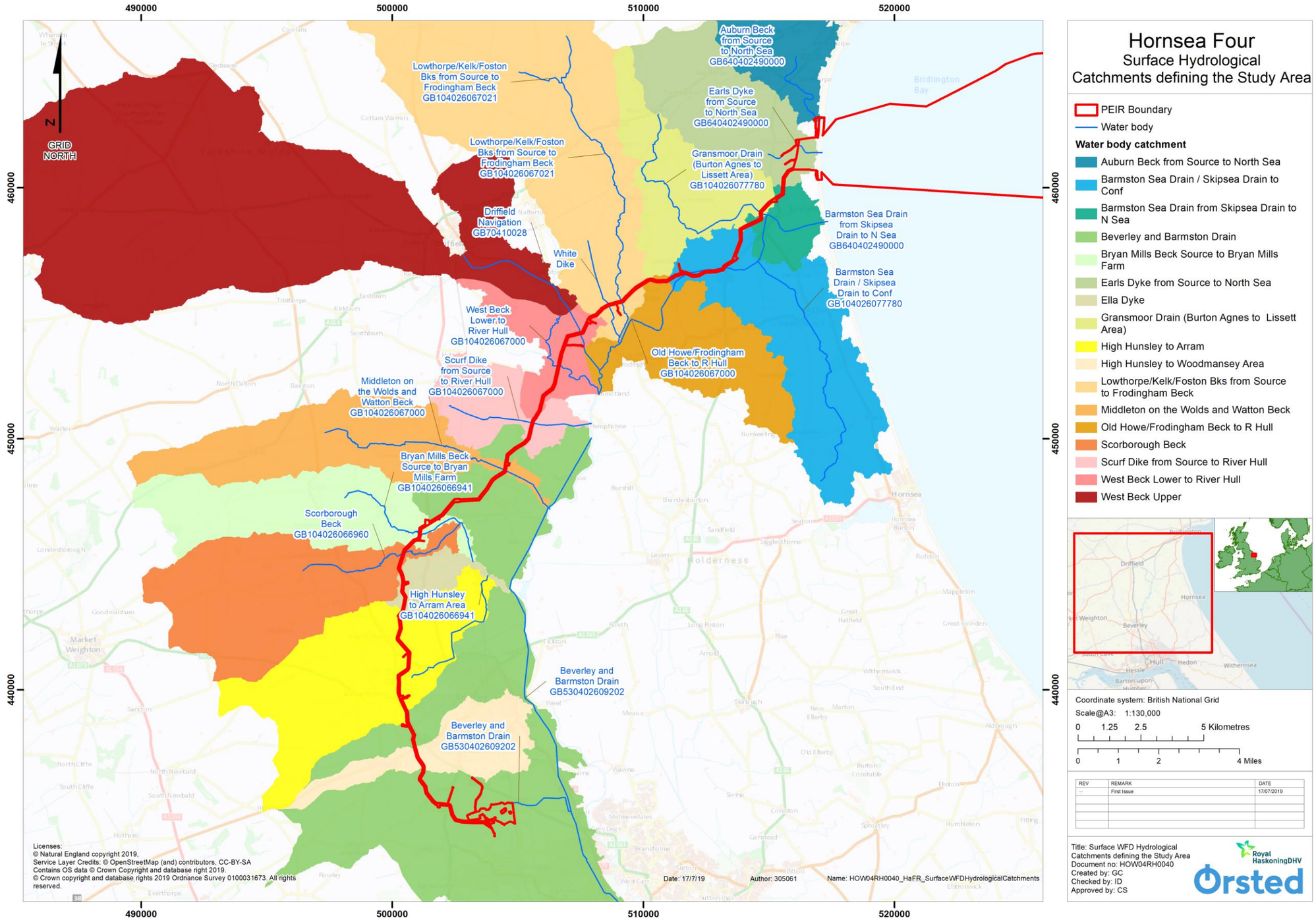


Figure 2.1: Study area, based on WFD water body catchments (Not to Scale).

2.6 Methodology to inform baseline

2.6.1.1 The assessment methodology and scope of baseline data and field surveys was agreed with stakeholders, including the LLFA, Environment Agency and the Yorkshire Consortium of Drain Boards, during the second and third evidence plan meetings 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 surface hydrological catchments that contain, or are hydrologically connected to, the Hornsea Four onshore survey area boundary through a detailed desktop review of existing studies and datasets.

2.6.2.2 The following sources of information in **Table 2.4** were consulted.

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

Source	Summary	Coverage of Hornsea Four development area
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 scoping boundary.
Department for Environment, Food and Rural Affairs (DEFRA)	MAGIC map (www.magic.defra.gov.uk)	Full coverage of the Hornsea Four onshore scoping boundary.
Natural England	Designated Sites (www.designatedsites.naturalengland.org.uk	Full coverage of the Hornsea Four onshore scoping boundary.
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 scoping boundary.
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; Hornsea Flood Mapping Study 2007);	Full coverage of the Hornsea Four onshore scoping boundary.
Environment Agency	Flood Map for Planning	Full coverage of the Hornsea Four onshore scoping boundary.

Source	Summary	Coverage of Hornsea Four development area
Environment Agency	Risk of Flooding from Surface Water	Full coverage of the Hornsea Four onshore scoping boundary.
Environment Agency	Risk of Flooding from Rivers and Sea	Full coverage of the Hornsea Four onshore scoping boundary.
Environment Agency	Habitat designations (e.g. for the River Hull Headwaters Site of Special Scientific Interest (SSSI)) and species data (detailed macrophyte, invertebrate, diatom and fisheries data) for WFD water bodies	Full coverage of the Hornsea Four onshore scoping boundary
LLFA – ERYC	Historic flood incident information relating to highway, surface water and / or drainage flooding and detailed information on COPFAS.	Full coverage of the Hornsea Four onshore scoping boundary

2.6.3 Site Specific Surveys

2.6.3.1 To inform the EIA, site-specific surveys were undertaken, as agreed with the Environment Agency during the consultation processes. A summary of surveys is outlined in **Table 2.5**, the locations of which can be found in **Volume 6, 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 development area
Hornsea Four Hydrology and Flood Risk Geomorphological Walkover March 2019 **Volume 6, Annex 2.1: Geomorphological Baseline Survey Report**	Characterising the baseline geomorphology of the key watercourses where survey access was possible, located within the Hornsea Four onshore project area.	Ten main rivers to be crossed by the proposed Hornsea Four onshore project area.

2.7 Baseline environment

2.7.1.1 The existing baseline environment of the Hornsea Four landfall, onshore ECC, onshore substation (OnSS) and 400 kV grid connection area 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**.

2.7.2 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 Lisset, 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, Scorborough 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 grid 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 – Figure 2.8. There are also a number of Internal Drainage Board (IDB) channels of importance which are also shown on Figure 2.2 – Figure 2.8. The Hornsea Four hydrology and flood risk study area passes through the Beverley and North Holderness IDB area, crossing 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 – 2.6).

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.	• 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.	• 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.	• 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.	• 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.	• East Field Drain • White Dike • Fisholme Drain

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.	• 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.	• Throstle Main Drain • Spring Dike • Kirby Drain • Kilnwick Arm • Beswick New Cut • Wilfholme Darm Drain • Beswick to Barfhill 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

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.	• 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 Scorborough where it bears northwest to meet the Bryan Mills Beck.	• 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.	• 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.	• Autherd Drain

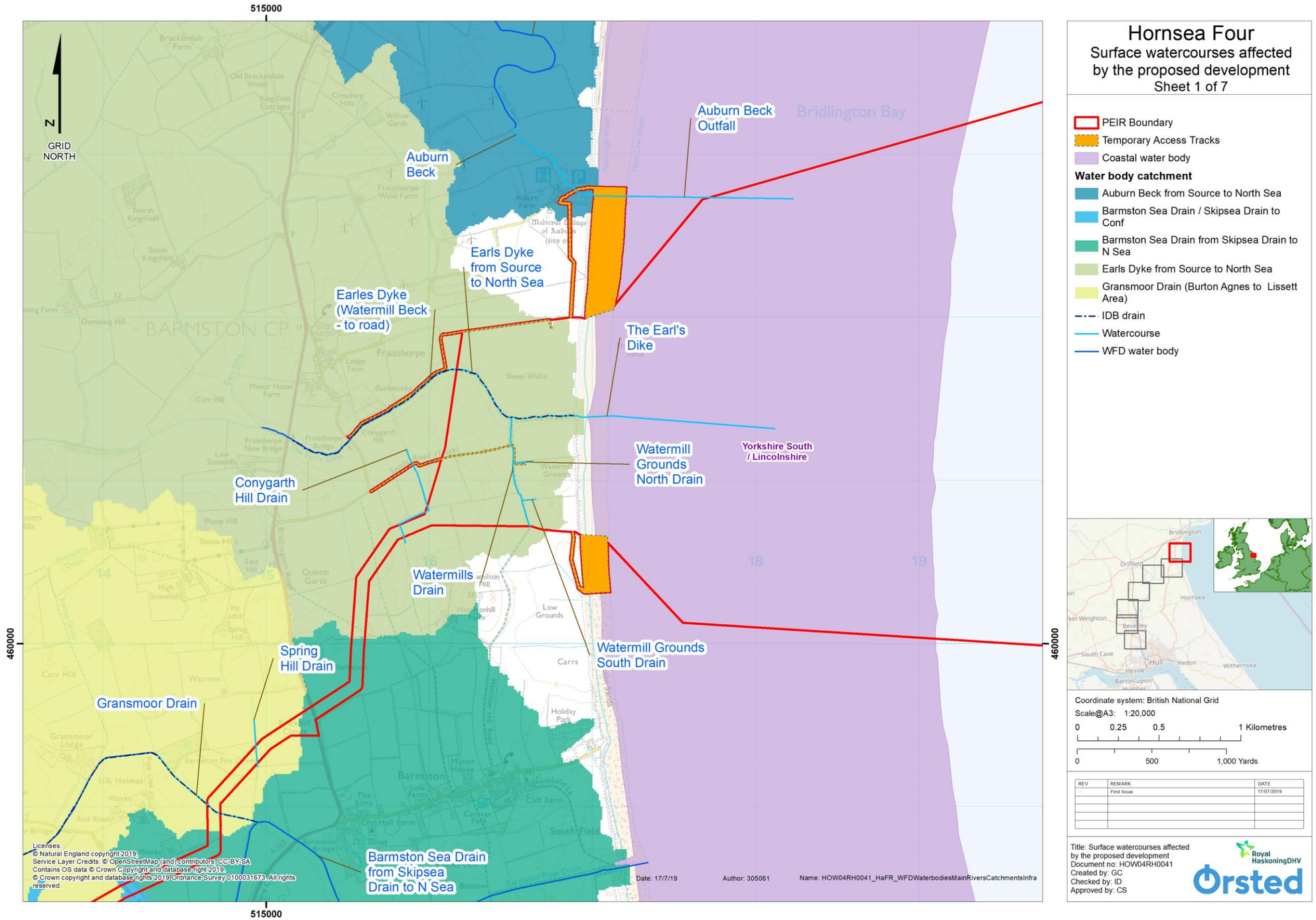
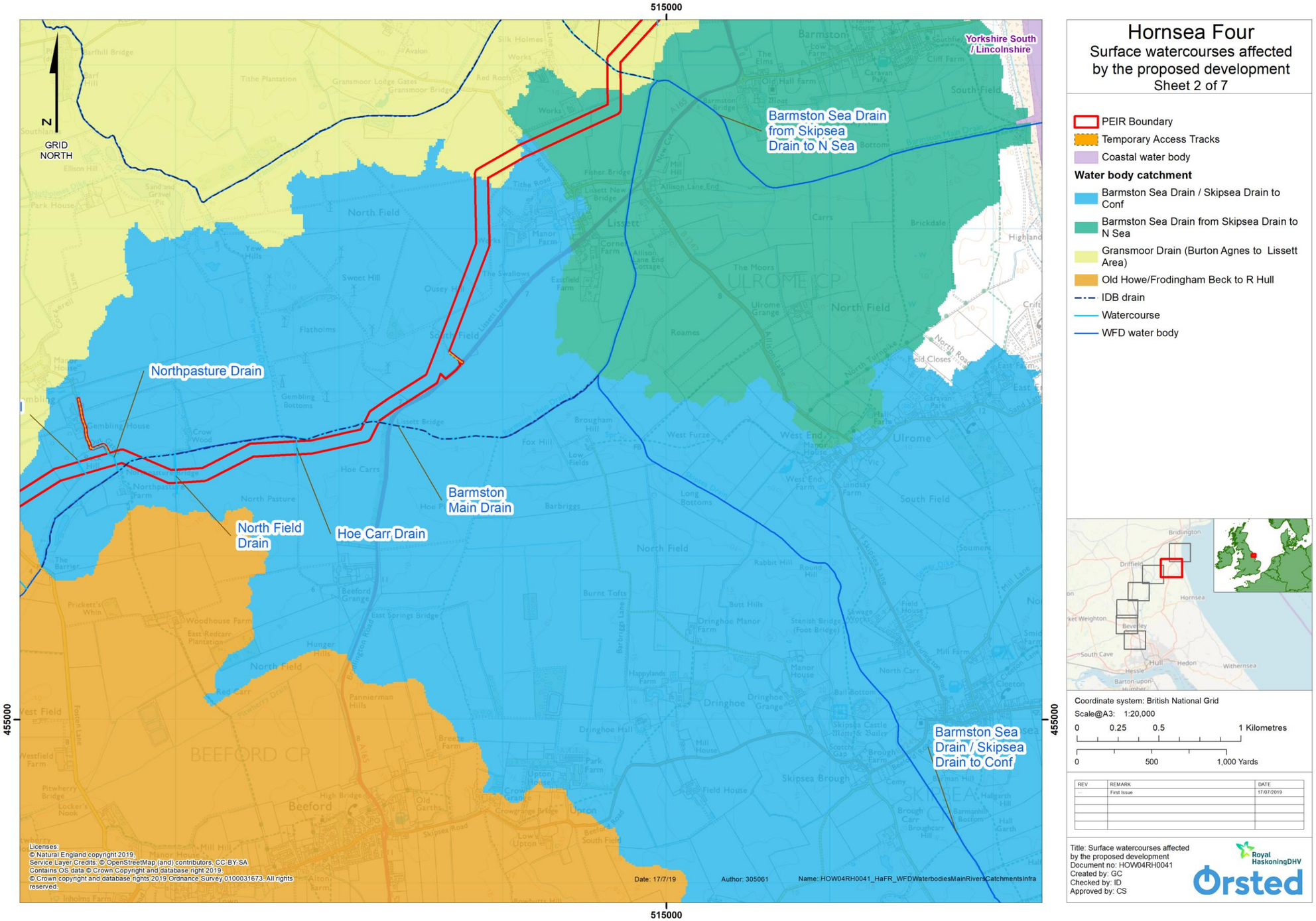


Figure 2.2: Surface water drainage features (Not to Scale).



Hornsea Four

Surface watercourses affected by the proposed development

Sheet 2 of 7

- PEIR Boundary
- Temporary Access Tracks
- 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
- IDB drain
- Watercourse
- WFD water body

Coordinate system: British National Grid

Scale@A3: 1:20,000

0 0.25 0.5 1 Kilometres

0 500 1,000 Yards

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-	First Issue	17/07/2019

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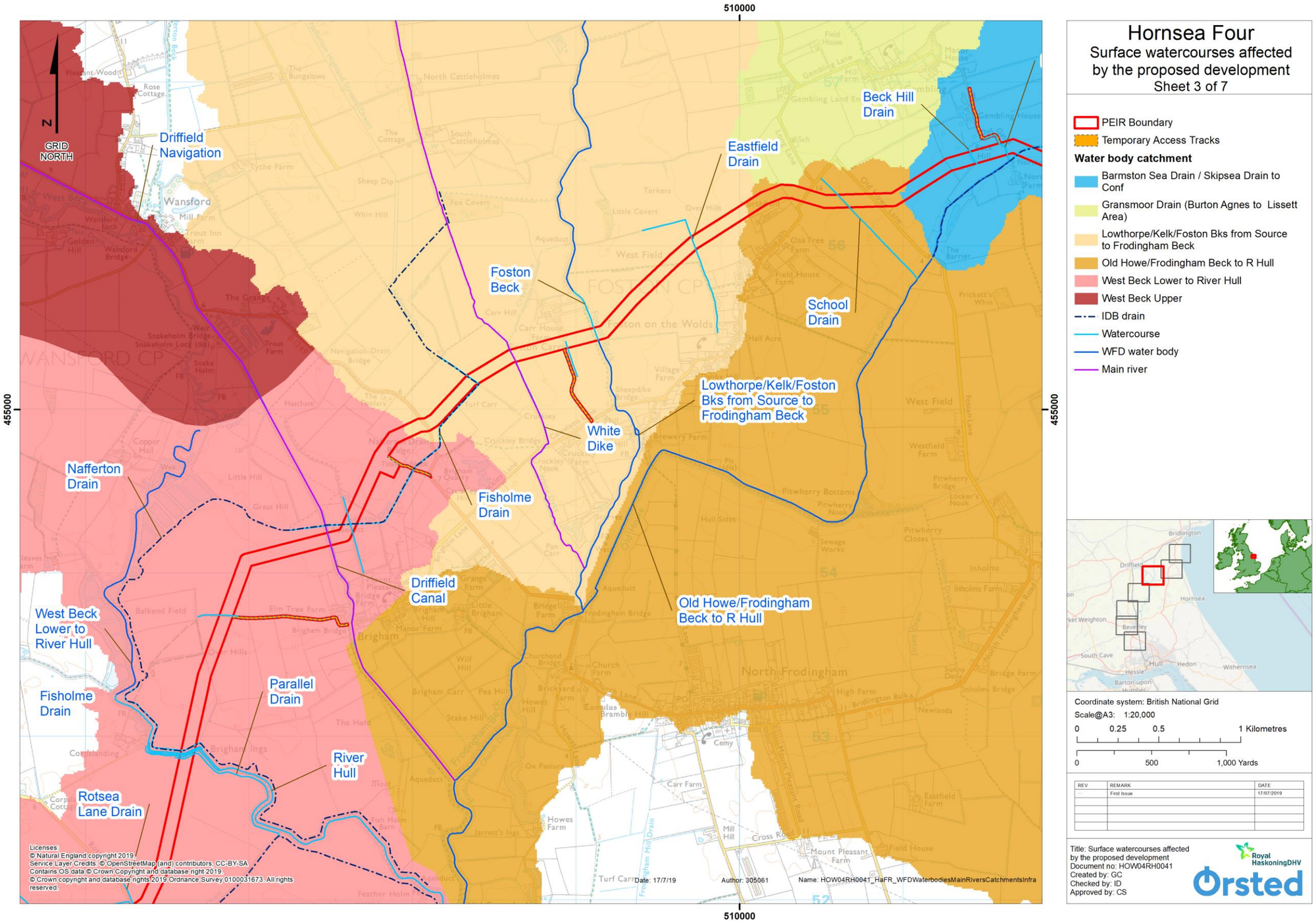
Figure 2.3: Surface water drainage features (continued) (Not to Scale).



Hornsea Four

Surface watercourses affected by the proposed development

Sheet 3 of 7

- PEIR Boundary
- Temporary Access Tracks

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
- IDB drain
- Watercourse
- WFD water body
- Main river

Coordinate system: British National Grid

Scale@A3: 1:20,000

0 0.25 0.5 1 Kilometres

0 500 1,000 Yards

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Figure 2.4: Surface water drainage features (continued) (Not to Scale).

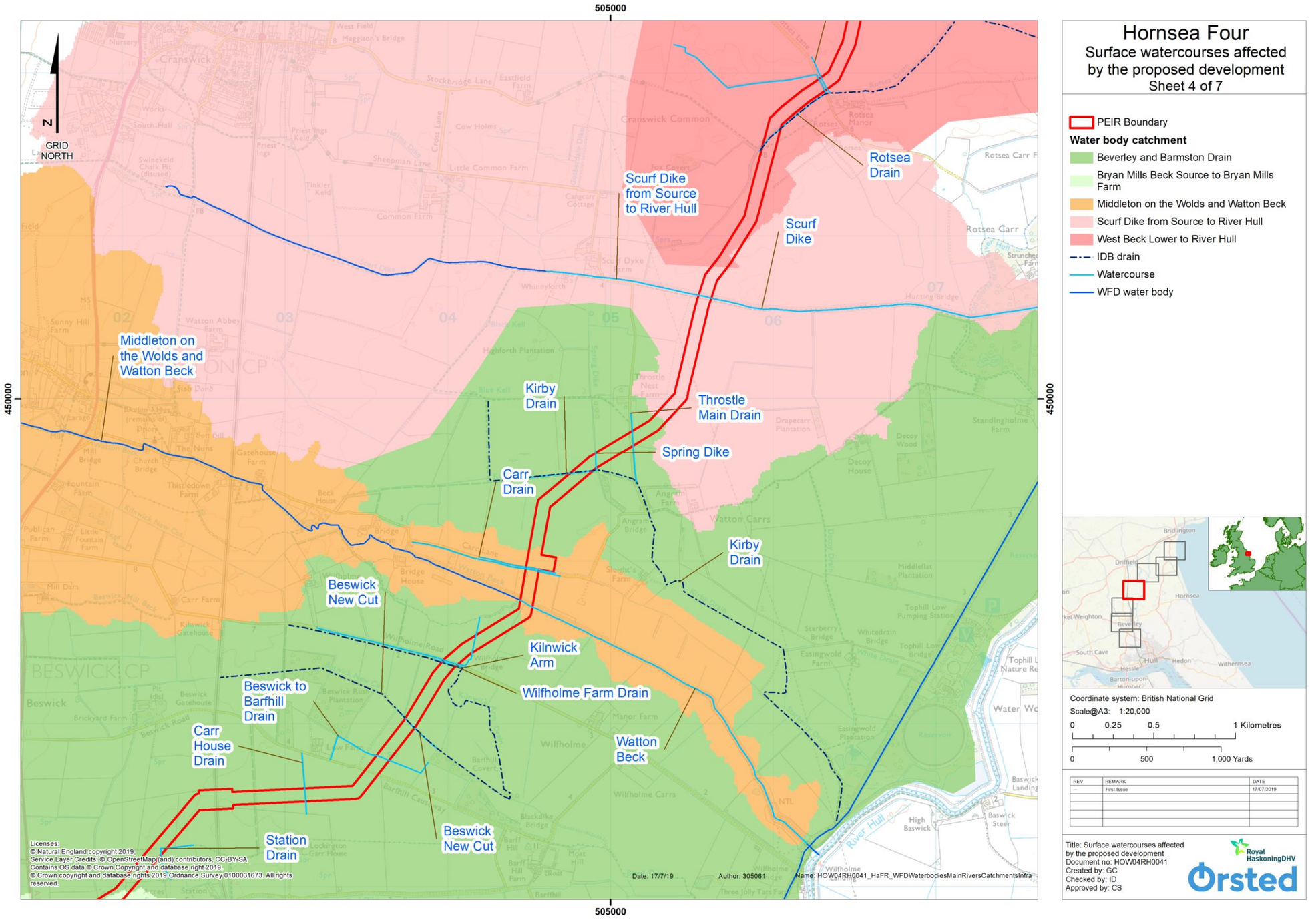
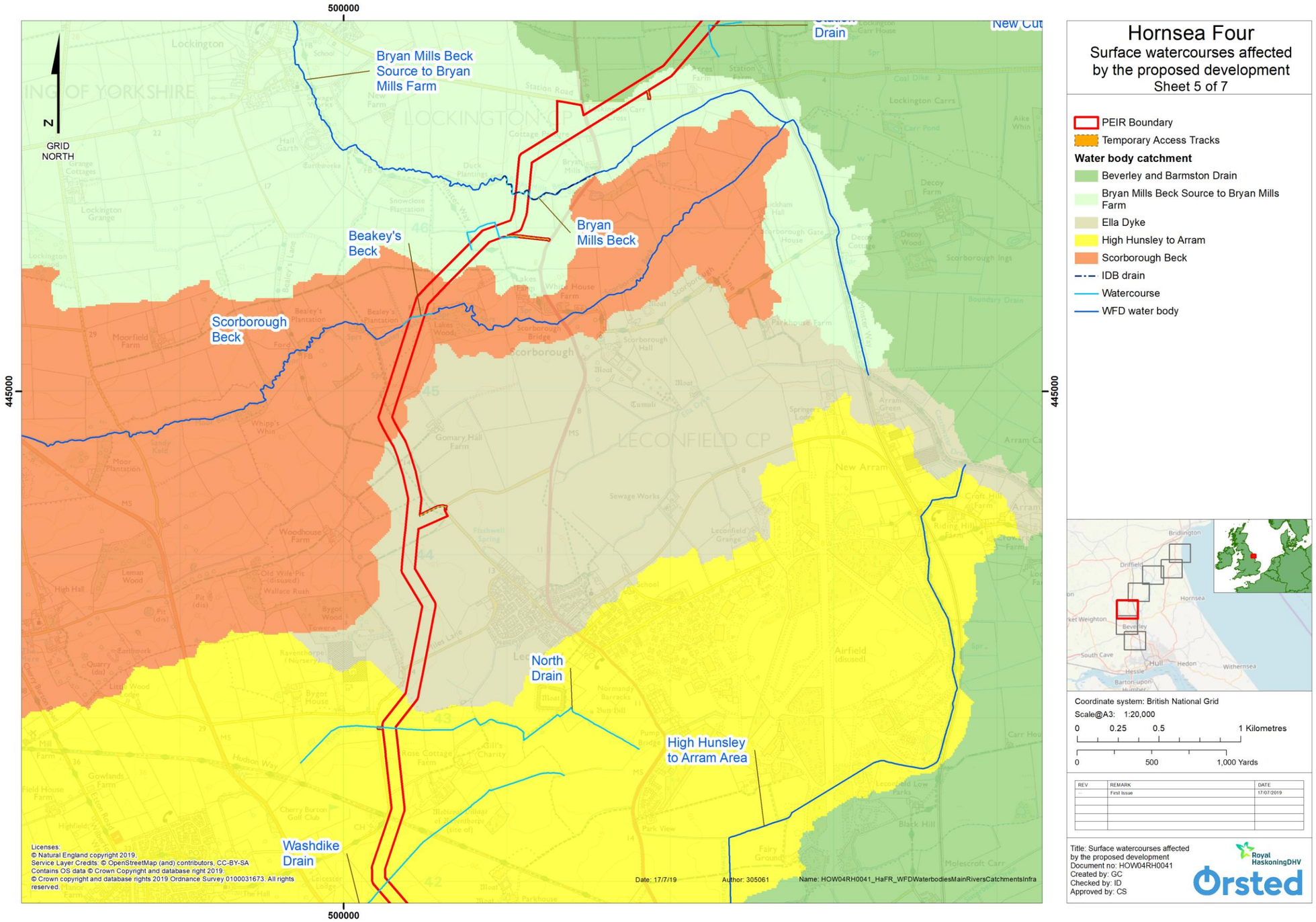


Figure 2.5: Surface water drainage features (continued) (Not to Scale).



Hornsea Four

Surface watercourses affected by the proposed development

Sheet 5 of 7

- PEIR Boundary
- Temporary Access Tracks

Water body catchment

- Beverley and Barmston Drain
- Bryan Mills Beck Source to Bryan Mills Farm
- Ella Dyke
- High Hunsley to Arram
- Scorborough Beck
- IDB drain
- Watercourse
- WFD water body

Coordinate system: British National Grid

Scale@A3: 1:20,000

0 0.25 0.5 1 Kilometres

0 500 1,000 Yards

REV	REMARK	DATE
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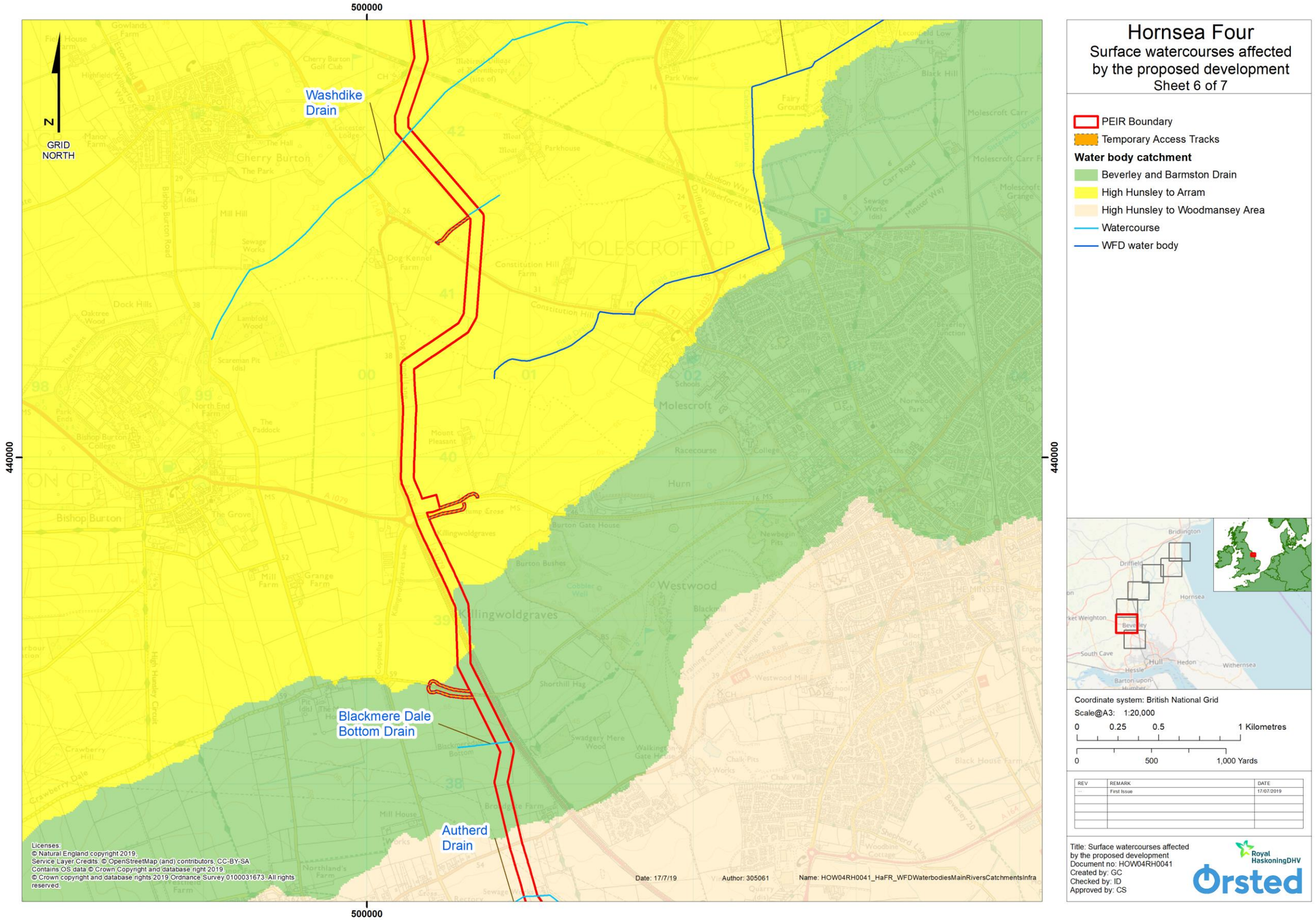
Figure 2.6: Surface water drainage features (continued) (Not to Scale).



Hornsea Four

Surface watercourses affected by the proposed development

Sheet 6 of 7

- PEIR Boundary
- Temporary Access Tracks

Water body catchment

- Beverley and Barmston Drain
- High Hunsley to Arram
- High Hunsley to Woodmansey Area
- Watercourse
- WFD water body

Coordinate system: British National Grid

Scale@A3: 1:20,000

0 0.25 0.5 1 Kilometres

0 500 1,000 Yards

REV	REMARK	DATE
--	First Issue	17/07/2019

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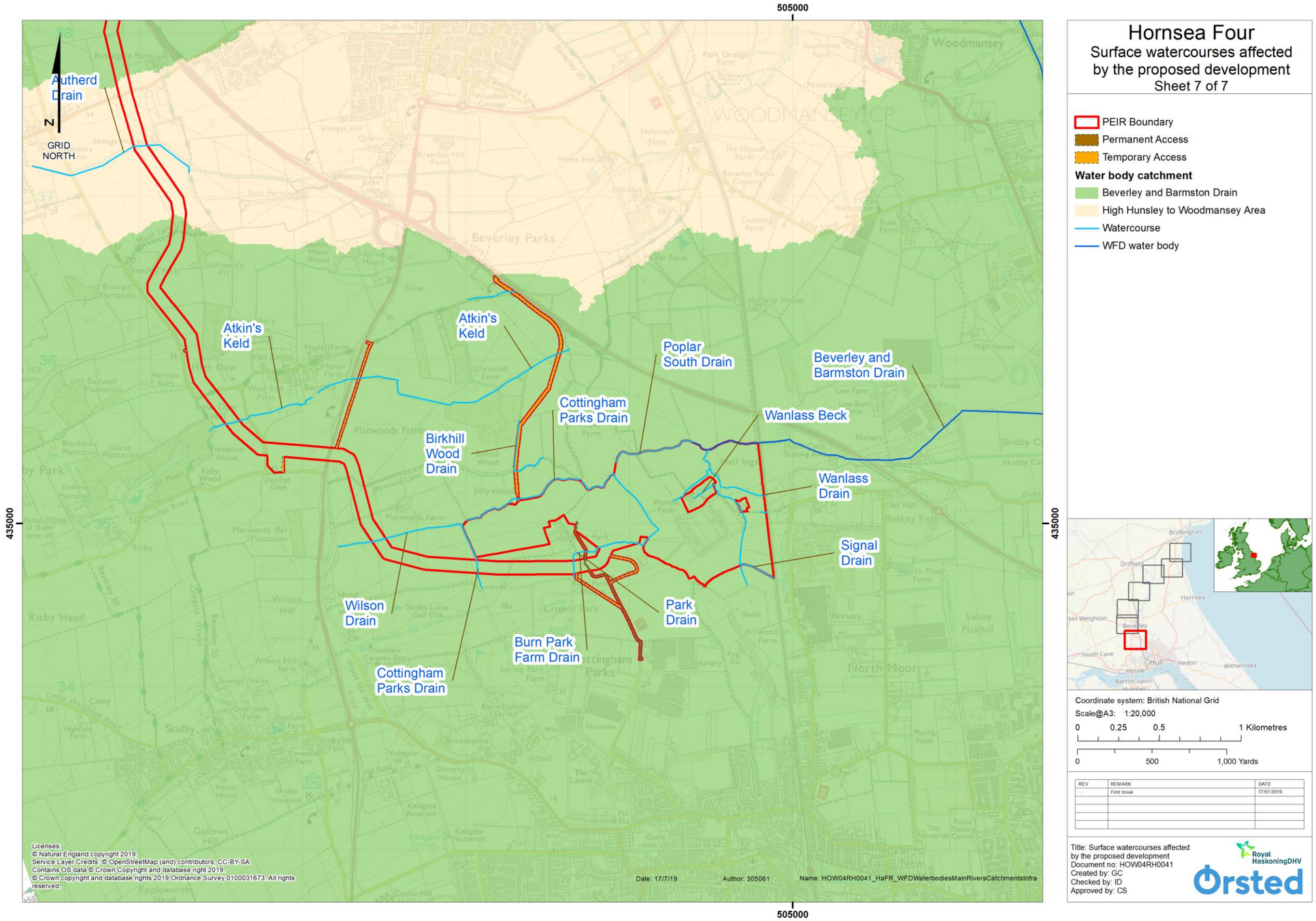
Figure 2.7: Surface water drainage features (continued) (Not to Scale).



Hornsea Four

Surface watercourses affected by the proposed development

Sheet 7 of 7

- PEIR Boundary
- Permanent Access
- Temporary Access

Water body catchment

- Beverley and Barmston Drain
- High Hunsley to Woodmansey Area
- Watercourse
- WFD water body

Coordinate system: British National Grid

Scale@A3: 1:20,000

0 0.25 0.5 1 Kilometres

0 500 1,000 Yards

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Figure 2.8: Surface water drainage features (continued) (Not to Scale).

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 onshore project area was undertaken in March 2019 (subject to access restrictions). 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 6, 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 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 course 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, undated 2) 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**.

2.7.3.4 The low-energy conditions observed in the majority of the watercourses in the 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 Eighteenth and Nineteenth centuries (Royal Haskoning, 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 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 Haskoning, 2010). Moreover, no significant evidence of vertical instability (i.e. incision) have been observed (Royal Haskoning, 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 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

Catchment	Watercourse	Geomorphological conditions at time of survey
		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 course 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 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.

Catchment	Watercourse	Geomorphological conditions at time of survey
	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 surface waters in the Hornsea Four hydrology and flood risk study area (i.e. in those catchments project activities would take place), as presented on the Catchment Data Explorer (Environment Agency, 2019) 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 metals are elevated in a large proportion of the Hornsea Four hydrology and flood risk study area.

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

Catchment	Watercourse	Water quality (Source: Environment Agency, 2019)
Barmston Sea Drain	Auburn Beck	Water quality in this catchment is reported to be good or high by the Environment Agency.
	Earls Dyke	The watercourse contains high levels of ammonia, high pH and high concentrations of copper and zinc. 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.
	Gransmoor Drain	Water quality is adversely affected by sewage discharges which result in elevated concentrations of phosphate and ammonia.
	Barmston Sea Drain	Water quality is adversely affected by sewage discharges which result in elevated concentrations of phosphate and ammonia.
	Skipsea Drain	Water quality is adversely affected by sewage discharges which result in elevated concentrations of phosphate and ammonia, high water temperatures and low dissolved oxygen concentrations.
River Hull (upper)	Frodingham Beck	High levels of manganese, copper, iron, mecoprop and zinc are recorded by the Environment Agency in this catchment.

Catchment	Watercourse	Water quality (Source: Environment Agency, 2019)
	Lowethorpe / Kelk / Foston Beck	High pH and elevated concentrations of ammonia, dissolved oxygen and phosphate are recorded by the Environment Agency in this catchment, as well as elevated concentrations of manganese, copper, iron and zinc. This appears to have resulted in a low fish population.
	Driffield Navigation	Water quality is identified as good by the Environment Agency.
	West Beck	High levels of manganese, arsenic, copper, iron and zinc are recorded by the Environment Agency in this catchment.
	Scurf Dike	Water quality is identified as good by the Environment Agency.
River Hull (lower)	Beverley and Barmston Drain	High concentrations of phosphate and low concentrations of dissolved oxygen are recorded by the Environment Agency.
	Watton Beck	High concentrations of ammonia and phosphate, elevated pH and temperature and low concentrations of dissolved oxygen are recorded by the Environment Agency.
	Bryan Mills Beck	High concentrations of ammonia and phosphate and elevated pH and temperature are recorded by the Environment Agency and attributed to sewage discharges and poor soil management.
	Scorborough Beck	Water quality is adversely affected by sewage discharges and poor soil management, which result in elevated concentrations of phosphate and ammonia, high pH and low dissolved oxygen concentrations.
	Ella Dyke	Water quality is adversely affected by sewage discharges, which result in elevated concentrations of copper, phosphate and ammonia and high biochemical oxygen demand, pH and temperature.
	High Hunsley to Arram Area	High concentrations of ammonia and phosphate and elevated pH and temperature are recorded by the Environment Agency.
	High Hunsley to Woodmansey Area	Water quality is identified as good by the Environment Agency.

2.7.5 Flood risk

2.7.5.1 The Environment Agency online Flood Map for Planning (EA, undated) and Product 4 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 (3.5 ha or 6% of the landfall site) and 3 (2.9 ha or 5% of the landfall site) due to the proximity of Earl's Dike. 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 be at risk from flooding. Design principles e.g. dewatering and / or cofferdams are proposed, should there be a need to adopt open cut installation, to ensure that there is no increase in flood risk during the construction works. The landfall logistics compound is temporary in nature and therefore would not be subject to 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 (80 ha in total, or 22% of the ECC) and 3 (60 ha in total, or 17% of the ECC). 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 related to temporary water crossings will be developed to limit this risk. Once operational there will be no flood risk posed to the onshore ECC from fluvial, tidal, surface or sewer flooding. A residual risk of flooding from groundwater shall be mitigated through the use of suitable waterproofing of the cable duct.

2.7.5.3 The OnSS is primarily located within Flood Zone 1 (80% of the total area), 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.

2.7.5.4 The 400 kV onshore ECC 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 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.

2.7.5.5 During the construction works any temporary damming and re-routeing of watercourses along the onshore ECC will be designed such that the original flow volumes and rates are maintained to ensure flood risk is not increased. Post-construction, watercourses will be reinstated to pre-construction depths to ensure flood risk is not affected.

2.7.5.6 A more detailed description of the baseline flood risk associated with the Hornsea Four hydrology and flood risk study area is provided in **Volume 6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment**. It concludes 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. Following construction there will be no risk to the onshore infrastructure associated with the onshore ECC.

2.7.6 Designated sites

2.7.6.1 A brief 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 and willow carr, and areas of riverside grassland and fen (Natural England, undated 3). 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, undated 4). 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 internationally important numbers of waterfowl the estuary supports in winter, and nationally important breeding populations of a variety of bird species (Natural England, undated 5) (JNCC, 2007).

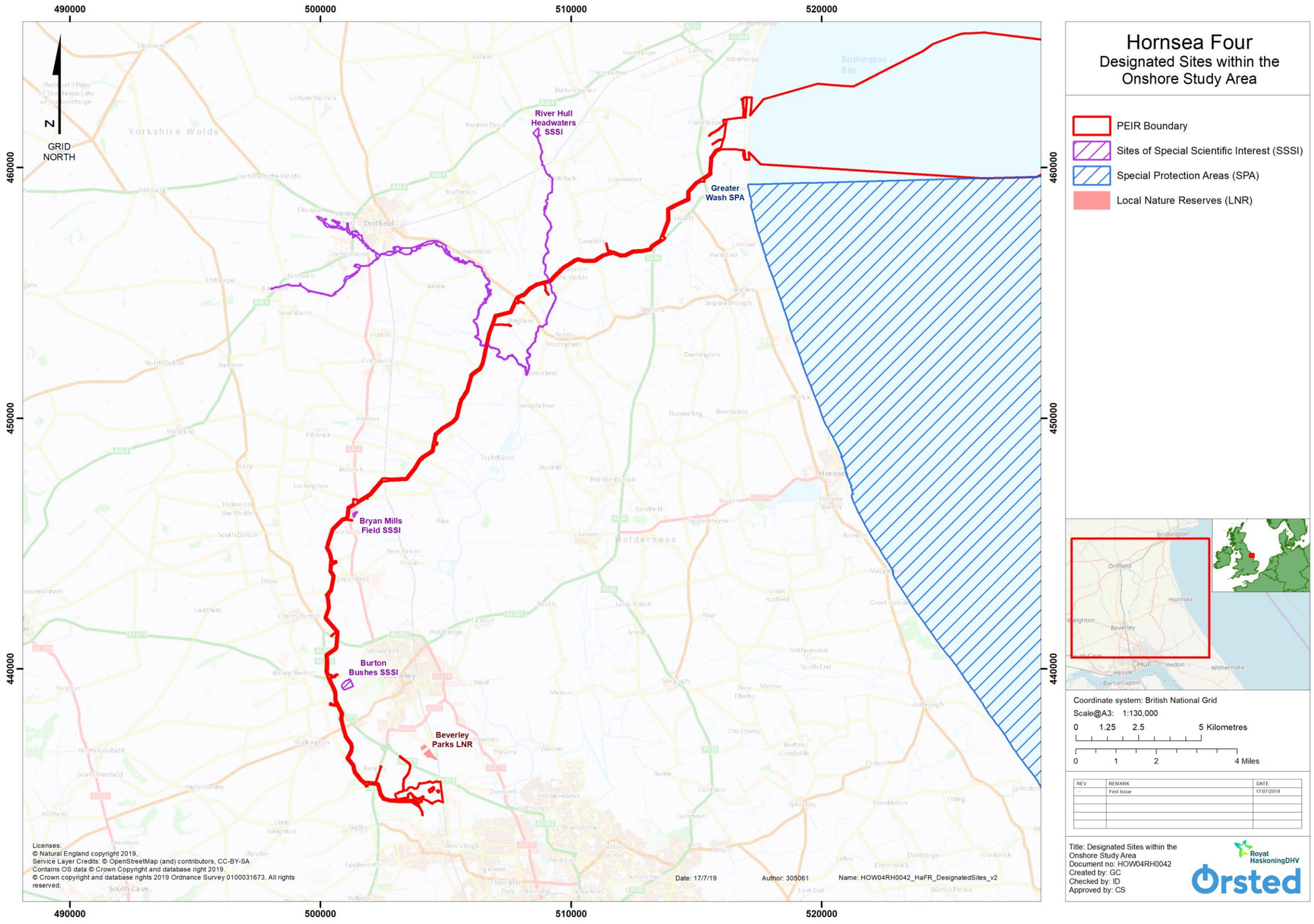


Figure 2.9: Designated Sites within the Onshore Study Area (Not to Scale).

2.7.7 Data limitations

2.7.7.1 With the exception of the results of the geomorphological walkover survey (**Table 2.5**), the data used to inform the assessment have largely been obtained from archive sources (**Table 2.4**). 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 have changed since the data were 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).

2.7.7.2 The results of the geomorphological walkover survey (**Volume 6, 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 aerial photography and current and historical Ordnance Survey mapping of each area was undertaken prior to the field survey to provide broader contextual information and ensure that each survey reach was sufficiently broad (i.e. greater than the area that could be directly affected by the proposed project) to provide an accurate representation of prevailing geomorphological characteristics. Hornsea Four is also planning to undertake more detailed watercourse surveys of key watercourses in August and September 2019.

2.7.7.3 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 not identified any significant concerns that the assessment of environmental impacts presented in this PEIR chapter is based on obsolete data that do not accurately reflect baseline conditions.

2.8 Project basis for assessment

2.8.1 Predicted future baseline

2.8.1.1 The baseline review presented in Section 2.7 demonstrates that the majority of the surface watercourse catchments with 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 in the environment, could potentially limit the improvements that are achieved within the project lifetime.

2.8.1.2 Predicted climate changes are likely to result in wetter winters, drier summers 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). It is therefore unlikely that significant geomorphological changes will occur during the operational life of the project.

2.8.1.3 Ongoing initiatives to improve the geomorphology and in-channel habitats of the surface drainage network is being undertaken by the Environment Agency, Natural England and partner organisations such as the East Yorkshire Rivers Trust (EYRT) (including initiatives to restore geomorphological functionality and in-channel habitats in Lowthorpe Beck and the Driffield Trout Stream (EYRT, 2019) to meet WFD status targets and to ensure that designated sites reach target condition, mean that localised geomorphological conditions are likely to improve in the future, within the constraints presented by the low energy, low gradient nature of the drainage network.

2.8.1.4 The risk of flooding will be amplified as a result of the predicted increase in rainfall associated with climate change, 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 6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment.

2.8.2 Impact register and impacts "scoped out"

2.8.2.1 Based on the baseline environment, the project description outlined in Volume 1, Chapter 4: Project Description and the Commitments in Volume 4, Annex 5.2: Commitments Register, a number of impacts are proposed to be "scoped out" of the PEIR assessment in relation to

hydrology and flood risk because they are not considered to result in significant effects. This is to ensure that the assessment of impacts on hydrology and flood risk remains proportional. These impacts are outlined, together with a justification for scoping them out, in **Table 2.9**. Further detail is provided in **Volume 4, Annex 5.1: Impacts Register**.

2.8.2.2 Please note that the term "scoped out" relates to the Likely Significant Effect (LSE) in EIA terms and not "scoped out" of the EIA process *per se*. All impacts "scoped out" of LSE are assessed for magnitude, sensitivity of the receiving receptor and conclude an EIA significance in the Impacts Register (see **Volume 4, Annex 5.1**). This approach is aligned with the Hornsea Four Proportionate approach to EIA (see **Volume 1, Chapter 5: EIA Methodology**).

2.8.2.3 The assessments of any likely significant effects are assessed in **Section 2.11**.

Table 2.9: Hydrology and flood risk impact register.

Project activity and impact	Likely significance of effect	Approach to assessment	Justification
Disturbance of watercourses: Construction phase: Works associated with the installation of cables across Main Rivers and IDB maintained watercourses may result in a reduction in water quality and channel hydro-morphology. (HFR-C-1)	No likely significant effects	Scoped out	Trenchless techiques will be adopted to cross all major watercourses along the cable route including main rivers, IDB maintained drains (Commitment (Co) 1 in **Volume 4, Annex 5.2: Commitments Register**). The entry and exit points will be located at least 9 m away from surface watercourses and the cabling will be installed at least 1.2 m beneath the watercourses (Co18) to minimise the likelihood of interaction. 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 2.7.3**) 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. Note that potential impacts associated with temporary access crossings are assessed in **Section 2.11.1**.
Disturbance of minor drainage ditches: Construction phase: Works associated with of the installation of cables across minor	No likely significant effects	Scoped out	Minor drainage features will be crossed using an open trench technique following a methodology agreed in advance with the relevant consenting authority and developed in consultation with land owners once detailed land drainage surveys have been undertaken (Co14 and Co19). This will include details of the temporary works, including measures to

Project activity and impact	Likely significance of effect	Approach to assessment	Justification
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)			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**). 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 instated to their pre-construction condition (Co172). These will prevent non-temporary effects on minor drainage features. Further details are provided **Volume 4, Annex 5.2: Commitments Register**. Note that potential impacts associated with temporary access crossings are assessed in **Section 2.11.1**.
Disruption of local land drainage: Construction phase: Works associated with cable installation leading to impacts on the integrity of the local land drainage systems and potential flooding. (HFR-C-5)	No likely significant effects	Scoped out	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**). 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 Lead Local Flood Authority (LLFA) and the EA (Co14). Further details are provided **Volume 4, Annex 5.2: Commitments Register**.
Changes in water quality: Construction phase: Works associated with cable installation leading to impacts on the water quality of watercourses and drainage systems local to the works. (HFR-C-6)	No likely significant effects	Scoped out	A Construction Method Statement (CMS) will be developed as part of the Code of Construction Practice and secured as a certified document within the DCO. This is secured through the Outline Code of Construction Practice (CoCP) (Co124) (**Volume F2, Chapter 2**). The CMS will adhere to construction industry good practice guidance (e.g. the Environment Agency's Pollution Prevention Guidance notes, including PPG01, PPG05, PPG08 and PPG21 (which remain best practice despite no longer being statutory guidance) and CIRIA's 'Control of water pollution from construction sites: Guidance for consultants and contractors'), to include specific measures to prevent contamination of water receptors during construction (Co4). Guidance on

Project activity and impact	Likely significance of effect	Approach to assessment	Justification
			pollution prevention will also be adhered to (Co6). The CoCP (**Volume F2, Chapter 2**) will involve measures to ensure there is no increase in the supply of fine sediment and other contaminants (e.g. from construction materials and machinery), including: • Guidance 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; • Avoidance of oil storage within 50 m of a spring, well or borehole; • Storage of oil where it could run over hard ground into a watercourse; • 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. • Control of Water Pollution from Construction Sites – Guidance for Consultants and Contractors CIRIA (C650); • Use of CIRIA – SuDS Manual (CIRIA, 2015); No discharge to surface watercourses will occur without permission from the Environment Agency (SuDS Manual); wheel washers and dust suppression measures to be used as appropriate to prevent the migration of pollutants (SuDS Manual); regular cleaning of roads of any construction waste and dirt to be carried out (SuDS Manual); and
Mobilisation of pollutants in the event of disturbance of contaminated soils: Construction phase: Works associated with construction of the cable and substation may mobilise contaminants into surface water runoff	No likely significant effects	Scoped out	Impacts relating to disturbance of contaminated ground (the location of which will be identified as part of a Phase 1 Preliminary Risk Assessment (PRA)) will be 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; and specific measures will be included in the CMS (part of 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 Pollution Prevent Plan will also be developed, to

Project activity and impact	Likely significance of effect	Approach to assessment	Justification
from the site. (HFR-C-8)			include adherence to good practice guidance (Co4). The outline CoCP (**Volume F2, Chapter 2**) also includes measures to: • Follow 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; • 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.
Hydrological and water quality effects on designated sites: Construction phase: Ground disturbance during construction could increase the supply of sediment and contaminants to the River Hull SSSI and change its hydrology. (HFR-C-12)	N/A	Scoped out	Trenchless crossing techniques will be adopted to allow the cable to cross all major watercourses along the cable route, including the River Hull Headwaters SSSI. The entry and exit points will be located a suitable distance away from the river channel (at least 9 m; Co18 in **Volume 4, Annex 5.2: Commitments Register**) and the cabling will be installed a suitable distance beneath the watercourses (at least 1.2 m; Co18) 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. Because trenchless cable crossings will not themselves directly interact with surface watercourses, they are proposed to be scoped out. Further information regarding crossing techniques will be provided in the Crossings Schedule and Commitments Register. Note that potential impacts associated with temporary access crossings on SSSI watercourses are assessed

Project activity and impact	Likely significance of effect	Approach to assessment	Justification
			alongside potential impacts on non-designated watercourses in Section 2.11.1. It is also proposed that, due to the measures set out in the CMS (part of the CoCP, a certified document within the DCO) to control the supply of fine sediment and other contaminants into surface watercourses and groundwaters, potential impacts on water quality in designated sites will also be scoped out. The outline CoCP will be provided to support the PEIR. Further details are provided in Volume 4, Annex 5.2: Commitments Register.
Alteration in run-off characteristics at substation site: Operational phase: 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)	Likely significant effects without secondary mitigation	Scoped out	An operational drainage strategy will be prepared as a certified document to support the DCO application. This sets out the performance requirements of the site drainage system that are necessary to ensure that there are no changes to the surface runoff resulting from the substation development. This will be agreed with the LLFA and the EA. This is secured through Volume F2, Chapter 6: Outline Onshore Infrastructure Drainage Strategy (Co19).
Impacts associated with operation: Operational phase Operational activities at the substation site and along the cable route could disturb watercourses and affect water quality. (HFR-O-11)	No likely significant effect	Scoped out	Potential impacts on water quality during operation are scoped out of the 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 will be provided in the Volume 1, Chapter 4: Project Description to demonstrate that there will be no impacts on water quality. 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).
Thermal impacts on water resources: Operational Phase	No likely significant effect	Scoped out	Potential impacts on water temperature during operation are scoped out of the 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 not

Project activity and impact	Likely significance of effect	Approach to assessment	Justification
Thermal effects of the underground power cables along the cable route could potentially impact upon the temperature of surface waters at watercourse crossings. (HFR-O-13)			significant. The optimal clearance depth beneath watercourses will be agreed with the relevant authorities prior to construction. Further details are provided in Co18 in **Volume 4, 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**.
Impacts associated with decommissioning of the cable route: Decommissioning phase Works associated with decommissioning of the cable. (HFR-D-9)	No likely significant effects	Scoped out	Buried cables will be de-energised with the ends sealed and left in place, therefore no ground disturbance is required (see **Volume 1, Chapter 4: Project Description** for further details). All project mitigation and commitments apply for decommissioning and a decommissioning plan will be developed in line with the latest relevant available guidance (Co127).
Impacts associated with the decommissioning of the Hornsea Four substation: Decommissioning phase Works associated with decommissioning of substation. (HFR-D-10)	No likely significant effect	Scoped out	Potential impacts resulting from decommissioning of the substation are considered to be equal to, or less than construction-stage impacts. All above ground infrastructure will be removed and the land reinstated (see **Volume 1, Chapter 4: Project Description** for further details). All project mitigation and commitments apply for decommissioning and a decommissioning plan will be developed in line with the latest relevant available guidance (Co127).

Notes:
Grey – Potential impact is scoped out and both PINS and Hornsea Four agree.
Red – Potential impact is scoped out with no consensus between PINS and Hornsea Four at EIA Scoping.

2.8.3 Commitments

2.8.3.1 Hornsea Four has secured several Commitments which include primary design principles inherent as part of the project, installation techniques and engineering designs/modifications as part of their pre-application phase, to eliminate a number of impacts or reduce impacts as far as possible. Further Commitments (adoption of best practice guidance) are embedded as an inherent aspect of the EIA process and will be secured through the DCO process. These can be found in **Volume 4, Annex 5.2: Commitments Register**.

2.8.3.2 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 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.	DCO Requirement 16 (Code of construction practice)
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 16 (Code of construction practice)
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 16 (Code of construction practice)
Co7	Primary: The temporary work area associated with onshore export cable corridor will be 80m working width to minimise the construction footprint, except the Network Rail Crossing near Beswick where the footprint is extended to 120m to facilitate HDD of the railway line. The permanent onshore export cable corridor width will be 60m except the Network Rail Crossing near Beswick where the footprint is extended to 120m to facilitate HDD of the railway line.	DCO Works Plan - Onshore
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 16 (Code of construction practice)

Commitment ID	Measure Proposed	How the measure will be secured
		DCO Requirement 19 (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 ensure that groundwater quality is not affected and detailed within the Pollution Prevention Plan (PPP) (Co4) to prevent changes to chemical quality, and the use of thermally insulated Direct Current cables to prevent effects on groundwater temperature). Furthermore, measures to ensure that the cable trench does not become a conduit for groundwater flow will also be implemented (e.g. ensuring that backfill is sufficiently compacted and has the same transmissivity as adjacent undisturbed material). Appropriate measures will be identified following consultation with the Environment Agency and will be reported within the CoCP (Co124). This will be in line with the requirements of Section 23-25 of the Land Drainage Act 1991, or the latest relevant available guidance.	DCO Requirement 16 (Code of construction practice)
Co14	Tertiary: A Construction Drainage Scheme will be developed for the temporary construction works, to ensure that existing land drainage is maintained during construction. Specific drainage measures for each area of land will be specified 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, Environment Agency and relevant Internal Drainage Board.	DCO Requirement 12 (Surface and foul water drainage)
Co18	Secondary: HDD entry and exit points will be located at least 9 m away from surface watercourses and the onshore export cable will be installed at least 1.2 m beneath the bed of any watercourses. The optimal clearance depth beneath watercourses will be agreed with the relevant authorities prior to construction. Where Hornsea Four crosses sites of particular sensitivity (e.g. SSSIs) a hydrogeological risk assessment will be undertaken to inform a site specific crossing method statement which will also be agreed with the relevant authorities prior to construction.	DCO Requirement 16 (Code of construction practice)
Co19	Tertiary: An Onshore Infrastructure Drainage Strategy will be developed for the permanent operational development along the onshore cable corridor and the onshore substation, and will include measures to ensure that existing land drainage is reinstated and maintained, and measures to limit discharge rates and attenuate flows such that pre-development run-off rates to surrounding land are retained. The Onshore Infrastructure Drainage Strategy will be developed in consultation with the Environment Agency, Lead Local Flood Authority and relevant Internal Drainage Board as appropriate.	DCO Requirement 12 (Surface and foul water drainage)

Commitment ID	Measure Proposed	How the measure will be secured
Co25	Primary: The onshore export cable corridor 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 16 (Code of construction practice) DCO Requirement 19 (Restoration of land used temporarily for construction)
Co64	Tertiary: Topsoil and subsoil will be stored in separate stockpiles in line with DEFRA 2009 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). No material will be stockpiled within the floodplain of any watercourse.	DCO Requirement 16 (Code of construction practice) DCO Requirement 13 (Contaminated land and groundwater scheme)
Co65	Tertiary: A Site Waste Management Plan (SWMP) will be developed with consideration of the latest relevant available guidance.	DCO Requirement 16 (Code of construction practice)
Co68	Secondary: All logistics compounds will be removed and sites restored to their original condition when construction has been completed.	DCO Requirement 16 (Code of construction practice) DCO Requirement 19 (Restoration of land used temporarily for construction)
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 13 (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 16 (Code of construction practice)
Co127	Tertiary: An Onshore Decommissioning Plan will be developed prior to decommissioning. 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 pollution prevention and avoidance of ground disturbance. The	DCO Requirement 22 (onshore decommissioning)

Commitment ID	Measure Proposed	How the measure will be secured
	Onshore Decommissioning Plan will be in line with the latest relevant available guidance.	
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 16 (Code of construction practice)
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 possible to retain them, any unavoidable damage will be repaired and reinstated as soon as reasonably practical.	DCO Requirement 16 (Code of construction practice)
Co170	Secondary: Joint bays and link boxes will be minimum 20 m away from main rivers.	DCO Requirement 16 (Code of construction practice)
Co172	Secondary: The bed and banks of watercourses will be reinstated to their pre-construction condition following the removal of any temporary structures.	DCO Requirement 16 (Code of construction practice)
Co175	Secondary: A pre and post construction condition survey will be undertaken at each of the crossing location on primary and secondary watercourses where infrastructure (e.g. A Bailey bridge) is emplaced upon banks.	DCO Requirement 16 (Code of construction practice)
Co183	Where possible the design of all temporary access tracks will replicate or be as consistent with existing ground levels as possible, to limit any effects on future flood risk.	DCO Requirement 16 (Code of construction practice)
Co184	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 existing ground elevations to ensure continued floodplain capacity and/or flow conveyance, where possible.	DCO Requirement 16 (Code of construction practice)

2.9 Maximum Design Scenario

2.9.1.1 A number of Maximum Design Scenarios (MDS) have been used as a basis for the impact assessment on hydrology and flood risk. In line with the Project Design Envelope (**Volume 1, Chapter 4: EIA Methodology**), the maximum design parameters and maximum duration of construction works for the area of temporary and permanent land take have been considered as the maximum design scenario in terms of potential impacts to hydrology and flood risk.

2.9.1.2 Following consultation feedback (**Section 2.4**), the temporary and permanent impacts on hydrology and flood risk are considered to predominantly occur during construction and decommissioning works. MDSs that have the potential to influence the level of impact on hydrology and flood risk during these two phases are identified in **Table 2.11** which sets out the MDS used in the assessment of each potential effect scoped into the assessment.

2.9.2 Construction Scenarios

2.9.2.1 It is considered that the key factors in determining the potential worse-case impacts to hydrology and flood risk during construction relate to the total area (and hence potential for interactions with the surface drainage network and underlying groundwater) affected by both temporary and permanent aspects of the development. **Table 2.11** contains detailed information on the MDS:

Table 2.11: Maximum design scenario for impacts on hydrology and flood risk.

Impact and Phase	Embedded Mitigation Measures	Maximum Design Scenario / Rochdale Envelope	Justification
Construction			
Access across watercourses: 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.	Secondary Co172 Co175 Tertiary • Ensuring culverts are adequately sized to avoid impounding flows (Co124); • Installing culverts below the active bed of the watercourse to ensure continuity for sediment, fish and aquatic invertebrates (Co124);	**Onshore ECC Construction Activities:** • Duration of temporary watercourse crossings: 30 months. **Onshore ECC:** • Type of temporary watercourse crossing: Culvert • Maximum number of temporary watercourse crossings on EA Main Rivers and IDB maintained watercourses: 15 • Location of temporary watercourse crossings: See **Figure 2.10** - **Figure 2.14**. • Length of temporary crossings: 10m • Width of temporary crossings: 6m	These parameters represent the maximum potential for disturbance of surface watercourses from temporary crossings. The scale of impacts resulting from watercourse crossings is a product of the number of temporary crossings per catchment and the spatial extent and duration of disturbance.
Access across minor drainage ditches: Works associated with access track crossings of minor drainage ditches (as defined in the watercourses crossing schedule and to be agreed with EA, IDB and LLFA) may result in a reduction in water quality and channel hydro-morphology.	Secondary Co172 Tertiary • Ensuring culverts are adequately sized to avoid impounding flows (Co124); • Installing culverts below the active bed of the watercourse to ensure continuity for sediment, fish and aquatic invertebrates (Co124);	**Onshore ECC Construction Activities:** • Duration of temporary watercourse crossings: 30 months. **Onshore ECC:** • Type of temporary watercourse crossing: Culvert • Maximum number of temporary watercourse crossings on minor drainage ditches: 14 • Location of temporary watercourse crossings: See **Figure 2.10** - **Figure 2.14**. • Maximum length of temporary crossings: 10m • Maximum width of temporary crossings: 6m	These parameters represent the maximum potential for disturbance of minor drainage features. The scale of impacts resulting from watercourse crossings is a product of the number of temporary crossings per catchment and the spatial extent and duration of disturbance.

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. Individual assessment methodologies have also been prescribed for the FRA and the WFD Compliance Assessment appended to this report. The assessment methodologies of these exercises are detailed within the respective appendices:

- **Volume 6, Annex 2.2: Onshore Infrastructure Flood Risk Assessment**; and
- **Volume 6, 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 2.12**) and the magnitude of potential impacts (**Table 2.13**). The terms used to define sensitivity and magnitude are based on those used in the Design Manual for Roads and Bridges (DMRB) methodology, which is described in further detail in **Volume 1, 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 2.12: 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	Receptor has very limited capacity to tolerate changes to hydrology, geomorphology, and water quality or flood risk. *Water resources* 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. *Flood risk* 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 Design Manual for Roads and Bridges (DMRB) 2009).
High	High importance and rarity, national scale and limited potential for substitution	Receptor has limited capacity to tolerate changes to hydrology, geomorphology, and water quality or flood risk. *Water resources* 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. *Flood risk* 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 Design Manual for Roads and Bridges (DMRB) 2009).
Medium	High or medium importance and rarity, regional scale, limited potential for substitution	Receptor has moderate capacity to tolerate changes to hydrology, geomorphology, and water quality or flood risk. *Water resources* 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.

Sensitivity	DMRB definition	Definition used in this chapter
		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 with water supply abstractions. Site is within a Catchment Source Protection Zone. *Flood risk* 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).
Low	Low or medium importance and rarity, local scale	Receptor has high capacity to tolerate changes to hydrology, geomorphology, and water quality or flood risk. *Water resources* 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. Supports Secondary A or Secondary B Aquifer without abstractions. *Flood risk* 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).
Negligible	Very low importance and rarity, local scale	Receptor is generally tolerant of changes to hydrology, geomorphology, and water quality or flood risk. *Water resources* Controlled waters with hydrology that does not support natural variations, geomorphology that does not support natural processes and water quality that constrains ecological communities. Aquatic or water-dependent habitats and/or species are tolerant to changes in hydrology, geomorphology or water quality. Non-productive strata that does not support groundwater resources. *Flood risk* 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).

2.10.2.2 The criteria for defining magnitude in this chapter are outlined in **Table 2.13**.

Table 2.13: Definition of terms relating to magnitude of an impact.

Magnitude of impact	Definition used in this chapter
Major	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. *Water resources* 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 resulting in prosecution. Permanent or wide scale degradation of habitat quality. *1 Flood risk* Permanent or major change to existing flood risk. Reduction in on-site flood risk by raising ground level in conjunction with provision of compensation storage. Increase in off-site flood risk due to raising ground levels without provision of compensation storage. Failure to meet either sequential or exception test (if applicable).
Moderate	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. *Water resources* Medium-term (1-5 years) effects on water quality or availability. Medium-term (1-5 years) degradation of a water supply source, possibly resulting in prosecution. Habitat change over the medium-term (1-5 years). *Flood risk* Medium-term (1-5 years) or moderate change to existing flood risk. Possible failure of sequential or exception test (if applicable). Reduction in off-site flood risk within the local area due to the provision of a managed drainage system.
Minor	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. *Water resources* Short-term (<1 year) or local effects on water quality or availability. Short-term (<1 year) degradation of a water supply source. Habitat change over the short-term.

Magnitude of impact	Definition used in this chapter
	Flood risk Short-term (<1 year), temporary or minor change to existing flood risk. Localised increase in on-site or off-site flood risk due to increase in impermeable area. Passing of sequential and exception test.
Negligible	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. *Water resources* Intermittent impact on local water quality or availability. Intermittent or no degradation of a water supply source. Very slight local changes to habitat that have no observable impact on dependent receptors. *Flood risk* Intermittent or very minor change to existing flood risk. 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 2.14**. Where a range of significance of effect is presented in **Table 2.14**, 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 minor or less have been concluded to be not significant in terms of the EIA Regulations.

Table 2.14: Matrix used for the assessment of the significance of the effect.

		Magnitude of Impact/Degree of Change			
		Negligible	Minor	Moderate	Major
Value, Importance, Sensitivity	Low	Not Significant	Not Significant or Minor (Not Significant)	Minor (Not Significant)	Minor (Not Significant) or Moderate (Significant)
	Medium	Not Significant	Minor (Not Significant)	Moderate (Significant)	Moderate (Significant) or Major (Significant)
	High	Not Significant	Minor (Not Significant) or Moderate (Significant)	Moderate (Significant) or Major (Significant)	Major (Significant) or Substantial (Significant)
	Very High	Not Significant	Moderate (Significant) or Major (Significant)	Major (Significant) or Substantial (Significant)	Substantial (Significant)

2.10.2.5 Where a magnitude of no change is identified, such potential impacts will not be assessed since it will always lead to a not significant effect. Likewise, any negligible magnitude impacts identified and where receptors are considered to be of not significant sensitivity, these will not be considered further within this assessment given that the magnitude of impact on such receptors will not lead to a significant effect.

2.11 Impact assessment

2.11.1 Construction

2.11.1.1 The impacts of the onshore construction of Hornsea Four have been assessed on hydrology and flood risk. The environmental impacts on hydrology and flood risk arising from the construction of Hornsea Four are listed in Table 2.11 along with the maximum design scenario against which each construction phase impact has been assessed.

2.11.1.2 A description of the potential effect on relevant hydrology and flood risk receptors caused by each identified impact is given below.

Access across watercourses: impacts due to construction works associated with access track crossings of Main Rivers, IDB maintained watercourses and larger ordinary watercourses (HFR-C-2); and

Access across watercourses: impacts due to construction works associated with access track crossings of minor drainage ditches (HRF-C-4)

2.11.1.3 Works associated with crossings to provide temporary access across main rivers, IDB maintained watercourses, larger ordinary watercourses and minor drainage ditches may result in a reduction in water quality and adverse impacts on the hydromorphology of the affected channels. Although the haul road will be designed to avoid high value watercourses where possible, it will be necessary to cross watercourses to provide access along the length of the onshore ECC. At these locations, it is proposed that access across watercourses will be provided using temporary bridges or culverts with a maximum width of 6 m and a maximum length of 10 m. These structures would remain in place for a maximum duration of 30 months. The installation, temporary use and subsequent removal of these structures could potentially impact upon the hydrology, geomorphology and quality of surface waters.

2.11.1.4 The installation of temporary bridges could result in the direct disturbance of the banks of the watercourse on which the structure would be placed; existing geomorphological features would be lost if reinforced supports are also installed. The presence of any bank reinforcement could result in increased scour downstream during the period that the reinforcement is in place. The installation of temporary culverts would result in the temporary loss of natural geomorphological features (and associated habitat niches) within the footprint of the structure. The presence of culverts in the channel could also potentially result in reduced flow and sediment conveyance (particularly of coarse sediment), create upstream impoundment and fine sedimentation, and create bed and bank instability due to increased scour downstream of the structure. Culverts could also act as a barrier to the movement of fish and invertebrates within the river system (see **Chapter 3: Ecology and Nature Conservation** for further details). The removal of the structures could potentially increase the supply of fine sediment and cause a period of geomorphological adjustment as the river channel re-equilibrates.

2.11.1.5 The use of construction materials and equipment in and adjacent to the watercourse could potentially affect water quality through the accidental release of contaminants directly into surface waters (e.g. due to leaks or spills of oil, fuels and construction materials).

2.11.1.6 The impact is predicted to be of local spatial extent, medium term duration (confined to the duration of onshore ECC construction) and continuous whilst the temporary structures are in place. The impact would be reversible once the temporary structures have been removed. Therefore, only those watercourses crossed by the access track are considered in the impact assessment below. These are shown by the 'Access Points / Haul Road Crossing' data in **Figure 2.10 - Figure 2.14.**.

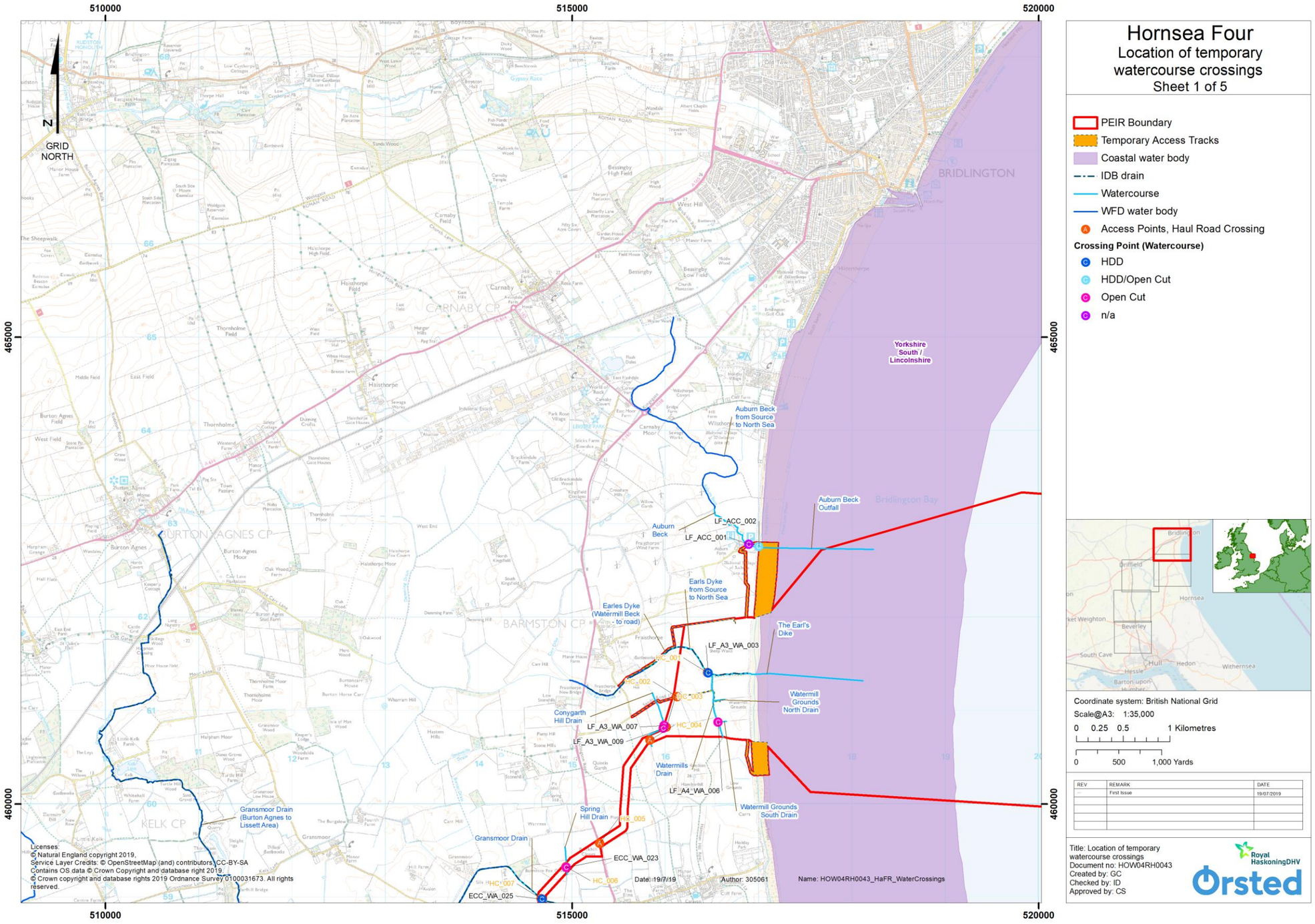
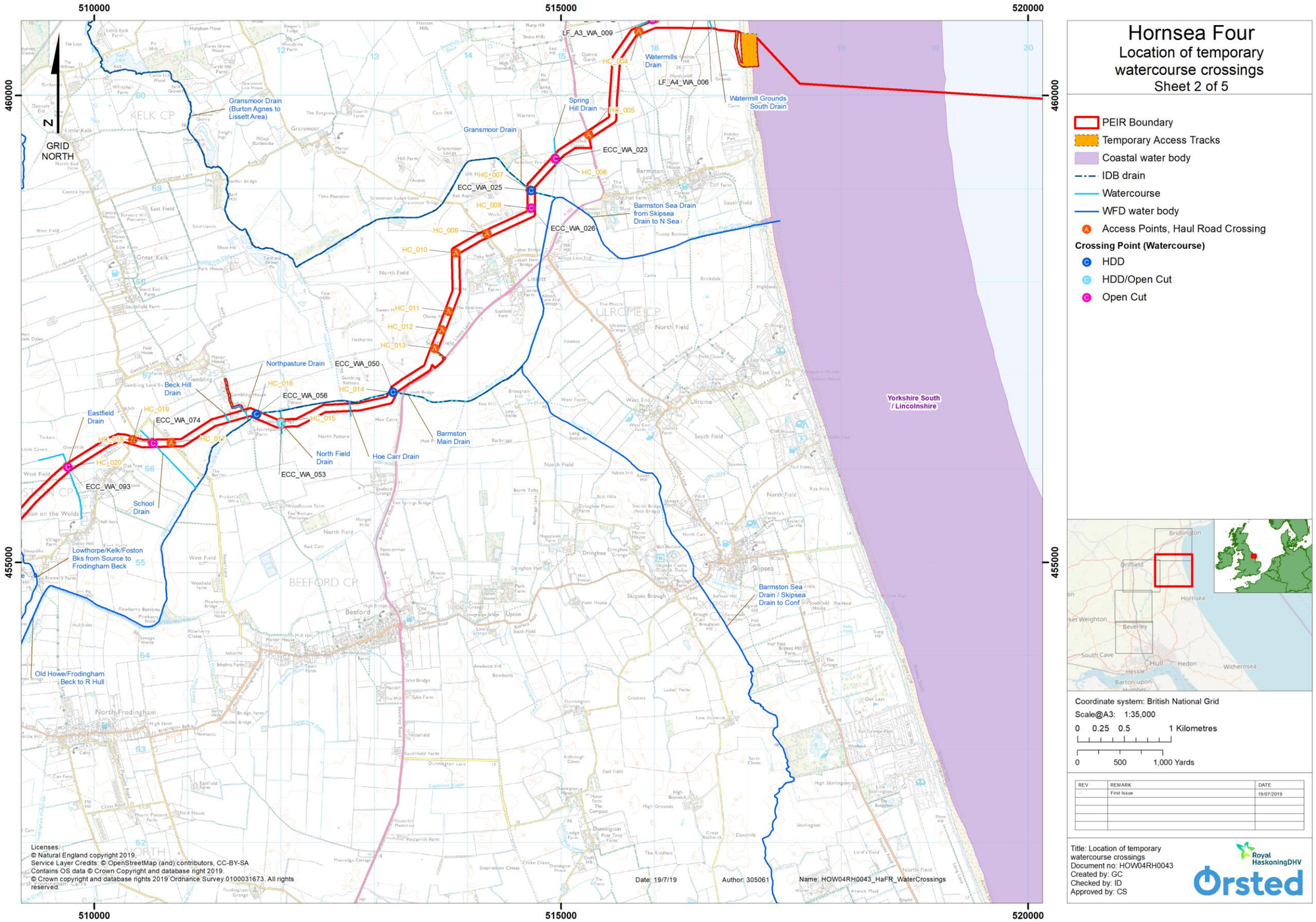


Figure 2.10: Watercourses crossed by temporary haul road crossings (Not to Scale).



Hornsea Four
Location of temporary watercourse crossings
Sheet 2 of 5

- PEIR Boundary
- Temporary Access Tracks
- Coastal water body
- IDB drain
- Watercourse
- WFD water body
- Access Points, Haul Road Crossing

Crossing Point (Watercourse)

- HDD
- HDD/Open Cut
- Open Cut

Coordinate system: British National Grid
Scale@A3: 1:35,000
0 0.25 0.5 1 Kilometres
0 500 1,000 Yards

REV	REMARK	DATE
---	First Issue	19/07/2019

Title: Location of temporary watercourse crossings
Document no: HOW04RH0043
Created by: GC
Checked by: ID
Approved by: CS

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Figure 2.11: Watercourses crossed by temporary haul road crossings (continued) (Not to Scale).

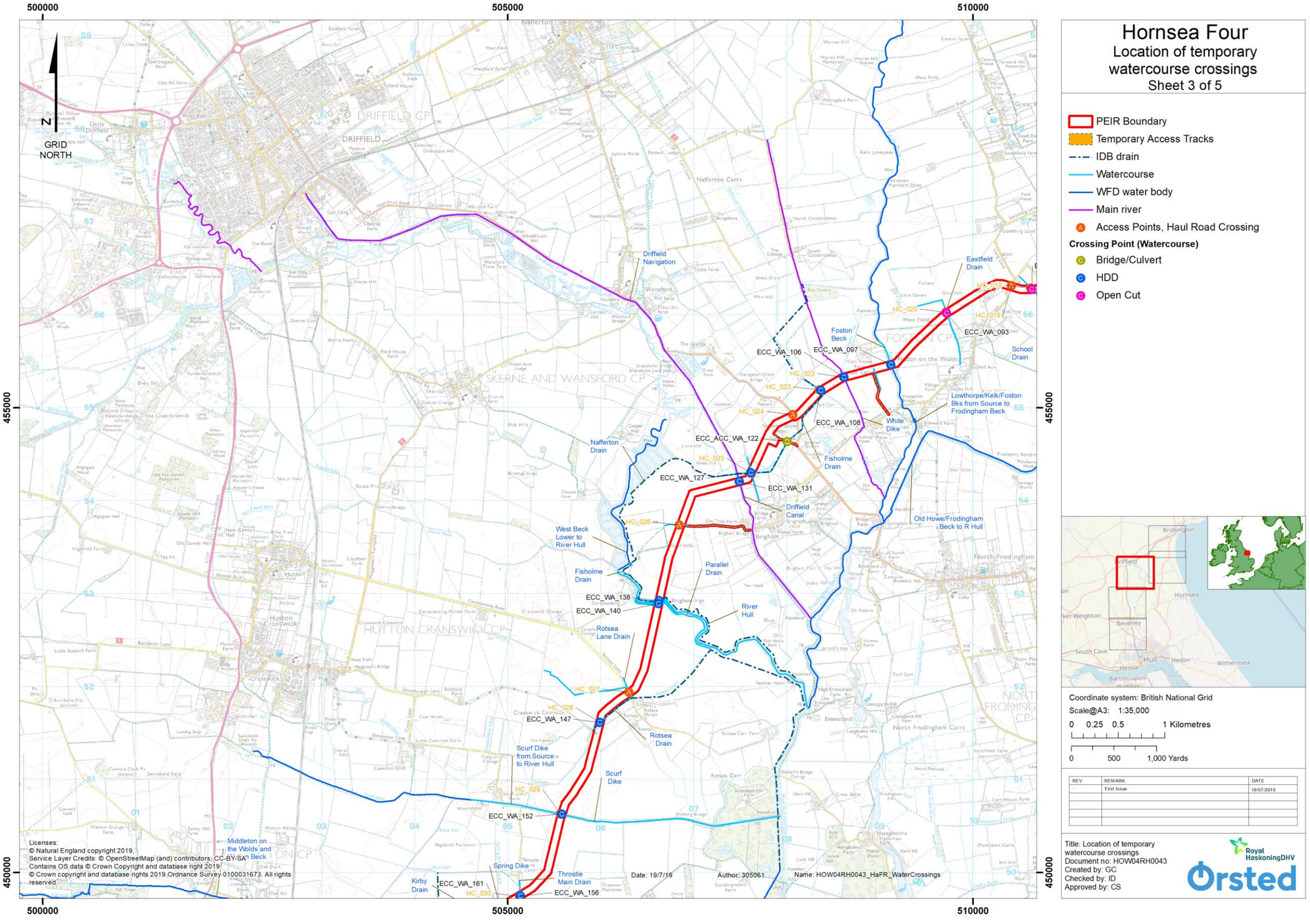

Figure 2.12: Watercourses crossed by temporary haul road crossings (continued) (Not to Scale).

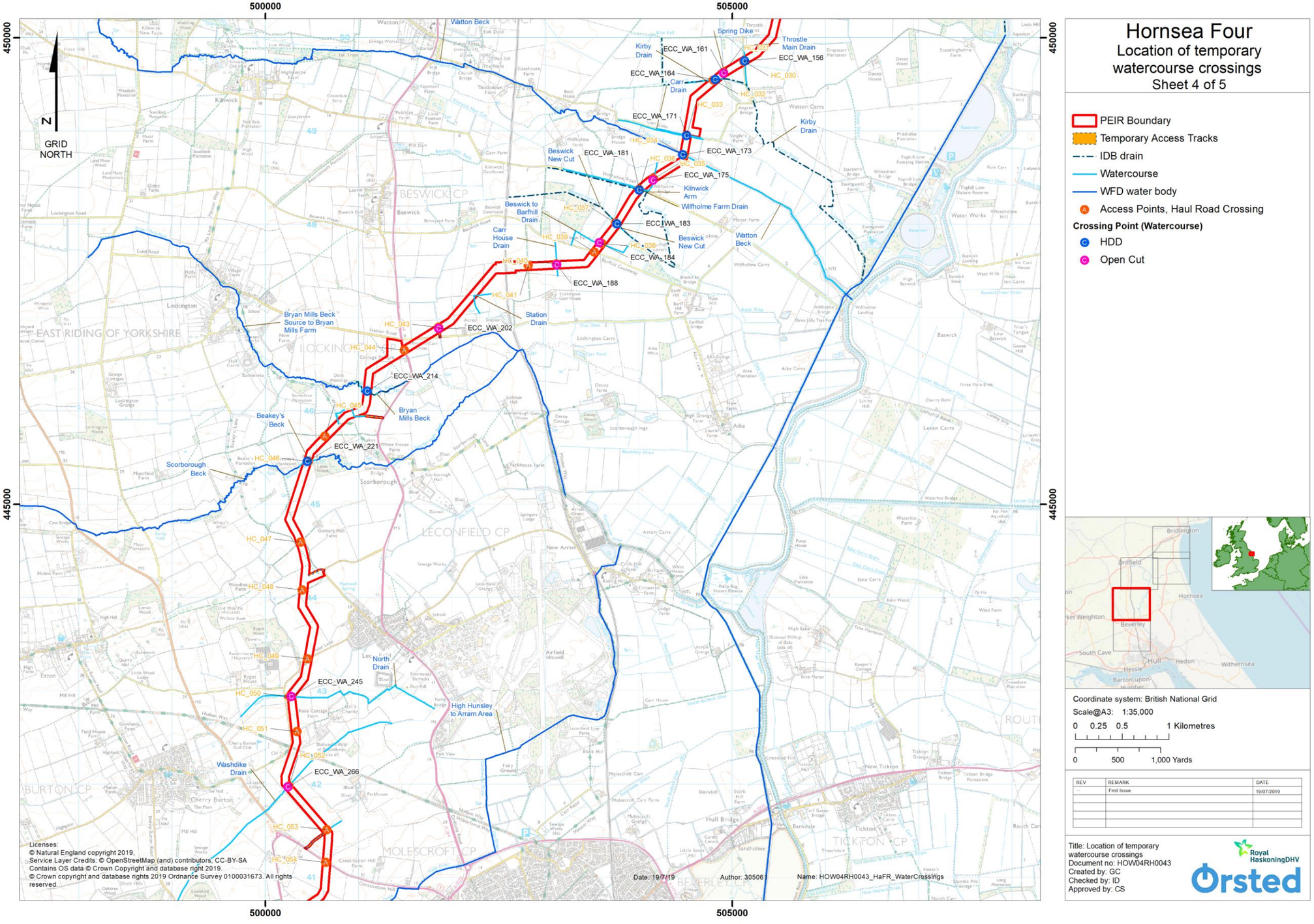

Figure 2.13: Watercourses crossed by temporary haul road crossings (continued) (Not to Scale)

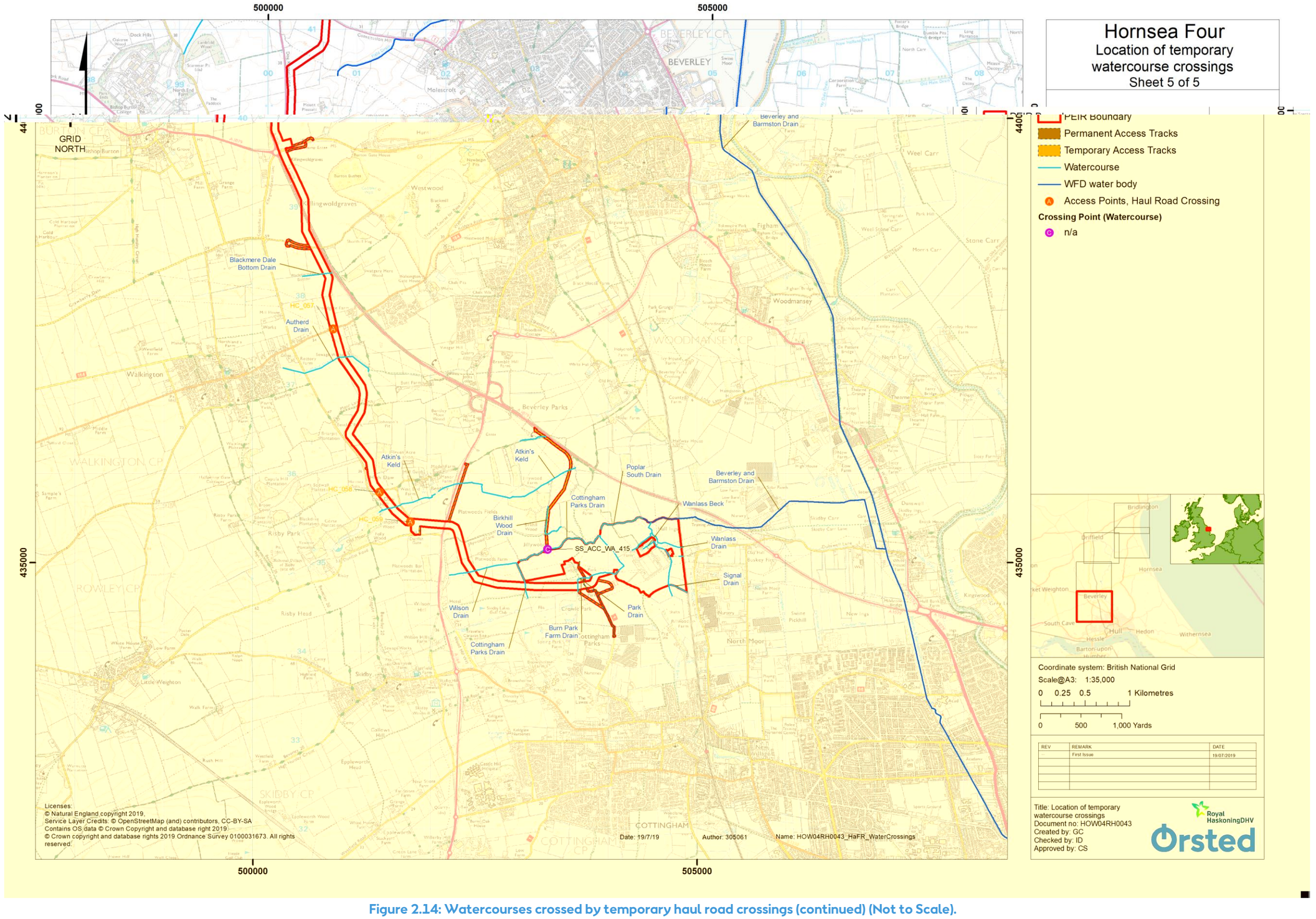

Figure 2.14: Watercourses crossed by temporary haul road crossings (continued) (Not to Scale).

Magnitude of impact

2.11.1.7 As listed in **Table 2.10**, commitments have been made in order to reduce the incidence of likely significant effects. Following construction, there is a commitment (Co10) to reinstate the working area to pre-existing condition as far as reasonably practical in line with the DEFRA 2009 Construction Code of Practise. In addition, industry best practise guidance will be followed with regards to pollution prevention and works in or near water (Co4, Co 6 and Co64). However, it is inevitable that some impact will be felt, without further mitigation measures, due to the likelihood that works will take place directly within watercourses, or directly adjacent to them, which may lead to increased sedimentation and the disturbance of riparian vegetation.

2.11.1.8 Impacts on main rivers, IDB maintained watercourses and larger ordinary watercourses and impacts on minor drainage features have been considered together because the mechanism for impact remains the same regardless of the scale of the watercourse affected. For the purposes of this assessment, the magnitude of impact is assumed to be proportional to the total number of temporary watercourse crossings within each receptor, as defined in **Table 2.15**. This approach recognises that smaller drainage features can play an important role in the hydrology and geomorphology of natural river systems and can support particularly sensitive or important habitats (e.g. chalk springs or spawning habitats for interest features in the River Hull Headwaters SSSI).

Table 2.15: Definition of impact magnitude resulting from access track watercourse crossings.

Magnitude of impact	Number of crossings per receptor
Major	≥ 10
Moderate	5 – 9
Minor	2 – 4
Negligible	1
No change	0

2.11.1.9 Because culverts are likely to have a greater geomorphological and hydrological impact than temporary bridges, the assessment of impact magnitude is based on the worst-case assumption that all crossings would be undertaken using culverts (although in reality this will not be the case). The magnitude of impact is considered to range from negligible to moderate, as summarised in **Table 2.16**.

Table 2.16: Magnitude of impact resulting from haul road watercourse crossings.

Catchment	Receptor	Number of watercourse crossings				Magnitude of impact
		Main rivers	IDB drains	Other ordinary watercourses*	Total	
Barmston Sea Drain	Earl's Dyke	0	1	1	**2**	Minor
	Gransmoor Drain	0	1	1	**2**	Minor
	Barmston Sea Drain	0	0	1	**1**	Negligible
	Skipsea Drain	0	2	1	**3**	Minor
River Hull (upper)	Frodingham Beck	0	0	1	**1**	Negligible
	Lowthorpe /Kelk/Foston Becks	0	1	1	**2**	Minor
	West Beck	0	2	3	**5**	Moderate
	Scurf Dike	1	0	0	**1**	Negligible
River Hull (lower)	Watton Beck	1	0	2	**3**	Minor
	Scorborough Beck	1	0	0	**1**	Negligible
	Beverley and Barmston Drain	0	3	6	**9**	Moderate
	High Hunsley	0	0	3	**3**	Minor

**Note that the number of ordinary watercourses quoted here has been derived from analysis of published Ordnance Survey mapping and aerial photography. Additional minor watercourses that are not identified in these sources will be identified during a comprehensive drainage survey that will be undertaken to inform the scheme design (see Co14 in Table 2.10).*

2.11.1.10 Although Table 2.16 demonstrates that several temporary crossings are proposed in the catchments of the Frodingham Beck, Lowthorpe/Kelk/Foston Beck and West Beck which comprise the River Hull Headwaters SSSI, these crossings would be located on tributaries rather than the main river channels. They will not therefore directly interact with the designated main river.

Sensitivity of the receptor

2.11.1.11 The sensitivity of each surface water receptor has been assigned on the basis of the drainage catchment within which the watercourse is located (as defined by the catchments of WFD river water bodies). The sensitivities of each receptor range from low to high, defined as a function of its vulnerability, recoverability and value (Table 2.17).

Table 2.17: Sensitivity of receptors crossed by the access track.

Catchment	Receptor	Sensitivity	Justification
Barmston Sea Drain	Earl's Dike	Low	Earl's Dike is a largely artificial watercourse with poor water quality that is not hydrologically connected to any designated sites. The modified nature of the watercourse means that the receptor is expected to have **low vulnerability** to physical disturbance and **high recoverability** once this disturbance has been removed. The modified

Catchment	Receptor	Sensitivity	Justification
			hydromorphology and poor water quality mean that the receptor is considered to have a **low value**.
	Gransmoor Drain	Low	Gransmoor Drain is a largely artificial watercourse with a deeply incised channel and poor water quality. The modified nature of the watercourse means that the receptor is expected to have **low vulnerability** to physical disturbance and **high recoverability** once this disturbance has been removed. The modified hydromorphology and poor water quality mean that the receptor is considered to have a **low value**.
	Barmston Sea Drain	Low	Barmston Sea Drain is a largely artificial watercourse with a uniform, straight channel and poor water quality. The modified nature of the watercourse means that the receptor is expected to have **low vulnerability** to physical disturbance and **high recoverability** once this disturbance has been removed. The modified hydromorphology and poor water quality mean that the receptor is considered to have a **low value**.
	Skipsea Drain	Low	Skipsea Drain is not artificial or heavily modified and is expected to have a **medium vulnerability** to physical disturbance and a **high recoverability** once this disturbance has been removed. Its poor water quality means that the receptor is considered to have a **low value**.
River Hull (Upper)	Frodingham Beck	High	The Frodingham Beck is a chalk river meaning that the receptor is expected to have **high vulnerability** to physical disturbance, despite its heavily modified nature, and **low recoverability** once this disturbance has been removed. The main channel (although not its tributaries) forms part of the River Hull Headwaters SSSI but suffers from poor water quality, however, the SSSI designation means it is considered to have a **high value**.
	Lowthorpe/ Kelk/ Foston Becks	High	The Lowthorpe/Kelk/Foston Becks have a predominantly straight planform with little flow or geomorphological diversity, typical of a large drainage system. As this is a chalk river it is expected to have a **high vulnerability** and **low recoverability**. The main channel (although not its tributaries) forms part of the River Hull Headwaters SSSI but suffers from poor water quality. However, the SSSI designation means that the receptor is considered to have a **high value**.
	West Beck	High	West Beck is a meandering chalk river that has been historically modified and affected by siltation. The watercourse forms part of the River Hull Headwaters SSSI. Because the watercourse is already affected by physical modifications, it is expected to have a **high vulnerability** to further physical disturbance and a **low recoverability** once this disturbance has been removed. The SSSI designation of the main channel (although not its tributaries) means that the receptor is considered to have a **high value**.

Catchment	Receptor	Sensitivity	Justification
	Scurf Dike	Low	Scurf Dike is a largely artificial watercourse with a uniform, straight channel and good water quality. The modified nature of the watercourse means that the receptor is expected to have **low vulnerability** to physical disturbance and **high recoverability** once this disturbance has been removed. The modified hydromorphology means that the receptor is considered to have a **low value**.
River Hull (Lower)	Watton Beck	Low	Watton Beck is an extensively straightened watercourse with poor water quality. The modified nature of the watercourse means that the receptor is expected to have **low vulnerability** to physical disturbance and high recoverability once this disturbance has been removed. The modified hydromorphology and poor water quality mean that the receptor is considered to have a **low value**.
	Scorborough Beck	Low	The Scorborough Beck is not heavily modified or artificial and is expected to have **medium vulnerability** to physical disturbance, and **high recoverability** once this disturbance has been removed. The poor water quality means that the receptor is considered to have **low value**.
	Beverley and Barmston Drain	Low	Beverley and Barmston Drain is a largely artificial watercourse which passes through a groundwater SPZ and flows into the Humber Estuary SAC, SPA and Ramsar site. The modified nature of the watercourse means that the receptor is expected to have **low vulnerability** to physical disturbance and **high recoverability** once this disturbance has been removed. The modified hydromorphology means that the receptor is considered to have a **low value**.
	High Hunsley	Low	The High Hunsley River is a largely artificial watercourse, meaning that the receptor is expected to have a **low vulnerability** to physical disturbance and a **high recoverability** when this disturbance is removed. It suffers from poor water quality and high temperatures and is therefore considered to have a **low value**.

Significance of the effect

2.11.1.12 Overall, it is predicted that only two of the twelve receptors considered within this impact assessment may experience an effect that is significant in EIA terms, with the remainder experiencing not significant or minor effects as outlined in Table 2.18 below.

Table 2.18: Significance of Effects on EA Main Rivers and IDB Maintained Drainage Channels.

Catchment	Receptor	Sensitivity	Magnitude of Impact	Overall Significance	Significance in EIA Terms
Barmston Drain	Earl's Dike	Low	Minor	Minor	Not significant
	Gransmoor Drain	Low	Minor	Minor	Not significant
	Barmston Drain	Low	Negligible	Not significant	Not significant
	Skipsea Drain	Low	Minor	Minor	Not significant

Catchment	Receptor	Sensitivity	Magnitude of Impact	Overall Significance	Significance in EIA Terms
River Hull (Lower)	Frodingham Beck	High	Negligible	Minor	Not significant
	Lowthorpe/Kelk/Foston Becks	High	Minor	Minor	Significant
	West Beck	High	Moderate	Moderate	Significant
	Scurf Dike	Low	Negligible	Not significant	Not significant
River Hull (Upper)	Watton Beck	Low	Minor	Minor	Not significant
	Scorborough Beck	Low	Negligible	Not significant	Not significant
	Beverley and Barmston Drain	Low	Moderate	Minor	Not significant
	High Hunsley	Low	Minor	Minor	Not significant

2.11.1.13 Significant effects are predicted for the Lowthorpe / Kelk / Foston Beck and West Beck catchments, which form part of the River Hull Headwaters SSSI. However, as stated above, the proposed crossings would be located on tributaries which drain into the SSSI-designated watercourses rather than the main river channels themselves. They will not therefore directly interact with the designated main river, and as such the potential for direct effects on the SSSI itself is minimised.

Further mitigation

2.11.1.14 Potential impacts resulting from the use of temporary structures at watercourse crossings along the cable route would be mitigated through the following mitigation measures:

- Following the best practice guidance set out in CIRIA C689 (2010) *Culvert design and operation guide,* culverts will be adequately sized to avoid impounding flows. Furthermore, the culvert bed will be installed below the active bed of the watercourse to ensure that sediment continuity and the movement of aquatic organisms can be maintained and the likelihood of upstream sedimentation and downstream scour is minimised (Co124); and
- The bed and banks of the watercourses following the removal of temporary structures will be reinstated to their pre-construction condition (Co172).

2.11.1.15 Following implementation of these measures, the magnitude of impact would be reduced to negligible for all the receptors and the resulting residual impact would be not significant for all receptors except for West Beck, which will be reduced to minor significance.

Future monitoring

2.11.1.16 It is recommended that a condition survey is undertaken at each of the temporary crossing locations following construction, once the temporary crossings have been removed and the banks have been reinstated. When compared to the results of the pre-construction surveys (Co14), this survey will ensure that construction mitigation has been effective, and determine whether there have been any significant changes to geomorphology as a result of the presence of the structures (e.g. upstream sedimentation and downstream scour). If necessary, this will allow further consultation with the regulators. This survey will be most pertinent in the sensitive chalk watercourses that feed into West Beck.

2.11.2 Operation and Maintenance

2.11.2.1 The impacts of the onshore operation and maintenance of Hornsea Four hydrology and flood risk have been scoped out of the assessment because no likely significant effects have been identified. Further information is provided in **Table 2.9**.

2.11.3 Decommissioning

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

2.11.3.2 It is considered that impacts associated with the decommissioning phase will be of equal ad no more than those identified for the construction phase with no additional significant effects identified above those set out for the construction phase. The onshore export cables will be left in situ underground with the cable ends cut, sealed and securely buried. The external structures of the jointing pits and link boxes along the corridor will be removed only if it is feasible with minimal environmental disturbance. All relevant construction management, mitigation and project commitments are applicable to decommissioning also.

2.11.3.3 Potential impacts arising from the decommissioning phase of Hornsea Four have been scoped out of further assessment following consultation with the Planning Inspectorate.

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.

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 4, Annex 5.5: Onshore Cumulative Effect Screening Matrix** and **Volume 4, 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 PEIR boundary.

2.12.1.3 The CEA has followed a four-stage approach developed from Advice Note 17. Each of the four stages is identified in **Table 2.19** along with commentary specifically relating to Hydrology and Flood Risk.

Table 2.19: Stages and activities involved in the CEA process.

CEA stage	Activity
Stage 1 – Establish the project's Zone of influence (ZoI) and establish a long-list of developments	Through consultation it has been identified that potential developments that require consideration as part of the onshore CEA are restricted to those that fall within the surface drainage catchments which contain the landfall, onshore ECC and OnSS (including temporary logistics compounds/storage areas and permanent working areas), and the 400 kV onshore ECC grid connection area. To determine a 'long-list' of possible projects for inclusion in the CEA the following actions have been carried out: • Interrogation of the ERYC planning portal (latest review is May 2019); and • Discussion of potential projects for specific inclusion in the CEA at the Evidence Plan meetings. To date these processes have identified the 'long-list'. In order to attribute an element of certainty to the assessment each project has been assigned a Tier reflecting their current status within the planning and development process. The full list of projects and relevant tiers assigned can be found in Appendix A of **Volume 4, Annex 5.5: Onshore Cumulative Effect Screening Matrix** and **Volume 4, Annex 5.6: Location of Onshore Cumulative Schemes**.
Stage 2 – Screening of long list: Identify a shortlist of other developments for the CEA	Due to the inter-connected nature of surface hydrological systems, activities in one part of a surface catchment have the potential to affect other parts of the catchment in which they take place and also affect other connected catchments downstream. For the purposes of this assessment, all river water body catchments (defined by the Environment Agency for the purposes of the Water Framework Directive) in which construction of operational activities would take place have been used to define the maximum theoretical extent of project impacts. It is considered unlikely that potential impacts on surface water receptors would occur outside of these catchments.
Stage 3 – Information gathering	Where available information on the other developments within the shortlist generated at Stage 2 has been collated to inform the CEA. At this stage (PEIR) information is of high level unless explicitly discussed with ERYC. The information collected on each project is presented in **Volume 4, Annex 5.5: Onshore Cumulative Effect Screening Matrix** and **Volume 4, Annex 5.6: Location of Onshore Cumulative Schemes**.

CEA stage	Activity
Stage 4 - Assessment	The CEA has been undertaken in two stages: i) Each of the potential effects that are subject to assessment alone have been reviewed against the potential for cumulative effects to occur. ii) A CEA assessment of each of the other developments on the short-list has taken place for those effects where it is considered that potential cumulative impacts could occur. The assessment also includes, where relevant, consideration of any mitigation measures where adverse cumulative effects are identified and signposts to the relevant means of securing mitigation.

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 2.19** (above). Information regarding all projects is provided in **Volume 4, Annex 5.5: Onshore Cumulative Effect Screening Matrix** and **Volume 4, Annex 5.6: Location of Onshore Cumulative Schemes**. Summary information on the short-list projects for Hydrology and Flood Risk is provided below.

2.12.2.2 Seven projects have been identified for inclusion on the short list of projects to be assessed cumulatively. The remaining projects have not been considered as having the potential to result in cumulatively significant effects as they are located outside of the surface water catchments within which the construction of operational activities will take place. The 18 projects can be summarised as:

- A substation and access track;
- A Wind Turbine;
- Facilities associated with two wind farms including Creyke Beck substation;
- A school campus;
- Battery storage;
- A highways improvement scheme; and
- Seven housing development sites.

2.12.3 CEA Stage 3 Assessment

2.12.3.1 As stated in **Table 2.19;** the assessment is undertaken in two stages:

- sets out the potential impacts assessed in this chapter and identifies the potential for cumulative effects to arise, providing a rationale for such determinations; and
- sets 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 stage 2 is only undertaken if stage 1 identifies that cumulative effects are possible. This summary assessment is set out in **Table 2.20**.

Table 2.20: Potential Cumulative Effects.

	Impact	Potential for Cumulative Effect?	Rationale
Construction			
1	Impacts due to construction works associated with access track crossings of Main Rivers, IDB maintained watercourses and larger ordinary watercourses; and Impacts due to construction works associated with access track crossings of minor drainage ditches.	Yes	Cumulative impacts could occur to the hydrology, geomorphology and quality of surface waters if other projects are undergoing construction within the catchment of watercourses concomitantly with the construction phase of Hornsea Four.
Operation			
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 1, Chapter 4: Project Description**).			
Decommissioning			
The detail and scope of the decommissioning works will be determined by the relevant legislation and guidance at the time of decommissioning and agreed with the regulator. A decommissioning plan will be provided (Co127). As such, cumulative impacts during the decommissioning stage are assumed to be the same as those identified during the construction stage. Additionally, PINS have stated in their Scoping Opinion that cumulative decommissioning effects are scoped out of the EIA.			

2.12.3.3 The second stage of the CEA is a project specific assessment of the potential for any significant cumulative effects to arise due to the construction and/or operation and maintenance of Hornsea Four. To identify whether this may occur, each shortlisted project is discussed in **Table 2.21**.

Table 2.21: Project Screening for CEA Hydrology and Flood Risk.

Project	Description	Location Description (relative to HOW04 PEIR Redline Boundary)	Discussion	Likelihood and Significance of Cumulative Effects
Jocks Lodge Highway Improvement Scheme	EIA Screening Opinion - A164 and Jocks Lodge Highway Improvement Scheme	Works occurring on the A1079.	No EIA is yet available and there is little detail related to this project online However, if the project complies with the DMRB guidance and best practice in terms of water quality, contamination and sediment release the impacts will be reduced. It is anticipated that there will not be an overlap in construction period, in which case no impacts will occur, and this project can be scoped out of CEA.	No
Land North East Of Killingwoldgraves Roundabout Bishop Burton	Erection of petrol filling station and retail store	Within the onshore ECC on the A1079 York Road.	The overall site area is 0.64 ha, which in the context of the High Hunsley to Arram Area catchment of 4079.58 ha within which it lies is small (0.015%) and therefore the potential for impacts to act cumulatively on this watercourse are also small. There is no confirmed construction period for this project, therefore it is not certain that construction, and the potential for impacts, will overlap. In view of the above, this project has been scoped out.	No
Willow Lane Beverley	Construction of a section of access road to link approved developments to North and South of Willow Lane	2.6 km east of the indicative onshore ECC.	This project will be only 0.0138 ha in size and does not lie within 20 m of a watercourse. Given these facts, there is no mechanism for cumulative impacts with the construction of Hornsea Four. In addition, the construction period is yet to be defined, and there may not be a temporal overlap. Therefore, this project is scoped out of the CEA.	No
Low Farm Dunswell Lane Dunswell	Erection of glasshouses, automated bedding units and wind breaks to outdoor planting	1.1 km east of the OnSS. 900 m north of the A1079.	Surface Water Management is considered within the Flood Risk and Drainage Assessment, and if best practice measures are followed such as CIRIA`s	No

Project	Description	Location Description (relative to HOW04 PEIR Redline Boundary)	Discussion	Likelihood and Significance of Cumulative Effects
	beds, external and internal alterations to redundant agricultural buildings to allow conversion to offices and stores, relocation of workers caravans, construction of reservoir with installation of drainage infrastructure across the site and creation of access to low farm, 5 passing places along Long Lane and junction improvements onto the A1174 (Hull Road)		Environmental Good Practice on Site, 3rd Edition (2010); and Construction Industry Publication (CIP) Construction Environmental Manual, there will be no mechanism for cumulative effects, therefore this project can be scoped out of further assessment.	
Land North Of 16 Bishop Burton Road Cherry Burton	Erection of 2no. detached dwellings, erection of detached single garage to rear, erection of boundary wall (maximum height 2.25m) to side and 1.27m timber boundary fence to front and side, and construction of associated access (dropped kerb)	1.4 km west of the indicative Onshore ECC.	The site area of 0.0855 ha in comparison to the High Hunsley to Arram catchment (4079.58 ha) is minimal – comprising only 0.0021%. In addition, there are no watercourses within 20 m of the development. Therefore, any potential impacts on the watercourses during construction are likely to be insignificant and will not act cumulatively with Hornsea Four, therefore this is scoped out of the further assessment.	No
Focus School Campus Hallgate Cottingham	Conversion of existing school buildings into 29 flats and the erection of a new building to provide 6 flats	1.6 km south of the OnSS. Located in Cottingham, directly south of the A1079.	This project lies within the village of Cottingham and comprises the change of use of existing buildings, therefore there is little mechanism for impact as minimal groundworks will be taking place reducing the potential for cumulative effects with Hornsea Four. In addition, no defined construction period is provided, so a temporal overlap is not certain, therefore this project can be scoped out of further assessment.	No

Project	Description	Location Description (relative to HOW04 PEIR Redline Boundary)	Discussion	Likelihood and Significance of Cumulative Effects
Land South West of Stone Cottage Long Lane Woodmansey East Riding Of Yorkshire HU17 0RN	Outline - Residential development, access, landscaping, open space and associated drainage and development infrastructure (All matters reserved) [Phase 2a]	1.8 km north of the Hornsea Four boundary access track	Although this project lies within a surface water catchment that contains Hornsea Four, it covers only 0.64% of the High Hunsley to Woodmansey catchment (9.67 ha compared to 1520.67 ha) and therefore its construction is unlikely to cause significant impacts to the water courses within the catchment. In addition, there is uncertainty over its construction date and due to its geographical distance from Hornsea Four, cumulative impacts are unlikely and can be scoped out of further assessment.	No

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

2.13 Transboundary effects

2.13.1.1 Due to the local nature of surface water and groundwater bodies, impacts to these are also localised and there is no mechanism for impacts to span international borders and create transboundary effects. Therefore, there is no potential for significant transboundary effects regarding flood risk and hydrology from Hornsea Four upon the interests of other European Economic Area (EEA) States.

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). The potential inter-related effects that could arise in relation to Hydrology and Flood Risk are presented in **Table 2.22**. 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 1 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 (Ørsted, 2018), the breadth of project details now available mean that it has now been possible to scope out the majority of potential impact pathways considered in this assessment (**Table 2.9**). The assessment presented in **Table 2.22** is therefore limited to the remaining impacts that have been scoped in.

Table 2.22: Inter-related effects assessment for Hydrology and Flood Risk.

Project phase(s)	Nature of inter-related effect	Assessment alone	Inter-related effects assessment
Project-lifetime effects			
Because the effects scoped in to this assessment are limited to the construction phase, no further project lifetime effects have been identified.			
Receptor-led effects			
Inter-related effects on minor watercourses due to the provision of temporary construction access across minor watercourses and the use of		Minor drainage features could potentially be affected by the use of open trench cable crossing techniques and the installation of temporary culverts to provide access during the construction stage. However, open trenching will follow a methodology agreed in advance with the	

Project phase(s)	Nature of inter-related effect	Assessment alone	Inter-related effects assessment
trenched techniques to allow cables to cross minor watercourses		relevant consenting authority (Co14) which will include details of the temporary works (including measures to maintain flows and reinstate the bed and banks of the watercourse) (Co124). Furthermore, the mitigation measures outlined in Section 2.11.1 mean that any physical changes to minor drainage features resulting from temporary culverts will be minimised. It is therefore not anticipated that any inter-related effects will be produced that are of greater significance than the effects of temporary access points alone.	
Inter-related effects on ecological receptors due to the provision of temporary construction access across watercourses: impacts due to construction works associated with access track crossings of watercourses.		The installation of temporary culverts to provide access across watercourses could result in a range of hydromorphological and geomorphological responses, including increased impoundment and sedimentation upstream and scour downstream. These changes, as well as the physical presence of the culverts themselves, could impact upon local habitat quality for fish and other aquatic organisms, and prevent the upstream and downstream movement of these organisms. However, the mitigation measures outlined in Section 2.11.1 mean that any physical changes to the river channel will be minimised and that the free movement of aquatic organisms will be maintained. It is therefore not anticipated that any inter-related effects will be produced that are of greater significance than the effects on water receptors alone.	

2.14.1.3 The analysis presented in Table 2.22 demonstrates that there are not any significant inter-related effects forecast, since any potential inter-related effects will be of no greater significance than those assessed in isolation.

2.15 Conclusion and summary

2.15.1.1 This chapter of the PEIR has assessed the potential impact of Hornsea Four on hydrology and flood risk. Table 2.23 presents a summary of the potential significant impacts assessed within this PEIR, any mitigation and the residual effects.

2.15.1.2 Overall, prior to the proposed mitigation, all impacts are expected to be not significant or minor (not significant), except for in two receptors; the Lowthorpe / Kelk / Foston Becks and West Beck. This is due in part to their high value as part of the River Hull Headwaters SSSI. Following the implementation of the proposed mitigation measures, the residual impact is expected to be not significant in all but West Beck, where the residual impact will be minor which is not significant in EIA terms. Furthermore, it is important to note that the impacts are associated with the proposed presence of temporary access crossings, which would be located on tributaries that drain into the SSSI-designated watercourses rather than the main river channels themselves. They will not therefore directly interact with the designated main river, and as such the potential for direct effects on the SSSI itself is minimised.

Table 2.23: Summary of potential impacts assessed for Hydrology and Flood Risk.

Impact and Phase	Receptor and value/sensitivity	Magnitude and significance	Mitigation	Residual impact
Construction				
Access across watercourses and **Access across minor drainage ditches:** Works associated with access track crossings of Main Rivers, IDB maintained and ordinary watercourses may result in a reduction in water quality and channel hydro-morphology.	• Earl's Dike- Low • Gransmoor Drain - Low • Barmston Sea Drain - Low • Skipsea Drain - Low • Frodingham Beck - High • Lowthorpe/ Kelk/ Foston Becks - High • West Beck - High • Scurf Dike - Low • Watton Beck - Low • Scorborough Beck - Low • Beverley and Barmston Drain – Low High Hunsley - Low	• Earl's Dike – Minor and not significant • Gransmoor Drain – Minor and not significant • Barmston Sea Drain – Negligible and not significant • Skipsea Drain – Minor and not significant • Frodingham Beck – Negligible and not significant • Lowthorpe /Kelk/Foston Becks – Minor and significant • West Beck – Moderate and significant • Scurf Dike – Negligible and not significant • Watton Beck – Minor and not significant • Scorborough Beck – Negligible and not significant • Beverley and Barmston Drain – Moderate and not significant • High Hunsley – Minor and not significant	<u>Secondary</u> Co172 Co175 <u>Tertiary</u> • Ensuring culverts are adequately sized to avoid impounding flows (Co124); • Installing culverts below the active bed of the watercourse to ensure continuity for sediment, fish and aquatic invertebrates (Co124);	Not significant, except for West Beck which is expected to experience a minor adverse residual impact.

2.16 References

Department for Transport (2015) Transport Analysis Guidance Unit A3: Environmental Impact Assessment. Department for Transport, London, 85pp.

European Commission (EC), (1992) Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC).

European Commission (EC), (2000) The Water Framework Directive (WFD) (Council Directive 2000/60/EC).

Environment Agency, (2019) Catchment Data Explorer, [Online], Available: http://environment.data.gov.uk/catchment-planning/

Environment Agency (undated) Flood Map for Planning, [Online], Available: https://flood-map-for-planning.service.gov.uk/

Environment Agency (2016). Flood risk assessments: climate change allowances (last update 15 February 2019). [Online] Available from: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

Environment Agency (2015) Humber River Basin District: River Basin Management Plan

East Riding of Yorkshire County Council (2015) Local Flood Risk Management Strategy

East Riding of Yorkshire County Council (2017) Preliminary Flood Risk Assessment

East Yorkshire Rivers Trust (2019) Projects [Online] Available: http://www.eastyorkshireriverstrust.org.uk/projects.html

Flood and Water Management Act (FWMA) (2010)

Joint Nature Conservation Committee (2007) Information Sheet on Ramsar Wetlands, Humber Estuary [Online] Available: http://archive.jncc.gov.uk/pdf/RIS/UK11031.pdf

Longfield, SA and Macklin, MG (1999) The influence of recent environmental change on flooding and sediment fluxes in the Yorkshire Ouse basin. Hydrological Processes 13 (7), 1051-1066.

Ministry of Housing, Communities and Local Government (2014) Planning Practice Guidance: Flood Risk and Coastal Change. [Online] Available from: https://www.gov.uk/guidance/flood-risk-and-coastal-change

National Planning Policy Framework and Supporting Guidance (2018)

Natural England (undated 1) Designated Sites View, [Online], Available from: https://designatedsites.naturalengland.org.uk/

Natural England (undated 2) Designated Sites View, Condition of SSSI Units for Site River Hull Headwaters SSSI, [Online], Available from: https://designatedsites.naturalengland.org.uk/ReportUnitCondition.aspx?SiteCode=S1003424&ReportTitle=River%20Hull%20Headwaters%20SSSI

Natural England (undated 3) River Hull Headwaters SSSI Citation, [Online] Available from: https://designatedsites.naturalengland.org.uk/PDFsForWeb/Citation/1003424.pdf

Natural England (undated 4) Natural England Conservation Advice for Marine Protected Areas, Humber Estuary SAC [Online] Available from: https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK0030170&SiteName=Humber%20Estuary&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=

Natural England (undated 5) Natural England Conservation Advice for Marine Protected Areas, Humber Estuary SPA [Online] Available from: https://designatedsites.naturalengland.org.uk/Marine/MarineSiteDetail.aspx?SiteCode=UK9006111&SiteName=humber&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=

Ørsted (2018) Hornsea Offshore Wind Farm Project 4 Scoping Report

Royal Haskoning (2010) Restoring the River Hull Headwaters SSSI. Report to the Environment Agency and Natural England, 333pp.

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

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