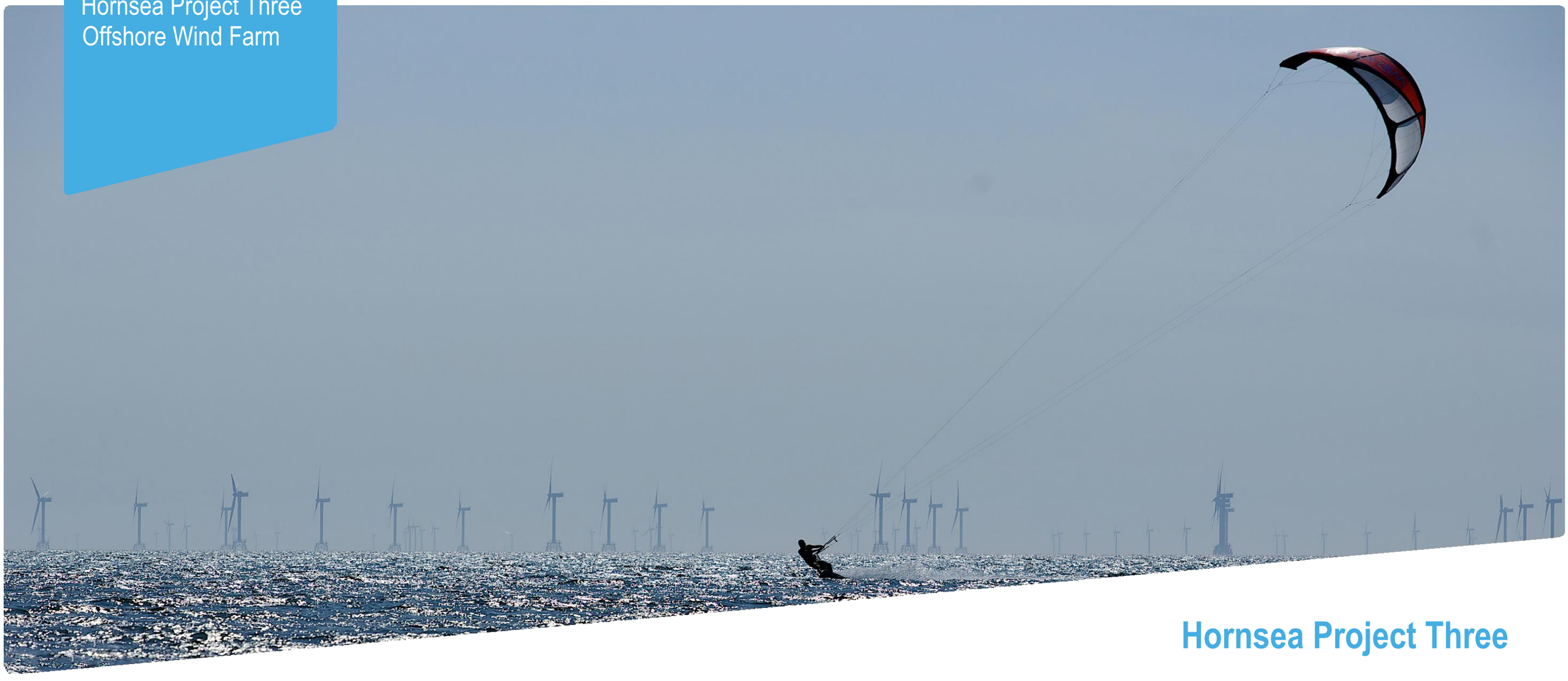
Hornsea Project Three
Offshore Wind Farm



Hornsea Project Three

Offshore Wind Farm

Environmental Statement:
Volume 3, Chapter 2 - Hydrology and Flood Risk

PINS Document Reference: A6.3.2
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Date: May 2018

Hornsea 3
Offshore Wind Farm

Ørsted

Environmental Impact Assessment

Environmental Statement

Volume 3

Chapter 2: Hydrology and Flood Risk

Liability

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Front cover picture: Kite surfer near a UK offshore wind farm © Orsted Hornsea Project Three (UK) Ltd., 2018.

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Glossary

Term	Definition
Anglian Water	Anglian Water is a water company which supplies drinking water, drainage and sewerage services for the East of England via a network of pipe and pump infrastructure.
Aquifer	A subsurface layer or layers of rock or other geological strata of sufficient porosity and permeability to allow either a significant flow of groundwater or the abstraction of significant quantities of groundwater
Catchment Flood Management Plan	Catchment Flood Management Plans are documents produced by the Environment Agency to establish flood risk management policies which will deliver long term sustainable flood risk management across a catchment. They consider all types of inland flooding, from rivers, groundwater, surface water and tidal flooding within specific river basin district.
Catchments	An area that serves a watercourse with rainwater. Every part of land where the rainfall drains to a single watercourse is in the same catchment.
Climate change	A long term change in weather patterns, in the context of flood risk, climate change will produce more frequent severe rainfall.
Discharge consents	Consent granted by the Environment Agency to discharge into watercourses, subject to conditions.
Drainage Board (DB)	Drainage Boards are an integral part of water level management in the UK. Each DB is a local public authority established in areas of special drainage need in England and Wales. They have permissive powers to manage water levels within their respective drainage districts. They undertake works to reduce flood risk to people and property and manage water levels to meet local needs.
Exceptions Test	The Exceptions Test ensures that development is permitted in flood risk areas only in exceptional circumstances and when strict qualifying conditions have been met. It is carried out if the Sequential Test demonstrates that a development cannot be located in areas of low flood risk.
Field drainage	Limiting the effect of flooding by maintaining surface water and land drainage systems.
Flood defences	A structure that is used to reduce the probability of floodwater affecting a particular area.
Flood risk assessment (FRA)	A flood risk assessment is an assessment of the risk of flooding from all flood mechanisms, including the identification of flood mitigation measures, in order to satisfy the requirements of the National Planning Policy Framework and Planning Practice Guidance.
Flood Zone 1	Low Probability Land having a less than 1 in 1,000 annual probability of river or sea flooding.
Flood Zone 2	Medium Probability Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding.
Flood Zone 3a	High Probability Land having a 1 in 100 or greater annual probability of river flooding; or Land having a 1 in 200 or greater annual probability of sea flooding.
Flood Zone 3b	The Functional Floodplain. This zone comprises land where water has to flow or be stored in times of flood. Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency.
Fluvial flooding	Fluvial flooding occurs when rivers burst their banks as a result of sustained or intense rainfall.
Geology	The scientific study of the origin, history and structure of the earth.
Greenfield runoff rate	Rates of surface water runoff from a site that is undeveloped (greenfield).
Ground conditions	The chemical and physical characteristics of the soil at a particular location and how it has been affected by historical land uses. .
Groundwater	All water which is below the surface of the ground in the saturated zone and in direct contact with the ground or subsoil.
Lead Local Flood Authority	Lead Local Flood Authorities have responsibility for developing a Local Flood Risk Management Strategy for their area identifying local sources of flooding. The local strategy produced must be consistent with the national strategy. It will set out the local organisations with responsibility for flood risk in the area, partnership arrangements to ensure co-ordination between these organisations, an assessment of the flood risk, and plans and actions for managing the risk.
Local authority	An administrative body in local government.
Main rivers	The term used to describe a water course in respect of which the Environment Agency has permissive powers in relation to its management.
Major HDDs	Over 200 m in length.
Minor watercourses	The term used to describe a water course owned and operated by a local Drainage Board, a Lead Local Flood Authority or a private land owner.
Onshore elements of Hornsea Three	Hornsea Three landfall, onshore corridor, the onshore HVAC booster station, the onshore HVDC converter/HVAC substation and the interconnection with the Norwich Main National Grid substation.
Ordinary watercourses	A river, stream, ditch, cut, sluice, dyke or non-public sewer that is not a designated Main river, and for which the local authority has flood risk management responsibilities and powers.
River Basin Management Plan	River Basin Management Plans describe the current state of the water environment in the river basin district. It sets out what improvements are possible by 2015 and how the actions will make a difference to the local environment - the catchments, estuaries, the coast and groundwater.
Sequential Test	A Sequential Test aims to steer new development to areas with the lowest probability of flooding by recommending that development is not allocated if there are reasonably available sites appropriate to the proposed development in areas with a lower probability of flooding.
Shoreline Management Plan	A Shoreline Management Plan is a large-scale assessment of the risks associated with coastal processes and sets out a policy framework to address these risks to people and the developed, historic and natural environments. Coastal processes include tidal patterns, wave height, wave direction and the movement of beach and seabed materials.
Strategic Flood Risk Assessment	A Strategic Flood Risk Assessment provides information on areas at risk from all sources of flooding.
Surface water resources	Water on the surface of the land such as in a river, lake, wetland, or ocean.
Surface water runoff	Surface water runoff is flow of water that occurs when excess stormwater, meltwater, or other sources of water flows over a surface.
Sustainable urban Drainage Systems	A sequence of management practices and control measures designed to mimic natural drainage processes by allowing rainfall to infiltrate, and by attenuating and conveying surface water runoff slowly at peak times.
Tidal (Coastal) flooding	Tidal flooding is caused by extreme tidal conditions including high tides and storm surges, overtopping local flood defences or coastal features.

Term		Definition
Treated Effluent		Water that has received primary, secondary or advanced treatment to reduce its pollution or health hazards and is subsequently released from a wastewater facility after treatment.
UK Climate Projections 2009		Climate projections expressed in terms of absolute values. A projection of the response of the climate system to emission scenarios of greenhouse gases and aerosols, or radiative forcing scenarios based upon climate model simulations and past observations.
Undefended Flood Zone		Environment Agency mapped river and sea flood water extents which do not take into account the presence of flood defences.
Water Framework Directive (WFD)	Poor WFD Status	Major change from natural conditions as a result of human activity. Some restrictions on the beneficial uses of the water body. Some impact on amenity. Moderate impact on wildlife and fisheries.
	Moderate WFD Status	Moderate change from natural conditions as a result of human activity. Some restrictions on the beneficial uses of the water body. No impact on amenity. Some impact on wildlife and fisheries.
	Good WFD Status	Slight change from natural conditions as a result of human activity. No restriction on the beneficial uses of the water body. No impact on amenity or fisheries. Protects all but the most sensitive wildlife.
Water Quality		The physical, chemical and biological characteristics of water.

Acronyms

Acronym	Description
CEA	Cumulative Effect Assessment
CoCP	Code of Construction Practices
CFMP	Catchment Flood Management Plan
DB	Drainage Board
DCLG	Department for Communities and Local Government
DCO	Development Consent Order
DECC	Department of Energy and Climate Change
Defra	Department of Food and Rural Affairs
EA	Environment Agency
EIA	Environmental Impact Assessment
EWG	Expert Working Group
FRA	Flood Risk Assessment
IDB	Internal Drainage Board
HDD	Horizontal Directional Drilling
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
LA	Local Authority
LDA 1991	Land Drainage Act 1991
LLFA	Lead Local Flood Authority
MHWS	Mean High Water Springs
NPPF	National Planning Policy Framework
NPS	National Policy Statement
NSIP	Nationally Significant Infrastructure Project
PEIR	Preliminary Environmental Information Report
PPG	Planning Practice Guidance
SAC	Special Area of Conservation
SPZ	Source Protection Zones
SSSI	Sites of Special Scientific Interest
SuDS	Sustainable Urban Drainage Systems
UKCP09	UK Climate Projections 2009
WFD	Water Framework Directive
WRA 1991	Water Resources Act 1991
WRMP	Water Resource Management Plan

Unit

Unit	Description
km	Kilometre (distance)
m	Metre (distance)
ha	Hectare (area)
mm	Millimetre (distance)
m^2	Metre Squared (area)

2. Hydrology and Flood Risk

2.1 Introduction

2.1.1.1 This chapter of the Environmental Statement presents the results of the Environmental Impact Assessment (EIA) for the potential impacts of the Hornsea Project Three offshore wind farm (hereafter referred to as Hornsea Three) on hydrology and flood risk. Specifically, this chapter considers the potential impact of Hornsea Three landward of Mean High Water Springs (MHWS) during its construction, operation and maintenance, and decommissioning phases.

2.1.1.2 Potential impacts of Hornsea Three on geology and ground conditions (including groundwater abstractions) landward of the MHWS are assessed in chapter 1: Geology and Ground Conditions, whilst potential impacts on ecology and nature conservation are assessed in chapter 3: Ecology and Nature Conservation.

2.1.1.3 This chapter summarises information from technical reports which are included at volume 6, annex 2.1: Onshore Infrastructure Flood Risk Assessment, annex 2.2: Environment Agency and Internal Drainage Board Watercourses and Flood Zones, annex 2.3: Surface Water Abstraction Licences, Discharge Consents and Pollution Incidents, annex 2.4: Hydrological Characterisation Report and annex 2.5: Water Framework Directive Surface Water Assessment.

2.2 Purpose of this chapter

2.2.1.1 The primary purpose of the Environmental Statement is to support the Development Consent Order (DCO) application for Hornsea Three under the Planning Act 2008 (the 2008 Act) and accompanies the application to the Secretary of State for Development Consent.

2.2.1.2 It is intended that the Environmental Statement will provide statutory and non-statutory consultees with sufficient information to complete the examination of Hornsea Three and will form the basis of agreement on the content of the DCO.

2.2.1.3 In particular this Environmental Statement chapter:

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

2.3 Study area

2.3.1.1 The Hornsea Three hydrology and flood risk study area is shown on Figure 2.1 and comprises a 250 m buffer around the onshore elements of Hornsea Three (namely the Hornsea Three landfall, the onshore cable corridor, the onshore HVAC booster station, the onshore HVDC converter/HVAC substation and the interconnection with the Norwich Main National Grid substation), as well as the storage areas and compounds. The Hornsea Three hydrology and flood risk study area also includes a 1 km buffer area around the onshore cable corridor, onshore HVAC booster station area and the onshore HVDC converter/HVAC substation area.

2.3.1.2 The accesses fall within the Hornsea Three hydrology and flood risk study area and any impacts from the modifications and use of these accesses have been assessed. No modifications or construction works are proposed at the main compound, however, its use has been considered within the hydrology and flood risk assessment and the mitigation measures in Table 2.17will be applied (as appropriate).

2.3.1.3 The 250 m buffer is considered appropriate for data collection taking into account the nature of the development and likely zone of influence on hydrological receptors. Given the landscape surrounding Hornsea Three and local land use activities, it would be difficult to ascertain the exact source of any impacts on water quality beyond 250 m. The 1 km buffer for the onshore HVAC booster station and HVDC converter/HVAC substation was chosen primarily to identify any existing assets, infrastructure or receptors that have the potential to be affected by the long-term presence of infrastructure constructed above ground in terms of flood risk.

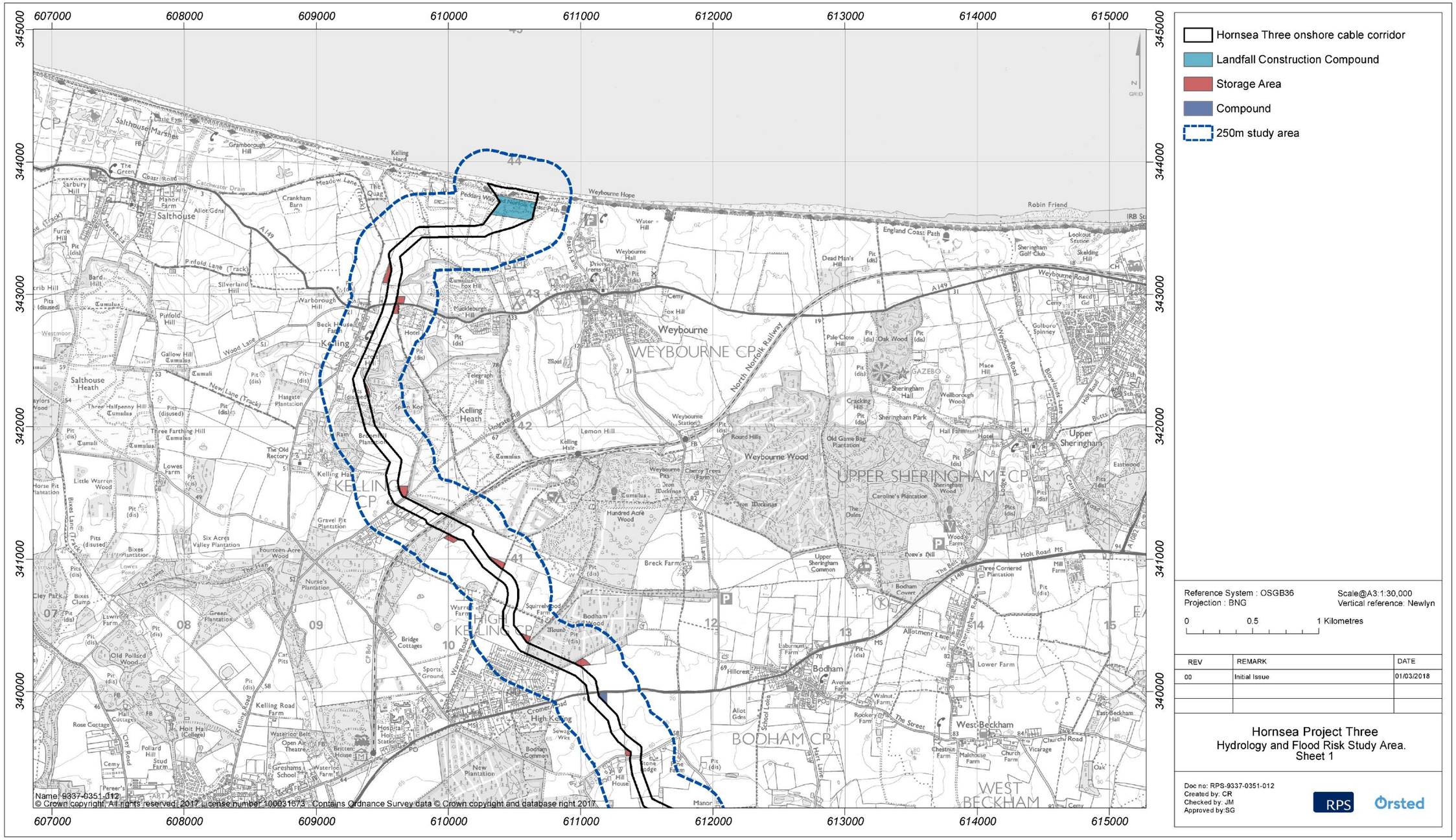


Figure 2.1: Hornsea Three hydrology and flood risk study area.

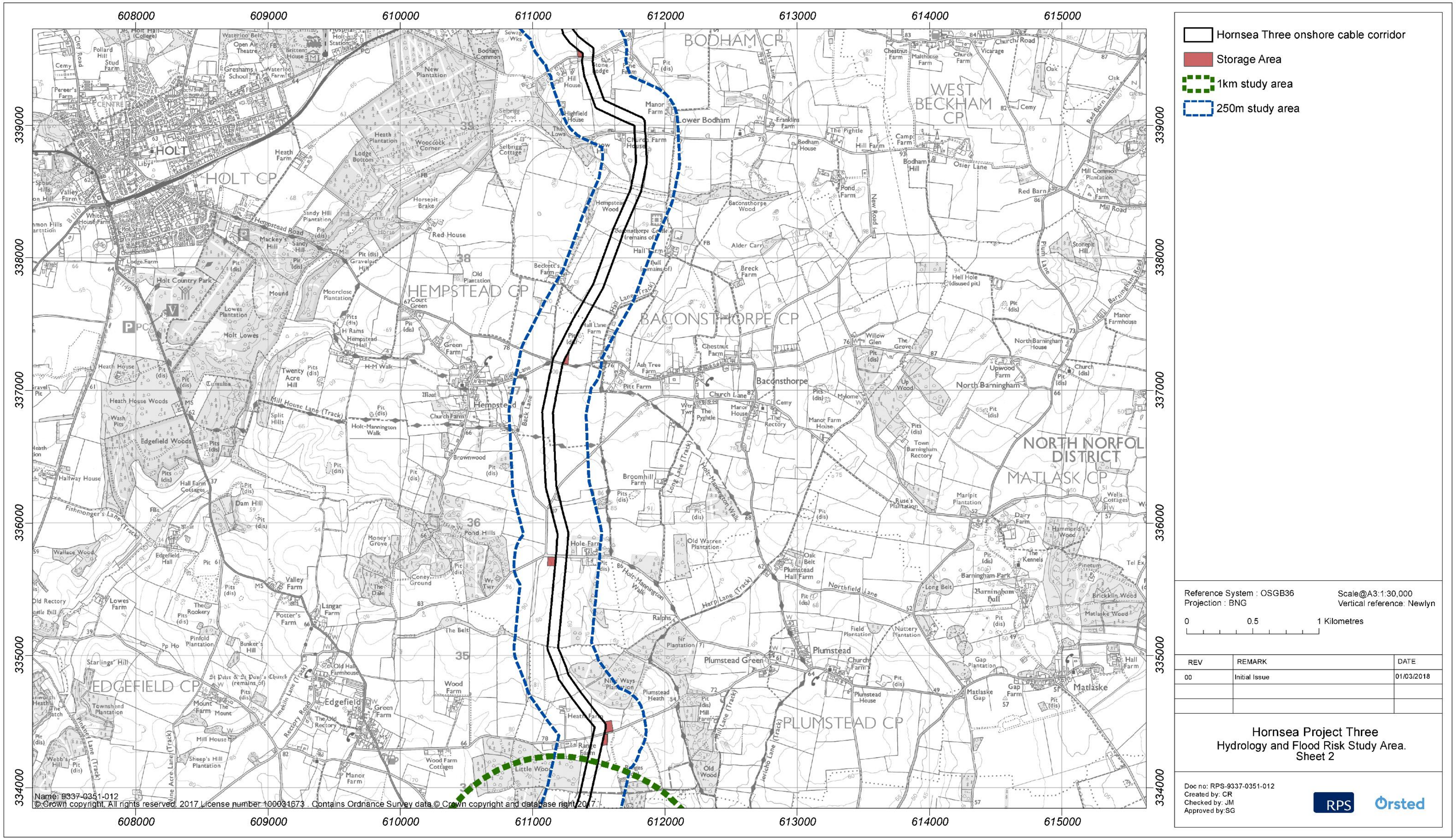
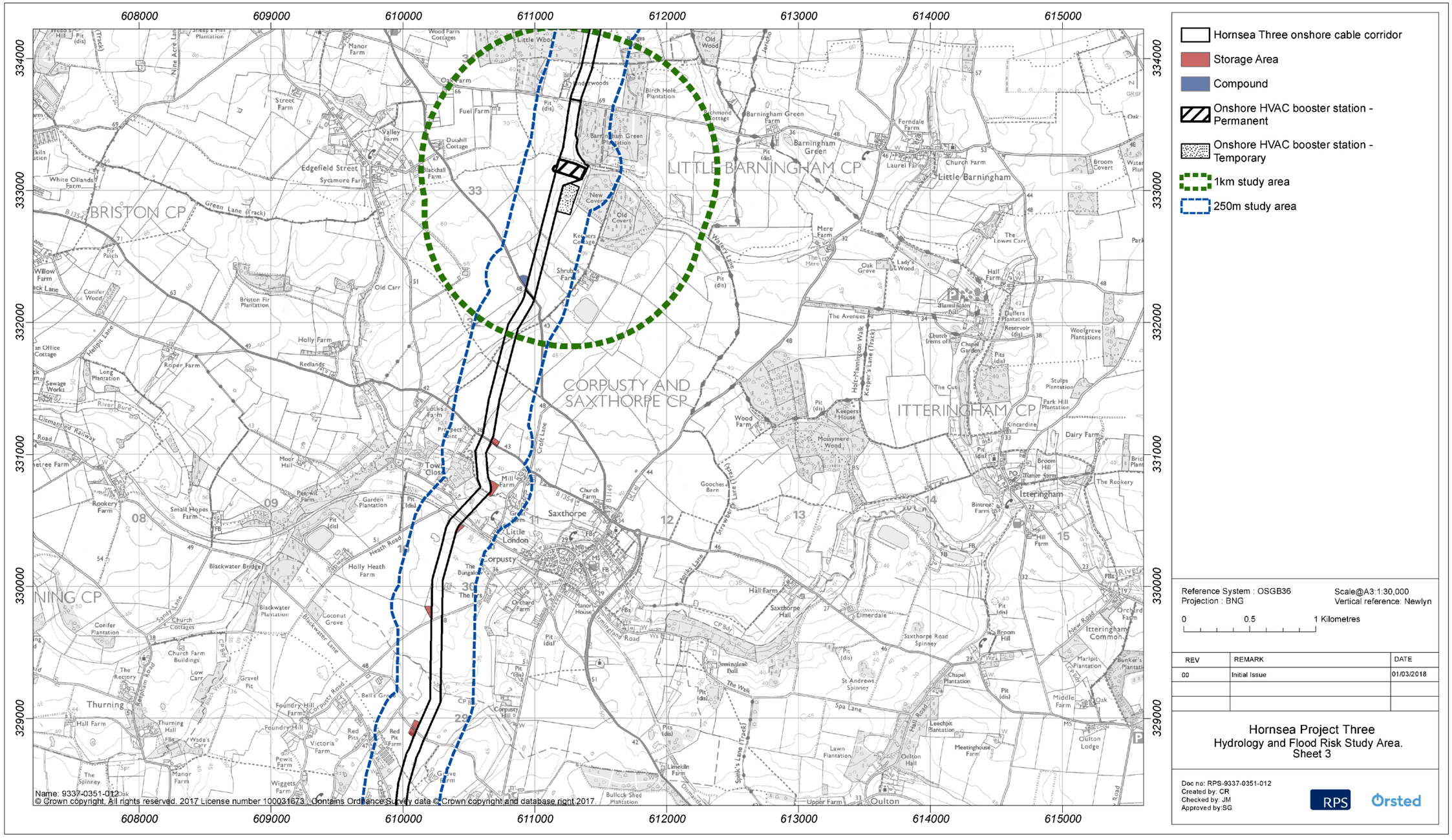


Figure 2.1: Hornsea Three hydrology and flood risk study area.



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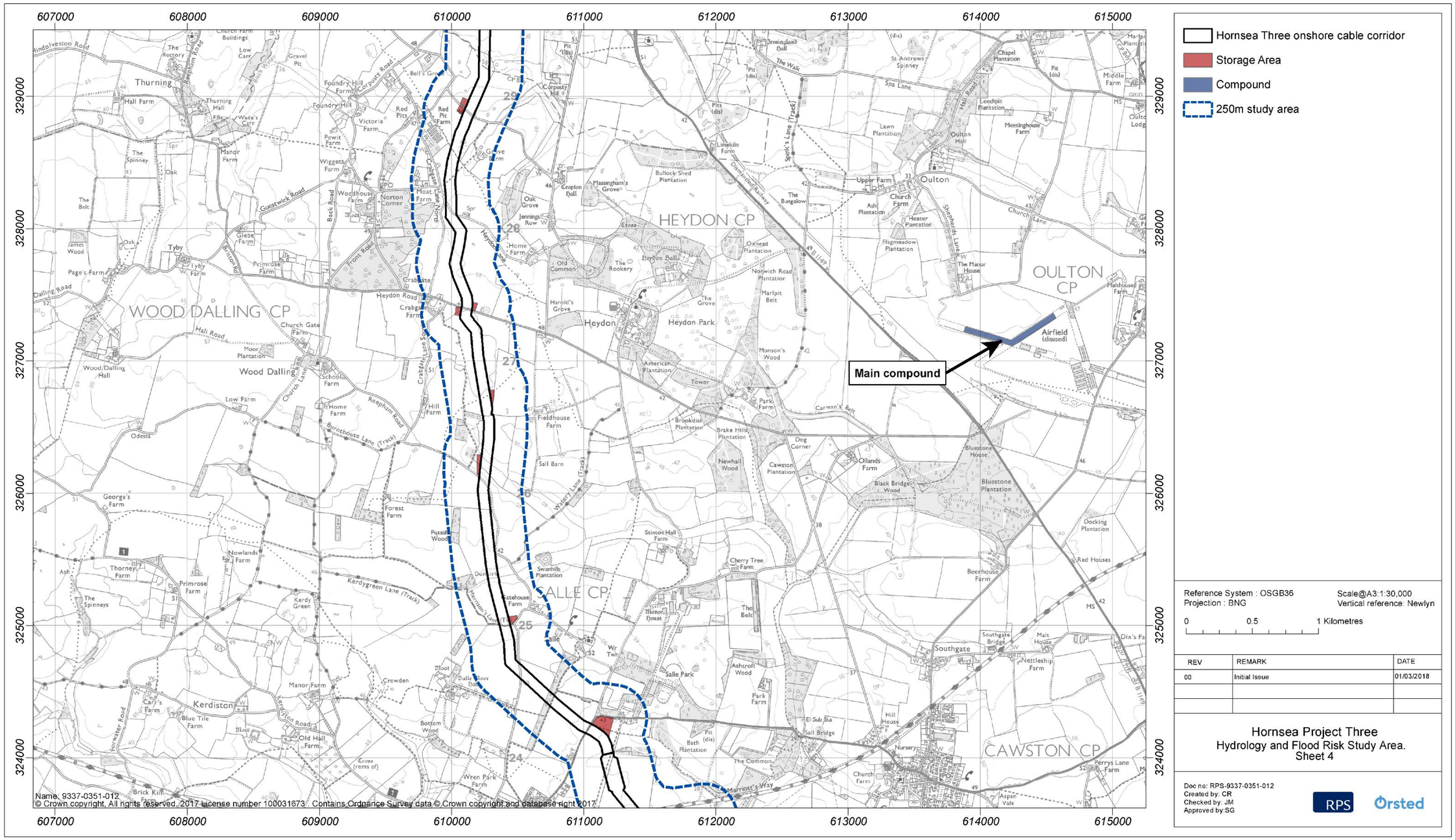

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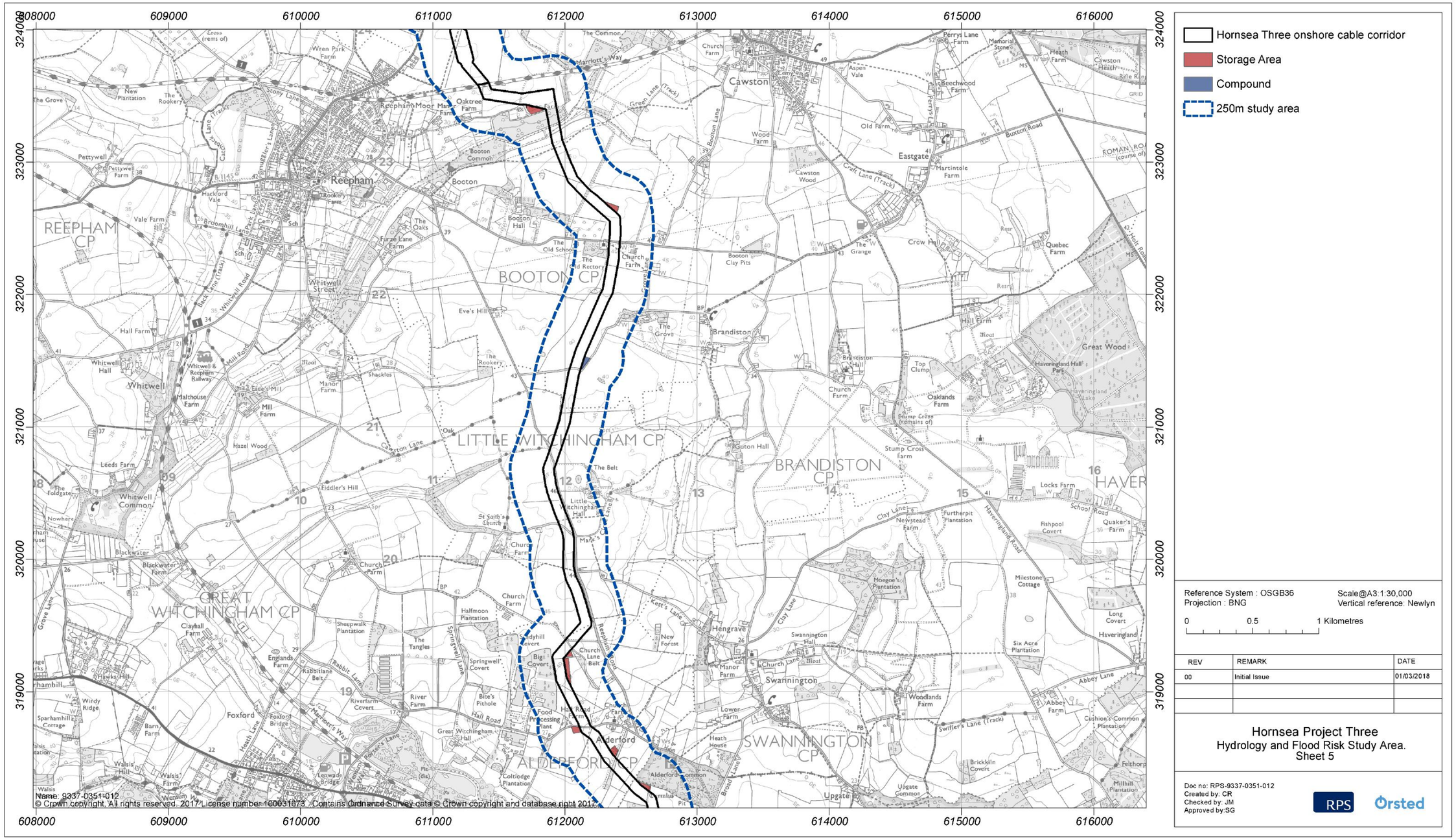

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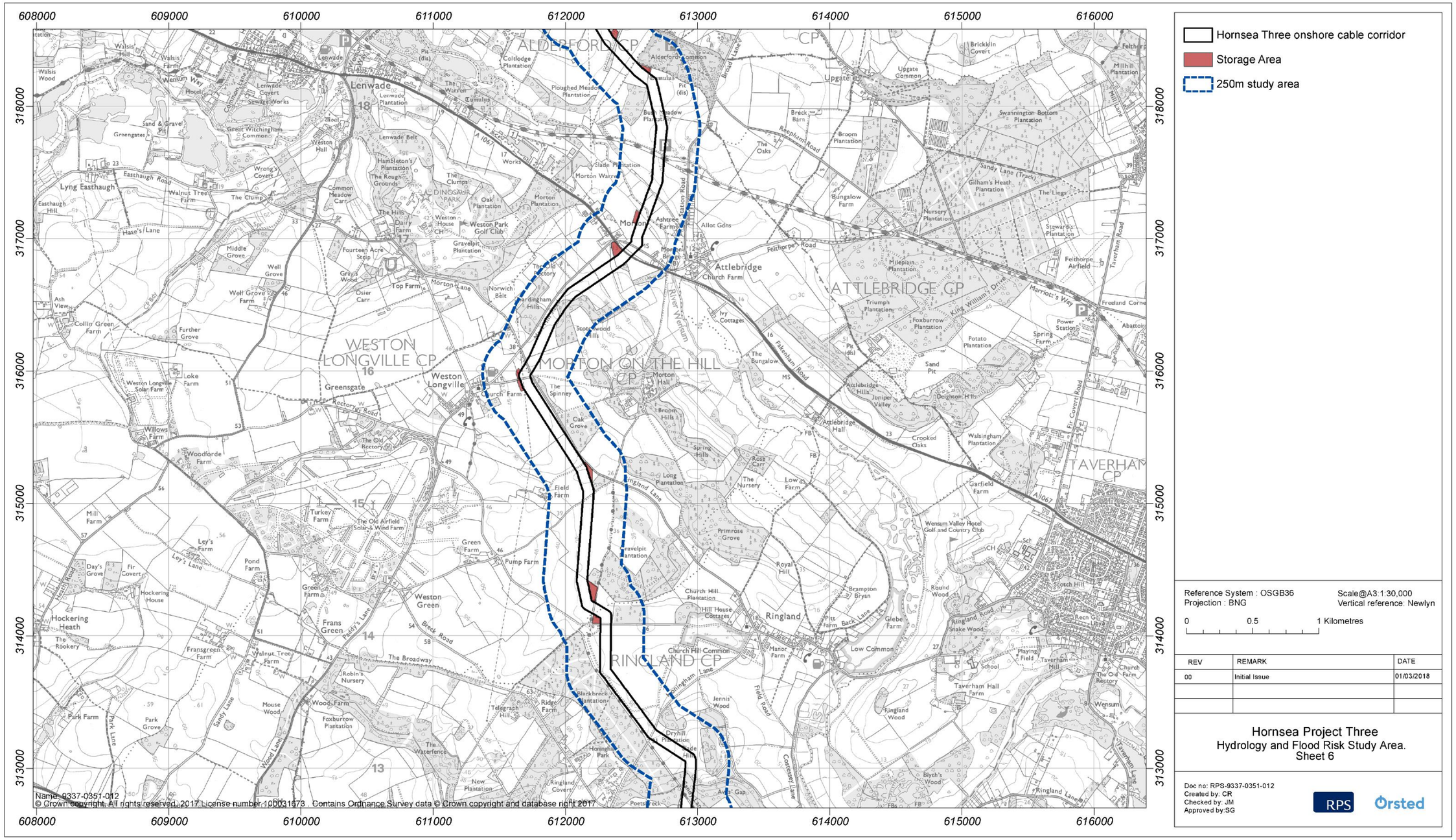

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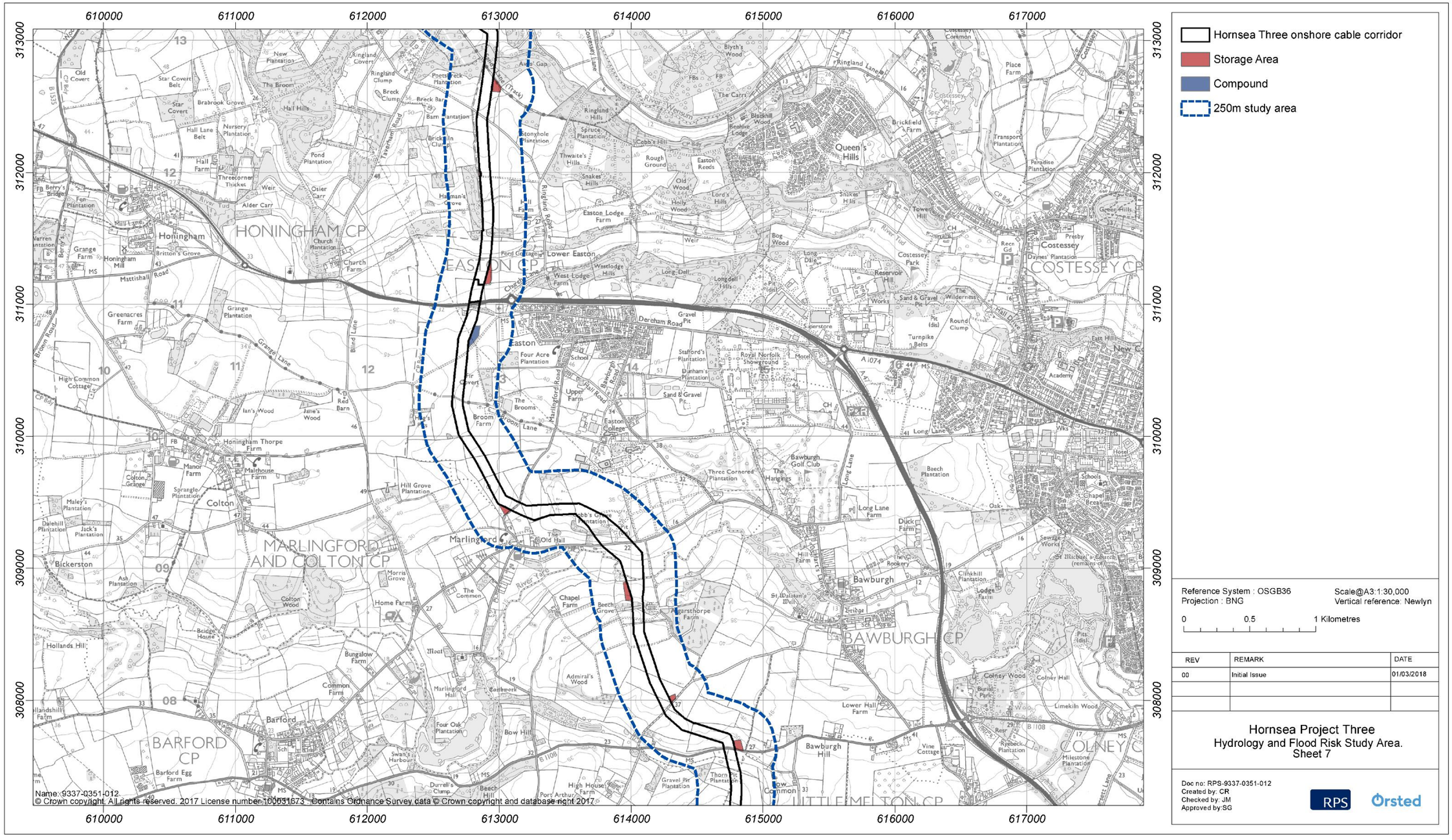

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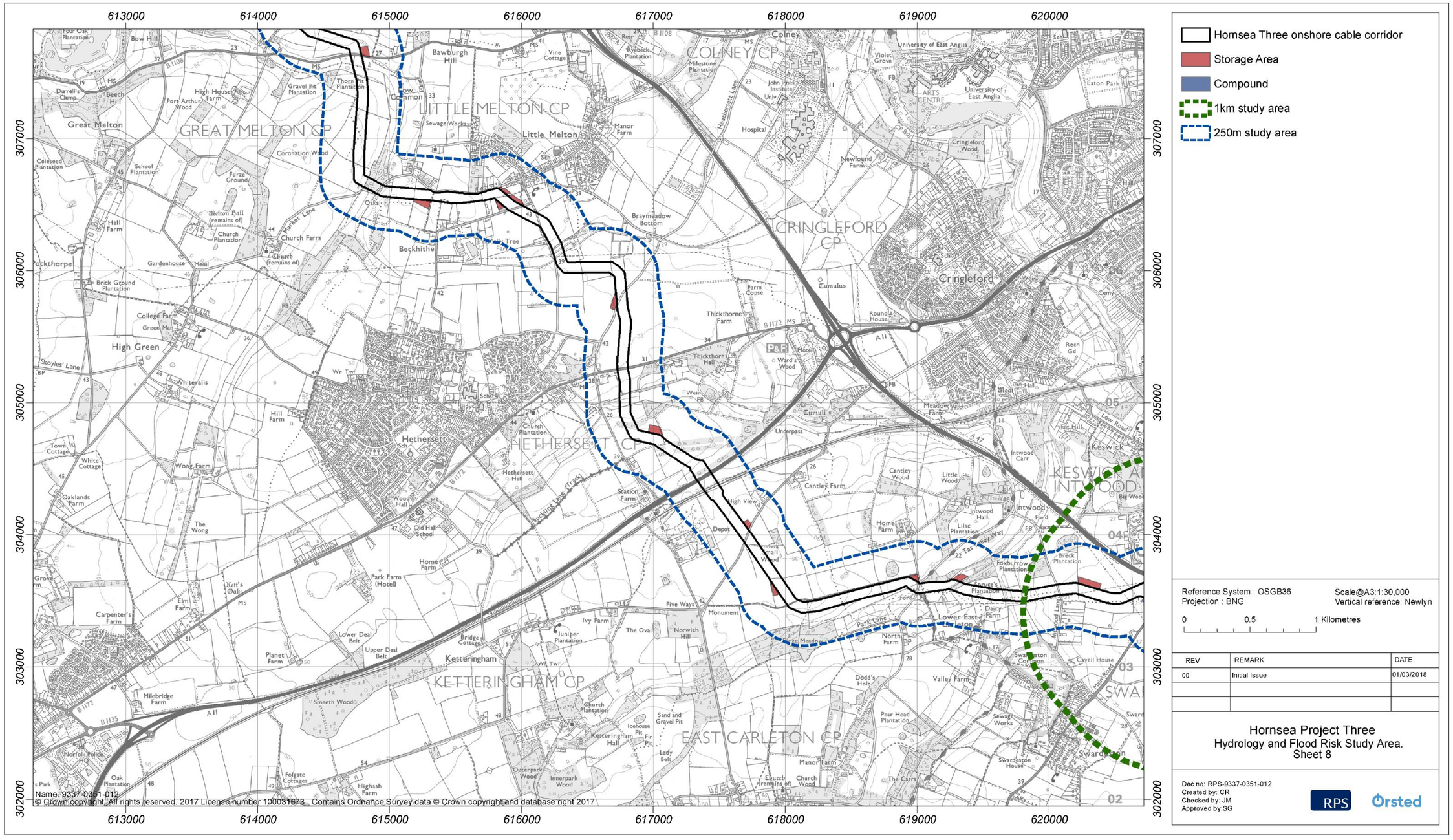

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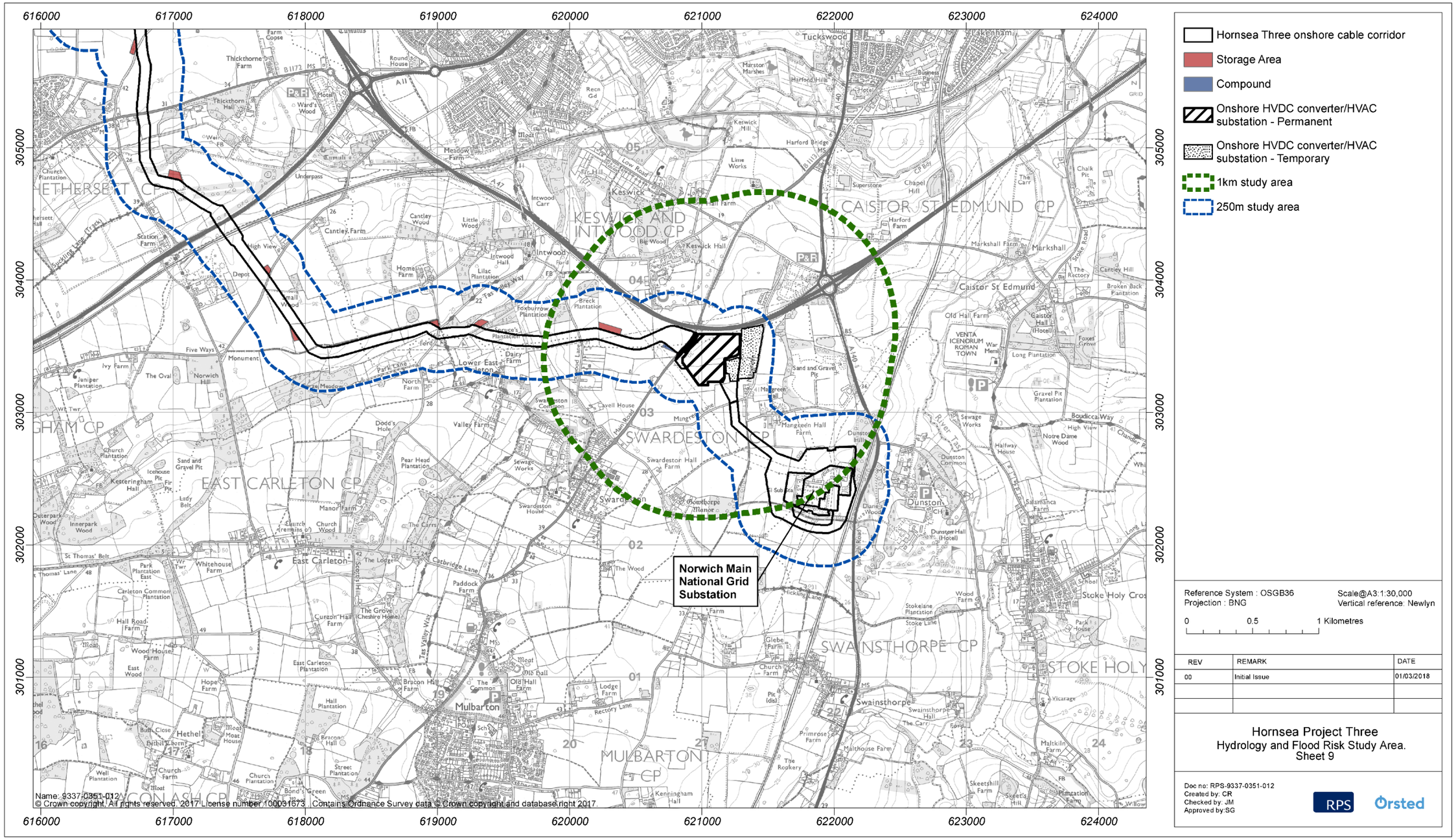

Figure 2.1: Hornsea Three hydrology and flood risk study area.

2.4 Planning policy context

2.4.1 National Policy Statements

2.4.1.1 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 of 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).

2.4.1.2 Specifically, the guidance provided within NPS EN-1, NPS EN-3 and NPS EN-5 was considered. Paragraph 4.8.6 (NPS EN-1) specifically identifies that applicants should have regard to climate change and should assess the resilience of their project to climate change. Paragraph 2.4.1 of NPS EN-5 specifically identifies the potential issues applicants should consider in terms of resilience to climate change. These are summarised in Table 2.1.

Table 2.1: Summary of NPS EN-1, EN-3 and EN-5 provisions relevant to hydrology and flood risk.

Summary of NPS EN-1, NPS EN-3 and NPS EN-5 policy relevant to the assessment of hydrology and flood risk	How and where considered in the Environmental Statement
Climate change adaption	
Applicants for new energy infrastructure must take into account the potential impacts of climate change using the latest UK Climate Projections available at the time the Environmental Statement was prepared to ensure they have identified appropriate mitigation or adaptation measures. This should cover the estimated lifetime of the new infrastructure. Should a new set of UK Climate Projections become available after the preparation of the Environmental Statement, the decision maker should consider whether they need to request further information from the applicant (paragraph 4.8.6 NPS, EN-1).	The characterisation of the flood risk baseline and future baseline has been established using the Environment Agency (EA) Flood Map for Planners and Strategic Flood Risk Assessments, which take into account climate change (see section 2.7.11). A site specific flood risk assessment FRA has been undertaken for the onshore HVAC booster station, HVDC converter/HVAC substation areas and onshore cable corridor in line with the National Planning Policy Framework (NPPF), Planning Practice Guidance (PPG) ID7 – Flood Risk and Coastal Change and includes a climate change allowance based on findings of the UK Climate Projections report (UKCP09) (2010).
Offshore and onshore wind farms are less likely to be affected by flooding but applicants should particularly set out how the proposal would be resilient to storms (paragraph 2.3.4, of NPS EN-3).	Resilience to storms is discussed in volume 2, chapter 1: Marine Processes in relation to the Hornsea Three intertidal area. The resilience to flood risk along the Hornsea Three onshore cable corridor and at the onshore HVAC booster station and onshore HVDC converter/HVAC substation are set out within this chapter, Table 2.17) and volume 6, annex 2.1: Onshore Infrastructure FRAs.
As climate change is likely to increase risks to the resilience of some electricity infrastructure from flooding, for example, in situations where it is located near the coast or is underground, applicants should in particular set out to what extent the proposed development is expected to be vulnerable, and as appropriate, how it would be resilient to flooding, particularly for substations that are vital for the electricity transmission and distribution network (paragraph 4.4.1, NPS EN-5).	Flood Risk Assessments (FRAs) have been prepared for the proposed onshore HVAC booster station, HVDC converter/HVAC substation and the Hornsea Three onshore cable corridor. The FRA forms volume 6, annex 2.1: Onshore Infrastructure FRAs.
Flood risk	
Applications for energy projects of 1 ha or greater in Flood Zone 1 in England and all proposals for energy projects located on Flood Zone 2 and 3 in England should be accompanied by an FRA. An FRA will also be required where an energy project less than 1 ha may be subject to sources of flooding other than rivers and the sea (for example surface water), or where the EA, Drainage Board (DB) or other body have indicated that there may be drainage problems. The FRA should identify and assess the risks of all forms of flooding to and from the project and demonstrate how these flood risks will be managed, taking climate change into account (paragraph 5.7.4, of NPS EN-1).	FRAs have been prepared for the proposed onshore HVAC booster station, HVDC converter/HVAC substation and Hornsea Three onshore cable corridor as each site exceeds 1 ha or is partially located within Flood Zone 2 and 3. The FRAs are contained in volume 6, annex 2.1: Onshore Infrastructure FRAs.
The minimum requirements for FRAs provided by applicants are that they should: • Be proportionate to the risk and appropriate to the scale, nature and location of the project; • Consider the risk of flooding arising from the project in addition to the risk of flooding to the project; • Take the impacts of climate change into account, clearly stating the development lifetime over which the assessment has been made; • Be undertaken by competent people, as early as possible in the process of preparing the proposal; • Consider both the potential adverse and beneficial effects of flood risk management infrastructure, including raised defences, flow channels, flood storage areas and other artificial features, together with the consequences of their failure; • Consider the vulnerability of those using the site, including arrangements for safe access; • Consider and quantify the different types of flooding (whether from natural and human sources and including joint and cumulative effects) and identify flood risk reduction measures, so that assessments are fit for the purpose of the decisions being made; • Consider the effects of a range of flooding events including extreme events on people, property, the natural and historic environment and river and coastal processes; • Include the assessment of the remaining (known as 'residual') risk after risk reduction measures have been taken into account and demonstrate that this is acceptable for the particular project; • Consider how the ability of water to soak into the ground may change with development, along with how the proposed layout of the project may affect drainage systems;	FRAs fulfilling the requirements stipulated within NPS EN-1 have been prepared. The FRAs are contained in volume 6, annex 2.1: Onshore Infrastructure FRAs.

Summary of NPS EN-1, NPS EN-3 and NPS EN-5 policy relevant to the assessment of hydrology and flood risk	How and where considered in the Environmental Statement
• Consider if there is a need to be safe and remain operational during a worst case flood event over the development's lifetime; and • Be supported by appropriate data and information, including historical information on previous events. (paragraph 5.7.5, NPS EN-1)	
Further guidance can be found in Practice Guide which accompanies Planning Policy Statement 25 (PPS25) or successor documents (paragraph 5.7.6, NPS EN-1).	FRAs have been prepared taking into account the requirements of NPPF and PPG ID7 on flood risk. The FRAs are contained in volume 6, annex 2.1: Onshore Infrastructure FRAs.
Applicants for the projects which may be affected by, or may add to, flood risk should arrange pre-application discussions with the EA and, where relevant other bodies such as DBs, sewerage undertakers, highways authority and reservoir owners and operators (paragraph 5.7.7, of NPS EN-1).	The EA, Norfolk County Council (Lead Local Flood Authority (LLFA)) and Norfolk Rivers Internal Drainage Board (IDB) have been consulted as detailed in Table 2.4.
Consultation on the assessment methodologies should be undertaken at early stages with the EA (paragraph 5.7.8, of NPS EN-1).	The EA, LLFA and Norfolk Rivers IDB have been consulted as detailed in Table 2.4.
Water quality and resources	
The applicant should undertake an assessment of the existing status of, and impacts of the proposed project on water quality, water resources and physical modifications to the water environment (paragraph 5.15.2, of NPS EN-1).	The baseline environment (see section 2.7) is described for the Hornsea Three hydrology and flood risk study area. An assessment of the impacts on water quality, resources and physical characteristics is provided in paragraphs 2.11.1.10 to 2.11.1.19.
The Environmental Statement should in particular describe: • The existing quality of waters affected by the proposed project and the impacts of the proposed project on water quality, noting any relevant existing discharges, proposed new discharges and proposed changes to discharges; • Existing water resources affected by the proposed project and the impacts of the proposed project on water resources, noting any relevant existing abstraction rates, proposed new abstraction rates and proposed changes to abstraction rates (including any impact on or use of mains supplies and reference to Catchment Abstraction Management Strategies); • Existing physical characteristics of the water environment (including quantity and dynamics of flow) affected by the proposed project and any impact of physical modifications to these characteristics; and • Any impacts of the proposed project on water bodies or protected areas under the Water Framework Directive (WFD) and Source Protection Zones (SPZs) around potable groundwater abstractions. (paragraph 5.15.3, NPS EN-1)	Baseline water quality and resources for the Hornsea Three hydrology and flood risk study area are described in section 2.7. Watercourses in the Hornsea Three hydrology and flood risk study area have been identified and information on abstractions, discharges, pollution incidents and water quality has been provided (see volume 6, annex 2.3: Surface Water Abstraction Licences, Discharge Consents and Pollution Incidents). The impacts on surface water courses are described in section 2.7. The impacts on SPZs are covered in chapter 1: Geology and Ground Conditions. A review of the WFD classifications for watercourses within the Hornsea Three hydrology and flood risk study area has been undertaken (see Table 2.7). Detailed WFD assessment works are presented in volume 6, annex 2.5: Water Framework Directive Assessment Hydrology Assessment.

2.4.1.3 NPS EN-1 and NPS EN-3 also highlight a number of points 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 NPS EN-3 policy on decision making relevant to this chapter.

Summary of NPS EN-1 policy on decision making (and mitigation) in relation to hydrology and flood risk	How and where considered in the Environmental Statement
Climate change adaption	
The decision maker should be satisfied that there are no features of the design of new energy infrastructure critical to its operation which may be seriously affected by more radical changes to the climate beyond that projected in the latest set of UK climate projections, taking account of the latest credible scientific evidence on, for example, sea level rise (for example by referring to additional maximum credible scenarios – i.e. from the Intergovernmental Panel on Climate Change or EA) and that necessary action can be taken to ensure the operation of the infrastructure over its estimated lifetime (paragraph 4.8.8, NPS EN-1).	Climate change has been taken into account in the characterisation of the baseline and future baseline environment (see paragraphs 2.7.11.1 to 2.7.11.8). Climate change is also considered in the FRA (see volume 6, annex 2.1: Onshore Infrastructure FRAs).
Flood risk	
The decision maker should be satisfied that where relevant: the application is supported by an appropriate FRA; the Sequential Test has been applied as part of site selection; a sequential approach has been applied at the site level to minimise risk by directing the most vulnerable uses to areas of lowest flood risk; the proposal is in line with any relevant national and local flood risk management strategy; priority has been given to the use of Sustainable urban Drainage Systems (SuDS) (as required in the next paragraph on National Standards); and in flood risk areas the project is appropriately flood resilient and resistant, including safe access and escape routes where required, and that any residual risk can be safely managed over the lifetime of the development (paragraph 5.7.9, NPS EN-1).	FRAs have been prepared, (see volume 6, annex 2.1: Onshore Infrastructure FRAs) which consider the flood risks from Hornsea Three. The FRAs note that the development is sequentially acceptable. The FRAs have been undertaken in line with NPS EN-1, NPPF and PPG ID7 - Flood Risk and Coastal Change. An outline drainage strategy has also been prepared in line with SuDS, the key points of which are summarised in volume 6, annex 2.1: Onshore Infrastructure FRAs.
The decision maker will need to be satisfied that the proposed drainage system complies with any National Standards published by Ministers under Paragraph 5(1) of Schedule 3 to the Flood and Water Management Act 2010. In addition, the DCO, or any associated planning obligations, will need to make provision for the adoption and maintenance of any SuDS, including any necessary access rights to property. The decision maker should be satisfied 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. The responsible body could include, for example, the applicant, the landowner, the relevant local authority, or another body, such as a DB (paragraph 5.7.10, NPS EN-1).	Drainage strategies have been prepared and are provided in volume 6, annex 2.1: Onshore Infrastructure FRAs. The proposed drainage strategies have been developed in accordance with the NPS, NPPF, PPG ID7 and the SuDS Manual, whereby sufficient attenuation storage is provided for 1 in 100 year plus climate change worst case storm event. Drainage provisions will be set out in an agreement with the relevant LLFA.

Summary of NPS EN-1 policy on decision making (and mitigation) in relation to hydrology and flood risk	How and where considered in the Environmental Statement
The decision maker should not consent development in Flood Zone 2 in England unless it is satisfied that the Sequential Test requirements have been met. It should not consent development in Flood Zone 3 or Zone C unless it is satisfied that the Sequential and Exception Test requirements have been met. The technology-specific NPSs set out some exceptions to the application of the Sequential Test. However, when seeking development consent on a site allocated in a development plan through the application of the Sequential Test, informed by a strategic flood risk assessment, applicants need not apply the Sequential Test, but should apply the sequential approach to locating development within the site. (Paragraph 5.7.12, NPS EN-1).	The proposed onshore HVDC converter/HVAC substation, HVAC booster station and the majority of the Hornsea Three onshore cable corridor are shown to be located entirely within Flood Zone 1 (volume 6, annex 2.1: Onshore Infrastructure FRAs), therefore, the Sequential Test has been met and an Exception Test is not required. Along the remainder of the Hornsea Three onshore cable corridor, localised areas associated with main rivers and ordinary watercourses are defined as Flood Zone 2 and 3 and therefore require an Exception Test. The Hornsea Three onshore cable corridor is needed to connect the landfall area to the onshore HVDC converter/HVAC substation and is unable to be routed without crossing the areas within Flood Zone 3. Therefore, on this basis, the Sequential Test has considered to be passed. The approach to flood risk and the assessment are described in the FRA (see volume 6, annex 2.1: Onshore Infrastructure FRAs) and has been summarised in this chapter (see paragraph 2.6.2.2 and 2.6.2.3). A localised low-lying area of the onshore HVDC converter/HVAC substation is shown to be at risk from surface water flooding. Appropriate mitigation measures are outlined within the FRA (volume 6, annex 2.1: Onshore Infrastructure FRAs).
Preference should be given to locating projects in Flood Zone 1 in England. If there is no reasonably available site in Flood Zone 1, then projects can be located in Flood Zone 2. If there is no reasonably available site in Flood Zones 1 or 2, then nationally significant energy infrastructure projects can be located in Flood Zone 3 subject to the Exception Test. Consideration of alternative sites should take account of the policy on alternatives (paragraph 5.7.13, NPS EN-1).	The entirety of the onshore HVAC booster station, the HVDC converter/HVAC substation and the majority of the onshore cable corridor are located in Flood Zone 1 (as described in paragraphs 2.7.10.2 to 2.7.10.7). The approach to flood risk and the assessment are described in the FRA (see volume 6, annex 2.1: Onshore Infrastructure FRAs) and has been summarised in this chapter (see paragraphs 2.6.2.2 and 2.6.2.3). Alternative sites are discussed in volume 1, chapter 4: Site Selection and Consideration of Alternative Sites. The Sequential and Exception tests are passed for those areas of the onshore cable corridor within Flood Zone 3 because the cable route has to cross watercourses in order to link the landfall to the HVDC converter/HVAC substation and Norwich Main National Grid Substation.
The decision maker will find an Exception Test to be only appropriate for use where the Sequential Test alone cannot deliver an acceptable site, taking into account the need for energy infrastructure to remain operational during floods. It may also be appropriate to use it where as a result of the alternative site(s) at lower risk of flooding being subject to national designations such as landscape, heritage and nature conservation designations, for example Areas of Outstanding Natural Beauty, Sites of Special Scientific Interest (SSSIs) and World Heritage Sites it would not be appropriate to require the development to be located on the alternative site(s) (paragraph 5.7.15, NPS EN-1).	The approach to flood risk and the assessment are described in the FRA (see volume 6, annex 2.1: Onshore Infrastructure FRAs) and has been summarised in this chapter (see paragraph 2.6.2.2 and 2.6.2.3). The Sequential Test has been applied and the onshore HVAC booster station, HVDC converter/HVAC substation and the majority of the Hornsea Three landfall area; all of which were found to be acceptable and therefore an Exception Test is not required. The Hornsea Three onshore cable corridor connects the landfall area with the onshore HVAC booster station and the HVDC converter/HVAC substation. The Sequential and Exception Test are considered to be passed (see above).
If an Exception Test is required the decision maker will have to be satisfied that all three elements of the test will have to be passed for development to be consented. For the Exception Test to be passed: • "*It must be demonstrated that the project provides wider sustainability benefits to the community that outweigh flood risk;* • *The project should be on developable, previously developed land or, if it is not on previously developed land, that there are no reasonable alternative sites on developable, previously developed land subject to any exceptions set out in the technology-specific NPSs; and* • *An FRA must demonstrate that the project will be safe, without increasing flood risk elsewhere subject to the exception below and, where possible, will reduce flood risk overall*". (paragraph 5.7.16, NP EN-1)	An Exception Test is not required as the Sequential Test demonstrated that the onshore HVAC booster station, HVDC converter/HVAC substation and the majority of the Hornsea Three onshore cable corridor are acceptable as described in the FRA (see volume 6, annex 2.1: Onshore Infrastructure FRAs). For the localised areas of the onshore cable corridor within Flood Zones 2 and 3, the Sequential and Exception Test are considered to be passed because the route of the corridor is required to link the landfall and HVDC converter/HVAC substation.

Summary of NPS EN-1 policy on decision making (and mitigation) in relation to hydrology and flood risk	How and where considered in the Environmental Statement
To satisfactorily manage flood risk, arrangements are required to manage surface water and the impact of the natural water cycle on people and property. The term SuDS refers to the whole range of sustainable approaches to surface water drainage management including, where appropriate: • Source control measures including rainwater recycling and drainage; infiltration devices to allow water to soak into the ground, that can include: • Individual soakaways and communal facilities; • Filter strips and swales, which are vegetated features that hold and drain water downhill mimicking natural drainage patterns; • Filter drains and porous pavements to allow rainwater and runoff to infiltrate into permeable material below ground and provide storage if needed; • Basins ponds and tanks to hold excess water after rain and allow controlled discharge that avoids flooding; and • Flood routes to carry and direct excess water through developments to minimise the impact of severe rainfall flooding. Site layout and surface water drainage systems should cope with events that exceed the design capacity of the system, so that excess water can be safely stored on or conveyed from the site without adverse impacts. The surface water drainage arrangements for any project should be such that the volumes and peak flow rates of surface water leaving the site are no greater than the rates prior to the proposed project, unless specific off-site arrangements are made and result in the same net effect. It may be necessary to provide surface water storage and infiltration to limit and reduce both the peak rate of discharge from the site and the total volume discharged from the site. There may be circumstances where it is appropriate for infiltration facilities or attenuation storage to be provided outside the project site, if necessary through the use of a planning obligation (paragraph 5.7.18 to 5.7.22, NPS EN-1).	Drainage strategies have been developed in accordance with the NPS, NPPF, PPG ID7 and the SuDS Manual, whereby sufficient attenuation storage is provided for 1 in 100 year plus climate change worst case storm event The approach to flood risk is presented in volume 6, annex 2.1: Onshore Infrastructure FRAs and has been summarised in this chapter (see paragraph 2.6.2.2 and 2.6.2.3).
The sequential approach should be applied to the layout and design of the project. More vulnerable uses should be located on parts of the site at lower probability and residual risk of flooding. Applicants should seek opportunities to use open space for multiple purposes such as amenity, wildlife habitat and flood storage uses. Opportunities should be taken to lower flood risk by reducing the built footprint of previously developed sites and using SuDS. Essential energy infrastructure which has to be located in flood risk areas should be designed to remain operational when floods occur. In addition, any energy projects proposed in Flood Zone 3b the Functional Floodplain (where water has to flow or be stored in times of flood), or Zone C2 in Wales, should only be permitted if the development will not result in a net loss of floodplain storage, and will not impede water flows. The receipt of and response to warnings of floods is an essential element in the management of the residual risk of flooding. Flood warning and evacuation plans should be in place for those areas at an identified risk of flooding. The applicant should take advice from the emergency services when producing an evacuation plan for a manned energy project as part of the FRA. Any emergency planning documents, flood warning and evacuation procedures that are required should be identified in the FRA (paragraph 5.7.23 to 5.7.25, NPS EN-1).	The entirety of the onshore HVAC booster station and HVDC converter/HVAC substation areas are located in Flood Zone 1 (as described in paragraphs 2.7.10.2 to 2.7.10.7). The Sequential Test has been passed. The drainage design will incorporate drainage measures in line with the requirements of NPS EN-1 and the NPPF. The approach to flood risk and the proposed drainage strategy is presented in volume 6, annex 2.1: Onshore Infrastructure FRAs and has been summarised in this chapter (see paragraph 2.6.2.2 and 2.6.2.3).
Water quality and resources	
The decision maker should satisfy itself that a proposal has regard to the River Basin Management Plans and meets the requirements of the WFD and its daughter directives, including those on priority substances and groundwater. The specific objectives for particular river basins are set out in River Basin Management Plans. The decision maker should also consider the interactions of the proposed project with other plans such as Water Resources Management Plans (WRMPs) and Shoreline/Estuary Management Plans (paragraph 5.15.6, NPS EN-1).	The assessment and the proposed mitigation measures have taken into account the requirements of the River Basin Management Plan and WFD to ensure all potential impacts on the water environment are mitigated to within acceptable levels (see Table 2.17).
The decision maker 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, NPS EN-1).	This has been described and considered in relation to the site flood risk and hydrology within the assessment of Hornsea Three.
The decision maker considers whether mitigation measures are needed over and above any which may form part of the project application. A construction management plan may help codify mitigation at that stage. The risk of impacts on the water environment can be reduced through careful design to facilitate adherence to good pollution control practice. For example, designated areas for storage and unloading, with appropriate drainage facilities, should be clearly marked. The impact on local water resources can be minimised through planning and design for the efficient use of water, including water recycling (paragraphs 5.15.8 to 5.15.10, NPS EN-1).	The approach to flood risk is presented in volume 6, annex 2.1: FRAs and has been summarised in this chapter (see paragraph 2.6.2.2 and 2.6.2.3). Appropriate mitigation measures are set out in Table 2.17 and an Outline Code of Construction Practice (CoCP) (document reference A8.5) has been prepared as part of the DCO application.

2.4.2 Other relevant policies

2.4.2.1 A number of other policies are relevant to hydrology and flood risk including:

- National Planning Policy Framework (NPPF) (2012);
- Web-based planning practice guidance is provided by the Department for Communities and Local Government (DCLG) - Flood Risk and Coastal Change (updated in March 2014);
- North Norfolk District Council Core Strategy (2008); and
- Joint Core Strategy for Broadland, Norwich and South Norfolk (2011).

2.4.2.2 Key provisions of these policies are set out in Table 2.3 along with details as to how these have been addressed within the assessment.

Table 2.3: Summary of other relevant policies relevant to hydrology and flood risk.

Summary of other relevant policy provision	How and where considered in the Environmental Statement
National Planning Policy Framework	
A site specific FRA is required for all proposals for new development in Flood Zones 2 and 3, and for any proposed development covering an area of 1 ha or greater in Flood Zone 1 (paragraph 99 to 108 of the NPPF).	The approach to flood risk is presented in volume 6, annex 2.1: Onshore Infrastructure FRAs and has been summarised in this chapter (see paragraph 2.6.2.2 and 2.6.2.4).
National Planning Practice Guidance	
PPG provides planning guidance on a range of topics including flood risk. PPG ID7 (March 2014) for Flood Risk and Coastal Change provides additional guidance in the implementation of the NPPF in relation to development and flood risk.	The FRAs have been undertaken in line with NPPF and PPG ID7 - Flood Risk and Coastal Change (see volume 6, annex 2.1: Onshore Infrastructure FRAs.
Local Planning Policy	
North Norfolk District Council Core Strategy (2008) Policy EN 10 of the adopted Local Development Framework, covers Hydrology and Flood Risk: "*The Sequential Test will be applied rigorously across North Norfolk and most new development should be located in Flood Risk Zone 1. New development in Flood Risk Zones 2 and 3a will be restricted to the following categories:* • *water compatible uses;* • *minor development;* • *changes of use (to an equal or lower risk category in the flood risk vulnerability classification);* • *where there is no operational development; and* • *'Less vulnerable' uses where the Sequential Test has been passed* • *New development in Flood Zone 3b will be restricted to water compatible uses only."* The Strategic Flood Risk Assessment defines zones 2, 3a and 3b in parts of North Norfolk and this will be used to inform the application of the Sequential Test. Where this information is not available, the EA Flood Risk Zones and a site specific FRA will be used to apply the Sequential Test. *"A site-specific FRA which takes account of future climate change must be submitted with appropriate planning applications in Flood Zones 2, 3a and 3b and for development proposals of 1 hectare or greater in Flood Zone 1.* *Land in Flood Zone 1 that is surrounded by areas of Flood Zones 2 or 3 will be treated as if it is in the higher risk zone and a FRA will be required to prove that safe access / egress exists for the development or that the land will be sustainable for the duration of the flood period. Appropriate surface water drainage arrangements for dealing with surface water runoff from new development will be required. The use of SuDS will be the preference unless, following an adequate assessment, soil conditions and / or engineering feasibility dictate otherwise."* (EN 10, North Norfolk District Council Core Strategy).	The entirety of the onshore HVAC booster station and the HVDC converter/HVAC substation and the majority of the Hornsea Three onshore cable corridor are located in Flood Zone 1 (as described in paragraphs 2.7.10) The Sequential Test has been applied and has been passed. For the localised areas of the onshore cable corridor within Flood Zones 2 and 3, the Sequential and Exception Test are considered to be passed because the route of the corridor is required to link the landfall and HVDC converter/HVAC substation. The approach to flood risk is presented in annex 2.1: Onshore Infrastructure FRAs and has been summarised in this chapter (see paragraph 2.6.2.3).
Joint Core Strategy for Broadland, Norwich and South Norfolk (2011) Policy 1 Addressing climate change and protecting environmental assets *"To address climate change and promote sustainability, all development will be located and designed to use resources efficiently, minimise greenhouse gas emissions and be adapted to a changing climate and more extreme weather. Development will therefore….be located to minimise flood risk, mitigating any such risk through design and implementing sustainable drainage".*	The entirety of the onshore HVAC booster station and the HVDC converter/HVAC substation and the majority of the Hornsea Three onshore cable corridor are located in Flood Zone 1 (as described in paragraphs 2.7.10).
Broadland District Council Development Management DPD (2015) Policy CSU5 – Surface water drainage "*Mitigation measures to deal with surface water arising from development proposals should be incorporated to minimise the risk of flooding on the development site without increasing flooding elsewhere".*	An outline drainage strategy has been prepared which sets out how surface water runoff will be managed at the onshore HVAC booster station and HVDC converter/HVAC substation.

2.5 Consultation

2.5.1.1 Table 2.4 below summarises the issues raised relevant to hydrology and flood risk, which have been identified during consultation activities to date. Table 2.4 also indicates either how these issues have been addressed within this Environmental Statement or how the Applicant has had regard to them. Further information on the consultation activities undertaken for Hornsea Three can be found in the Consultation Report (document reference number A5.1) that accompanies the application for Development Consent.

Table 2.4: Summary of key consultation issues raised during consultation activities undertaken for Hornsea Three relevant to hydrology and flood risk.

Date	Consultee and type of response	Issues raised	Response to issues raised and/or where considered in this chapter
November 2016	Anglian Water – Scoping Response.	Paragraph 3.8.3 states that site investigations are due to be undertaken quarter 4 of 2016 and quarter 1 of 2017. Anglian Water would like to be consulted with regarding site surveys and ground investigations so we can mitigate any risks to our assets. Table 10.4 of volume 4, annex 5.5: Scoping Report and PINS Scoping Opinion states that water supply pipelines could be damaged and there could be impacts on water quality during construction, operation and maintenance, and decommissioning phases. It is recognised that a desk based study will be carried out. Anglian Water recommends early engagement so that we can input into this study. Table 13.1 of volume 4, annex 5.5: Scoping Report and PINS Scoping Opinion does not identify utilities, specifically water infrastructure. It is crucial that impacts on the network and on our assets are considered and any issues highlighted early on in the project. It is suggested that the Environmental Statement should include reference to the foul sewerage network, sewage treatment and water services. It is unclear what the requirement for potable water and wastewater services will be during the construction phases. Discussions with Anglian Water should take place to ensure this issue is considered at an early stage. In addition, we would wish to review any impact on any schemes for water or wastewater, which are currently in design, which may be affected by the development. Reference is not made to Anglian Water's WRMP and it is suggested that this is taken into account. The WRMP is available to view at the following address: http://www.anglianwater.co.uk/environment/our-commitment/our-plans/water-resource-management.aspx.	Site investigations within the Hornsea Three onshore cable corridor are not due to take place until post consent. The design of any investigation would take into account the location of nearby utility services. Anglian Water will be consulted regarding any works that may be carried out in close proximity (within 10 m) of their assets. Specific Anglian Water drainage infrastructure is considered within the baseline conditions section of this chapter. The construction of Hornsea Three is unlikely to generate a requirement for potable water or wastewater services. Discharges to ground or surface water may be necessary at specific locations however, these discharges would be regulated by environmental permits where required. Anglian Water's WRMP was one of the information sources which informed the baseline section (see paragraph 2.6.1.2) and its principles have been used in the design of mitigation measures (Table 2.17).

Date	Consultee and type of response	Issues raised	Response to issues raised and/or where considered in this chapter
November 2016	Natural England – Scoping Response.	The River Wensum Special Area of Conservation (SAC): The Hornsea Three onshore cable corridor has potential to directly affect both the hydrological processes and habitats present within the River Wensum SAC. There are many springs and seepages along the length of the river which would not be detectable during a desk study, and if missed has the potential to damage the river system, resulting in changes to the direction and speed of flow of the river water supply. Furthermore, there are floodplain meadows that form an integral part of the SAC that may be directly damaged by setting up the start of the underground cable within the wrong location. We therefore recommend that prior to any decisions on location a hydro-ecologist is employed to survey the area, to check for seepages/springs and to review where to place the cable to avoid damaging the habitats associated with the SAC. We would welcome placement of the cable as far away from the river as feasible, to protect the habitats and wildlife present in close proximity to the river. Norfolk Valley Fens SAC and component SSSIs: The area along the Hornsea Three onshore cable corridor includes several sites that form part of the Norfolk Valley Fens SAC. These sites, along with many of the locally designated sites in the area, form a complex network of hydrologically linked sites which are very sensitive to changes in water levels, quality or flow. Some of the sites that form part of this network and may be affected by the Hornsea Three onshore cable corridor are Alderford Common, Swanningate Upgate Common, and Booton Common SSSIs (though this list is not exhaustive). We recommend that a desk study is carried out to ensure that all SSSIs associated with this SAC that may be affected by the Hornsea Three onshore cable corridor are scoped into the assessment. We advise that the Environmental Statement considers in detail how the placement of the route will affect surface and ground water flow across any of the sites that are components of the Norfolk Valley Fens SAC, along with any County Wildlife sites with a hydrological focus.	Hydrological characterisation of the proposed crossing locations of the EA designated main rivers has been undertaken and is presented in volume 6, annex 2.4: Hydrological Characterisation Report. The work comprised a desk study and site walkover to identify the hydrological and ecological features in these locations and how they interact. Potential constraints have been mapped and have been used to inform the initial design of the crossing methodologies in these areas.

Date	Consultee and type of response	Issues raised	Response to issues raised and/or where considered in this chapter
November 2016	Norfolk County Council – Scoping Response.	The LLFA strongly recommend that any EIA or planning application for development is accompanied by a FRA/surface water drainage strategy to address: • Local sources of flood risk, including those from ordinary watercourses, surface runoff and groundwater; • How surface water drainage will be managed on the substation sites and show compliance with the written Ministerial Statement HCWS161 by ensuring that SuDS for the management of runoff are put in place; • Post construction ground levels not disrupting current overland flow routes along and across the alignment of the proposed underground cables for land at risk of flooding; • Temporary arrangements to maintain overland flow paths that cross the alignment of the proposed underground cables for land at risk of flooding; and • The requirement to seek consent from Norfolk County Council for works that affect the flow in ordinary watercourses outside of the control of an IDB. This supporting information would need to show how the development does not increase flood risk on the site or elsewhere, in line with NPPF (paragraph 103). In this particular case this would include appropriate information on SuDS proposals in accordance with appropriate guidance including "Non-statutory technical standards for sustainable drainage systems" March 2015 by Department for Environment, Food and Rural Affairs (Defra, 2015). The LLFA welcome that the applicant indicates that a FRA will be completed and it is recommended that this is undertaken in line with the requirements of the NPPF. The LLFA also welcome that the applicant indicates that an FRA will include a drainage strategy for the preparation of the onshore HVAC booster station and HVAC/HVDC substation site. It is recommended that appropriate SUDS features are incorporated into the development in accordance with policy guidelines. The LLFA highlight that peak river flow climate change allowances should be considered for ordinary watercourses as well as main rivers. Please note, if there are any works proposed as part of this application that are likely to affect flows in an ordinary watercourse outside of the IDB areas, then the applicant is likely to need the approval of the County Council. The Council seeks to avoid culverting, and its consent for such works will not normally be granted except as a means of access. It should be noted that this approval is separate from planning. The LLFA would expect a drainage strategy for the substation and preferred route for the cables to assess and justify compliance with the SuDS hierarchy for surface water disposal location.	The scope of the Hornsea Three FRA is outlined in paragraph 2.6.2.3. The FRAs are provided in volume 6, annex 2.1: Onshore Infrastructure FRAs. The FRAs have been produced in line with the requirements of NPS EN-1 and the NPPF. Outline drainage strategies have also been produced in line with relevant SuDS guidance and are appended to the FRAs.

Date	Consultee and type of response	Issues raised	Response to issues raised and/or where considered in this chapter
November 2016	Public Health England – Scoping Response.	When considering a baseline (of existing water) and in the assessment and future monitoring of impacts these: • Should include assessment of potential impacts on human health and not focus solely on ecological impacts; • Should identify and consider all routes by which emissions may lead to population exposure (e.g. surface watercourses; recreational waters; sewers; geological routes etc.); • Should assess the potential off-site effects of emissions to groundwater (e.g. on aquifers used for drinking water) and surface water (used for drinking water abstraction) in terms of the potential for population exposure; and • Should include consideration of potential impacts on recreational users (e.g. from fishing, canoeing etc.) alongside assessment of potential exposure via drinking water.	The abstraction licences, discharge consents and pollution incidents are shown in volume 6, annex 2.3: Surface Water Abstraction Licences, Discharge Consents and Pollution Incidents. The potential for pollution linkages from contaminated land affecting surface waters is considered in chapter 1: Geology and Ground Conditions. No uncontrolled discharges (emissions) to surface water or groundwater from Hornsea Three during the construction, operation and maintenance or decommissioning would be permitted. Where discharges are required, they would be regulated by an environmental permit which would identify potential impacts to human health and (if relevant) potential impacts on recreational users. Where environmental permits are required, they would be obtained post consent.
December 2016	PINS – Scoping Opinion.	On the refinement of the corridor, the applicant should take care to ensure that the Hornsea Three hydrology and flood risk study area is sufficient to consider potential impacts outside of the application site, noting the potential for flood risk elsewhere, and for impacts to occur downstream of the site. The Hornsea Three hydrology and flood risk study area should be agreed with relevant consultees and justified within the Environmental Statement. The Environmental Statement should include figures depicting the hydrological features described within the text in relation to the application site, including the network of ordinary watercourses, streams, drains and waterbodies The Secretary of State welcomes the proposal for a FRA and the assessment of impacts on WFD watercourses; these assessments should form an appendix to the Environmental Statement. In relation to Horizontal Directional Drilling (HDD) activities, the Environmental Statement should address potential risks to both groundwater resources and surface water bodies from leakage of drilling fluid and provide details of measures that will be implemented to address such risks.	The Hornsea Three hydrology and flood risk study area was discussed with the statutory consultees and was presented within the Preliminary Environmental Information Report; no comments relating to the study area were received from the consultees including during the section 42 consultation process. The Hornsea Three hydrology and study area is considered sufficient to address the potential impacts from Hornsea Three in relation to hydrology and flood risk. The hydrological features are outlined within volume 6, annex 2.2: EA and IDB Watercourses and Flood Zones. WFD objectives for the watercourses in the Hornsea Three hydrology and flood risk study area are provided in Table 2.7 and the effects on these watercourses are assessed in section 2.11. Detailed WFD assessment works are presented in volume 6, annex 2.5: Water Framework Directive Surface Water Assessment. The scope of the Hornsea Three FRA is outlined in paragraph 2.6.2.3. The full FRAs are provided in volume 6, annex 2.1: Onshore Infrastructure FRAs. The FRAs have been produced in line with the requirements of NPS EN-1 and the NPPF taking into account the effects of climate change and potential for changes in flood risk. A proposed drainage strategy has also been produced in line with relevant SuDS guidance and is appended to the FRA. An Outline CoCP (document reference A8.5) will accompany the DCO application, whilst an outline drainage strategy will form part of the FRAs contained in volume 6, annex 2.1: Onshore Infrastructure FRAs. Potential risks to groundwater resources and hydraulically connected surface waters are assessed in chapter 1: Geology and Ground Conditions.

Date	Consultee and type of response	Issues raised	Response to issues raised and/or where considered in this chapter
February 2017	Norfolk Rivers IDB – Meeting.	Consent would be required where the Hornsea Three onshore cable corridor crosses a maintained IDB drain/watercourse with the Norfolk Rivers IDB's District. An IDB licence would be usually required to discharge surface water into a watercourse within the Norfolk Rivers IDB District, whether or not the receiving drain was maintained. Norfolk Rivers IDB is compiling details of standardised approaches to cable installation beneath IDB assets, drawing on past experiences, and noting that some drains are more suitable to trenchless techniques and other are more suitable to open cut. Norfolk Rivers IDB noted the need for managing channel flow during open cut installation. On site arrangements would be required for over pumping and that seasonal restrictions on installation may be required in areas prone to flash flood/flow.	IDB watercourses are identified in volume 6, annex 2.2: EA and IDB Watercourses and Flood Zones. The majority of watercourses will be crossed using HDD methods and described in volume 4, annex 3.5: Onshore Crossing Schedule.
February 2017	Onshore Ecology Expert Working Group - meeting	RPS proposed to undertake a hydrological characterisation study to address Natural England's comments on the scoping report (see volume 4, annex 5.5: Scoping Report and PINS Scoping Opinion) (relating to the potential impacts of construction on the hydrological processes and habitats at the River Wensum – see above). The scope and methodology of the study were discussed and agreed at the meeting.	The hydrological characterisation study is presented in volume 6, annex 2.4: Hydrological Characterisation Report and summarised in section 2.7.
September 2017	Anglian Water – Section 42 Response	There are a number of existing water mains and foul sewers in the boundary of the proposed cable route. In addition, there is an existing sewer outfall within the proposed Hornsea Three onshore cable corridor route. These are essential assets which allow us to serve our existing customers and should be considered as part of the above project.	Comments have been taken into account and included where practicable into design mitigation measures outlined in section 2.10. The onshore crossing schedule (see volume 4, annex 3.5: Onshore Crossing Schedule) identifies the location of pipeline infrastructure (including water mains and foul sewer) and the methodologies that will be used to cross them.
September 2017	Norfolk Rivers Trust - Section 42 Response	Due to observations from previous cable input, confirmation is required that clear mitigation measures are in place to ensure that runoff from open sites does not enter the sensitive chalk rivers on the proposed path. The ground should not be allowed to be bare for any length of time in historical periods of high rainfall. Downhill gradients should not be allowed to become open silt carriageways. Silt traps should be a statutory feature in vulnerable areas. Planting of areas affected should be carried out as soon as possible to alleviate flooding.	Appropriate mitigation measures would be implemented during construction to minimise flood risk, minimise the generation of silt and prevent runoff entering the watercourses. These measures are included in Table 2.17 and the Outline CoCP (document reference A8.5).
September 2017	Norfolk County Council - Section 42 Response	Flood and Drainage Issues The County Council would wish to see further ground investigation work including infiltration testing together with an outline drainage design as part of the final application and request that DONG Energy continue to work closely with the County Council in its role as LLFA.	Outline drainage strategies have been prepared and are provided in volume 6, annex 2.1: Onshore Infrastructure FRAs. The proposed drainage strategies have been developed in accordance with the NPS, NPPF, PPG ID7 and the SuDS Manual, whereby sufficient attenuation storage is provided for 1 in 100 year plus climate change worst case storm event. Drainage provisions will be further developed during detailed design in agreement with the Norfolk County Council as LLFA. During pre-application, it was not possible to undertake infiltration testing due to access permission restrictions. However, this testing will be undertaken during detailed design to inform the detailed design of the Drainage Strategy.

Date	Consultee and type of response	Issues raised	Response to issues raised and/or where considered in this chapter
September 2017	EA - Section 42 Response	The EA expressed concern about how the WFD is to be assessed (e.g. the assumption in the Preliminary Environmental Information Report (PEIR) FRAs all the affected waterbodies will achieve 'Good' status because this is the aim and appears to conclude that the affected waterbodies do not require assessment. This is an unreasonable assumption and goes against the general ethos of the WFD, which is about constant improvement of waterbodies. EA WFD-specific detail will be required in the final WFD assessment. In particular the assessment needs to make a clear link between activities and WFD receptors, quantifying the likely impacts and assessing the risk of deterioration. Also, data used appears to be from 2012; we ask that more recent baseline is used. The proposed crossings of the main rivers by both open cut and trenching methods will require a Flood Risk Activity Permit from the EA. The proposed crossings of main river by directional drilling may fall under an exemption FRA3 if they meet all of the conditions, which include being further than 200 m from a SSSI, SAC and Special Protection Area, and the crossing is within 10 degrees of perpendicular to the direction of flow in the river.	The hydrological features within the Hornsea Three hydrology and flood risk study area are identified in volume 6, annex 2.2: Environment Agency and IDB Watercourses and Flood Zones. WFD objectives for the watercourses in the Hornsea Three hydrology and flood risk study area are provided in Table 2.7 and the effects on these watercourses are assessed in section 2.11. A detailed WFD assessment work is presented in volume 6, annex 2.5: Water Framework Directive Surface Water Assessment. Up to date baseline data has been used in the assessment. Flood Risk Activity Permits or exemptions will be obtained for the watercourse crossings by open cut or HDD techniques where required.
September 2017	Natural England – Section 42 Response	Geology and Hydrology Without details of the pollution prevention measures in terms of runoff from the cable route activities it is not possible to comment on the assessment of the magnitude and significance of its effect. With regard to the impact of pollution and runoff all wet receptors should be recognised as part of a wider catchment that ultimately leads to designated rivers, the sea and priority habitats. As such any pollutants, nutrients and sediment are likely to have greater spatial and temporal impacts than implied in the PEIR. Their removal from catchment watercourses is also difficult so the reversibility appears to have been underestimated. Runoff and any sediment it contains is likely to: • Smother aquatic substrates, flora and fauna; • Carry nutrients, particularly phosphates – a key water quality issue for the River Wensum; and • Carry pollutants such as agricultural pesticides. These issues need to be recognised and addressed, particularly when dealing with runoff from exposed soils and subsoils. Water quality testing for key nutrients and pollutants should be undertaken before permitting runoff to enter surface water receptors or ground supplies. Natural England's advice on hydrological assessment provided to the EIA Scoping consultation (25 November 2016) still applies. The hydrological characterisation will need to consider effects on groundwater supplies and flows in addition to all surface waters, and not just EA main rivers. All surface waters form part of interconnected wider catchments and many sites and habitats are dependent on groundwater, in particular the River Wensum and the ponds at Alderford Common. The cable trenches and lines may act as preferential flow paths for ground water and effects of this needs consideration and mitigation.	A hydrological report has been prepared to specifically address comments originally raised by Natural England. The scope and approach of the report was agreed with the Onshore Ecology Expert Working Group (EWG) and is presented within volume 6, annex 2.4: Hydrological Characterisation Report. A WFD hydrological assessment has been prepared in order to classify the potential water quality issues along the onshore cable corridor. The assessment is presented within volume 6, annex 2.5: Water Framework Directive Surface Water Assessment. An Outline CoCP (document reference A8.5) has been prepared as part of the DCO application and includes outline method statements for open cut crossings and bentonite break out plans for crossings using HDD methods. Comments have been taken into account and included where practicable into mitigation measures outlined in section 2.10.
November 2017	Norfolk County Council – Post PEIR Update Meeting	The FRA for the PEIR did not consider the flood risk associated with the corridor. Therefore, it was agreed that an FRA for corridor would be included in the Environmental Statement, however the FRA would focus on the areas of the cable corridor located in Flood Zones 2 and 3. No FRA would be undertaken for the cable corridor within Flood Zone 1.	The FRA for the onshore cable corridor is presented in volume 6, annex 2.1: Onshore Infrastructure FRAs.
December 2017	EA – Further Section 42 Response	The EA identified a number of areas of the corridor that are located within Flood Zone 3.	These areas have been noted and the flood risk has been assessed in volume 6, annex 2.1: Onshore Infrastructure FRAs.

2.6 Methodology to inform the baseline

2.6.1 Desktop study

2.6.1.1 Information on hydrology and flood risk within the Hornsea Three hydrology and flood risk study area was collected through a detailed desktop review of existing studies and datasets. These are summarised in Table 2.5.

Table 2.5: Summary of key desktop reports.

Title	Source	Year	Author
BGS 1:50,000 and 1:10,000 digital geological mapping	BGS via Groundsure GeoInsight Report	2017	BGS
SPZs/Aquifer Designations	EA via Groundsure EnviroInsight Report Correspondence with the EA	2017	EA
Groundsure Environmental Search (Ref: RPS_3656707).	Groundsure	February 2017	Groundsure Limited
Climate data	Met Office	2016	Met Office
Draft Norfolk Local Flood Risk Management Strategy.	Norfolk County Council	2015	Mott Macdonald
WRMP	Anglian Water	2015	Anglian Water
Flood Zone and Watercourse Map	EA	2017	EA
Flood Hazard Map	EA	2017	EA
Kelling to Lowestoft Ness Shoreline Management Plan	East Anglia Coastal Group	2012	AECOM
North Norfolk Shoreline Management Plan.	Defra	2010	Defra
North Norfolk Catchment Flood Management Plan.	EA	2009a	EA
Broadland Rivers Catchment Flood Management Plan.	EA	2009b	EA
Anglian River Basin District River Basin Management Plan.	Defra and EA	2009 (updated in 2016)	Defra and EA.
Strategic Flood Risk Assessment (North Norfolk, Broadland District Council, The Broads Authority, Norwich City Council and South Norfolk District Council).	North Norfolk, Broadland District Council, The Broads Authority, Norwich City Council and South Norfolk District Council	2008	Millard Consulting Engineers

Identification of designated sites

2.6.1.2 A review of desktop reports, publicly available information and information requests (as identified in Table 2.5) did not identify any hydrologically designated sites within the Hornsea Three hydrology and flood risk study area. Watercourses designated for their ecological interest are identified in chapter 3: Ecology and Nature Conservation.

Water Framework Directive

2.6.1.3 The current overall WFD status for watercourses potentially affected by the onshore elements of Hornsea Three have been identified via the publicly available EA's Catchment Data Search. The open access database provides the most up to date (2016) Current Status classifications for a number of main rivers within the Anglian River Basin District and the Hornsea Three hydrology and flood risk study area. The WFD classification is not site specific, but classifies a defined river reach based on site samples. These watercourses have been included within the WFD assessment as they are watercourses likely to be the most affected by Hornsea Three. A WFD assessment has been undertaken and is provided in volume 6, annex 2.5: Water Framework Directive Surface Water Assessment.

2.6.1.4 For surface waters, the WFD objectives are based on the ecological and chemical status of the waterbody (i.e. the predicted future status if technically feasible measures are implemented). These measures are required to prevent deterioration in the current status of the waterbody and (once implemented) produce more benefits than they cost to implement. The date to achieve the objective status is determined by the type of measures which are needed in order to improve the status of the waterbody (i.e. the cost of the measures (are they affordable) and the time taken for the status to improve once the measures have been implemented).

2.6.2 Site specific surveys

2.6.2.1 In order to inform the EIA, site-specific surveys were undertaken, as agreed with the EA and Norfolk County Council via the Onshore Ecology EWG (see chapter 3: Ecology and Nature Conservation for further details). This primarily comprised a walkover survey undertaken as part of the hydrological characterisation of the main river and IDB crossing locations (see Table 2.6 and volume 6, annex 2.4: Hydrological Characterisation Report).

2.6.2.2 The onshore HVAC booster station and HVDC converter/HVAC substation will each cover an area of more than 1 hectare (ha), and the onshore cable corridor will pass through areas designated as Flood Zone 2 and 3. In accordance with the guidance in the NPPF (and PPG ID7 – Flood Risk and Coastal Change) and NPS EN-1 site-specific FRA have been undertaken. This is included in volume 6, annex 2.1: Onshore Infrastructure FRAs.

2.6.2.3 The key components of the site specific FRAs are as follows:

- Review of publicly available EA documentation, local flood management plans and future flood management schemes;
- Review of Strategic FRAs;
- Assessment of the flood risk to the existing conditions and future conditions (assuming Hornsea Three in place);
- A site-specific assessment of flood risk at the proposed onshore HVAC booster station, onshore HVDC converter/HVAC substation areas and Hornsea Three onshore cable corridor; and
- A hydrological assessment of the surface water flows for the proposed onshore HVAC booster station, onshore HVDC converter/HVAC substation areas and Hornsea Three onshore cable corridor.

2.6.2.4 The approach of the FRA for the onshore cable corridor was agreed with Norfolk County Council (as the LLFA). Whilst the Hornsea Three onshore cable corridor will exceed 1 ha when considering the full length of the onshore cable corridor, the majority is located within Flood Zone 1. Given this, in combination with the fact that the cable would be below ground which reduces the potential for increased runoff, it was agreed with the Norfolk County Council (as LLFA) that the FRA for the onshore cable corridor would focus on the locations where the corridor was within Flood Zones 2 and 3 (i.e. crossing locations of main rivers and ordinary watercourses).

Table 2.6: Summary of site-specific survey data.

Title	Extent of survey	Overview of survey	Survey contractor	Date	Reference to further information
Hydrological characterisation surveys.	Locations where the Hornsea Three onshore cable corridor crosses main rivers and ordinary watercourses: • River Yare; • River Tud; • River Wensum; • River Bure; • River Glaven (Gunthorpe Stream); • Spring Beck; • Intwood Stream; • Swannington Beck; and • Blackwater Drain.	The survey comprised a walkover of the proposed main river and IDB watercourse crossing locations to gather information on the local hydrological environment. Observations were made on the width of the main channel, flow and depth of the water, presence and location of tributaries and drainage ditches, and ecological habitats. The site visit was not undertaken after a prolonged period of unusually heavy rainfall and therefore, the water flows observed are considered to represent "normal" conditions. The walkover survey was supplemented by a desk study to identify any abstraction licences, discharge consents/permits, flood risk information and landowner questionnaires.	RPS	March 2017	See volume 6, annex 2.4: Hydrological Characterisation Report.
FRA.	Desk based survey for the proposed onshore HVAC booster station, HVDC converter/HVAC substation and onshore cable corridor.	The survey comprised a desk based study of flood risk information listed in Table 2.5 and information from the hydrological characterisation report. The FRAs present the detailed flood risk for each project element in relation to fluvial, tidal, groundwater, surface water etc. and outlined site specific management and drainage strategies (where required) to mitigate flood risk to the onshore HVAC booster station, HVDC converter/HVAC substation and onshore cable corridor and the surrounding areas.	RPS	November 2017	See volume 6, annex 2.1: Onshore Infrastructure FRA.

2.7 Baseline environment

2.7.1.1 This section describes the hydrological resources and flood risk within the Hornsea Three hydrology and flood risk study area. Observations have been summarised from the hydrology characterisation study (see volume 6, annex 2.4: Hydrological Characterisation Report) where relevant.

2.7.2 Land use

2.7.2.1 The Hornsea Three hydrology and flood risk study area runs through the Anglian River Basin District (as designated by the EA), which covers 27,890 km^2 from Lincolnshire in the north to Essex in the south. The landscape ranges from gentle chalk and limestone ridges to the extensive lowlands of the fens and East Anglian coastal estuaries and marshes. The river basin district is predominantly rural, with more than half of its land surface (c. 1.5 million ha) used for agriculture and horticulture.

2.7.3 Surface watercourses

2.7.3.1 The Hornsea Three hydrology and flood risk study area includes a number of catchments associated with EA designated main rivers and IDB/local authority ordinary watercourses. Definitions of these hydrological features are provided below and their locations are identified in volume 6, annex 2.2: EA and IDB Watercourses and Flood Zones:

- Main rivers – watercourses where the EA has permissive powers over their management; and
- Ordinary watercourses – includes rivers, streams, ditches, drains which do not form part of a main river and are managed by either Norfolk County Council, as LLFA, or Norfolk Rivers IDB.

2.7.3.2 The Hornsea Three hydrology and flood risk study area also passes through an area managed by Norfolk Rivers IDB. The Board's drainage and water level management infrastructure consists of a number of watercourses, of varying sizes, which all discharge by gravity into EA designated main rivers. The IDB maintains only the most critical ordinary watercourses (i.e. that are not main rivers), which equates to around 25% of the total length of ordinary watercourses in the IDB district. IDB watercourses which fall within the Hornsea Three hydrology and flood risk study area are described below and are shown in volume 6, annex 2.2: EA and IDB Watercourses and Flood Zones.

2.7.3.3 The following sections draw key observations from the site visit regarding the baseline conditions of the watercourses; further information on the watercourses is provided in volume 6, annex 2.4: Hydrological Characterisation Report.

EA designated main rivers

River Yare

2.7.3.4 The river rises south of Dereham to the west of the village of Shipdham. It flows in a generally eastward direction passing Barnham Broom and is joined by the River Tiffey before reaching Bawburgh. At Whitlingham, the Yare converges with the River Wensum. Within the Hornsea Three hydrology and flood risk study area, the River Yare flows in an open channel and at the time of the site visit, the river was reasonably fast flowing.

2.7.3.5 A number of field drains were noted within the Hornsea Three hydrology and flood risk study area which fed into the river and were observed to be slow flowing/stagnant and heavily vegetated. Land close to the river is wet for the majority of the year and is susceptible to flooding.

River Tud

2.7.3.6 The River Tud is a tributary of the River Wensum. The Tud's source is just south of East Dereham and flows in an easterly direction for 27 km to its confluence with the River Wensum below Hellesdon Mill.

2.7.3.7 Within the Hornsea Three hydrology and flood risk study area, the river flows in an open channel. A number of field drains were identified during the site visit which contained water but were slow flowing/still. Landowners in the Hornsea Three hydrology and flood risk study area indicated that the drains hold water for the majority of the year, whilst the marshy area to the south of river is wet for the majority of the year.

River Wensum

2.7.3.8 The River Wensum is a chalk fed river and is an internationally designated site of ecological importance (i.e. SAC and SSSI). The source of the River Wensum lies between the villages of Colkirk and Whissonsett in north west Norfolk. The river flows westward initially, close to the villages of South Raynham, West Raynham and East Raynham. At New Mills Yard in the centre of Norwich, the river becomes tidal and navigable by boat.

2.7.3.9 Within the Hornsea Three hydrology and flood risk study area, the river flows in a wide open channel and is relatively fast flowing. A number of field drains were identified during the site visit which were slow flowing or stagnant and heavily vegetated. The topography surrounding the river is generally flat and the ground was soft with localised wet areas. Landowners in the Hornsea Three hydrology and flood risk study area confirmed that the surrounding streams and ditches hold water all year round and the land near the river is susceptible to flooding.

River Bure

2.7.3.10 The river rises near Melton Constable, 18 km upstream of Aylsham. After Aylsham Lock and Burgh Bridge, the Bure passes through Buxton Lammas, Coltishall and along the northern border of the Halvergate Marshes and through Great Yarmouth where it meets Breydon Water and flows into the sea at Gorleston.

2.7.3.11 Within the Hornsea Three hydrology and flood risk study area, the river flows west to east in an open channel. At the time of the site visit, the river had a clear flow over a mixed gravel and sandy bed. A number of field drains lead up to or run parallel with the river. At the time of the site visit, the drains contained water but had a slow flow or were stagnant with algae on the surface in places.

Ordinary watercourses (IDB managed)

River Glaven (Gunthorpe Stream)

2.7.3.12 The River Glaven flows for a 16 km (approximately) reach through Norfolk flowing in a general northerly direction through North Norfolk before discharging into the North Sea. The river has a catchment area of approximately 115 km^2 and from its source, it falls 50 m to the tidal limit at Cley sluice. The sub-surface geology is predominantly chalk and in the parts of the lower valley, the river runs over chalk beds.

2.7.3.13 Within the Hornsea Three hydrology and flood risk study area, the Gunthorpe Stream is generally fairly uniform in terms of water depth and lacks areas of riffles and woody debris. The Gunthorpe Stream flows in an open channel in a general easterly direction and is a tributary of the River Glaven. A number of smaller surface watercourses and field drains drain into the Gunthorpe Stream within the Hornsea Three hydrology and flood risk study area.

Spring Beck

2.7.3.14 Spring Beck flows near and through the village of Weybourne. The beck originates from a spring located on the edge of Hundred Acre Wood in an area called Weybourne Pits. From its source, it flows in a general northerly direction towards the village of Weybourne approximately 1.6 km to the north, discharging into the North Sea via a piped outfall at Weybourne Hope.

2.7.3.15 Within the Hornsea Three hydrology and flood risk study area, the river flows in a small open channel in a generally northerly direction. The chalk stream habitat flows through agricultural land near its source and at the time of the site visit it had a small flow volume within the channel.

Intwood Stream

2.7.3.16 Intwood Stream originates as two streams: one branch outfall from Ketteringham Hall Lake flowing in a general north easterly direction; the second branch issues close to Mulbarton and heads in a northerly direction converging at Intwood. The combined stream flows northerly and is joined by a number of smaller un-named tributaries and drainage channels before discharging into the River Yare, near Keswick.

2.7.3.17 Within the Hornsea Three hydrology and flood risk study area, Intwood Stream is a small channel watercourse narrowed by aquatic vegetation and is relatively fast flowing. A series of field drains discharge into Intwood Stream which are heavily vegetated and relatively shallow.

Swannington Beck

2.7.3.18 The beck is formed via inflows from the two sub-catchments, the largest of which originates from agricultural land to the north east including Haveringland Lake and Upgate. The second reach originates at Brandiston and flows in a southerly direction fed by a number of un-named drainage and irrigation channels. The two reaches converge at Alderford to form Swannington Beck and discharging into the River Wensum.

2.7.3.19 The beck is relatively shaded and flows in an open channel within the Hornsea Three hydrology and flood risk study area. The channel is approximately 1 m wide and was slow flowing at the time of the site visit. A number of field drains run parallel with Swannington Beck.

Blackwater Drain

2.7.3.20 The drain is formed via the convergence of a number of un-named streams which issue from numerous locations to the north of Reepham. The drain flows in a general southerly direction around the outskirts of Reepham discharging into the River Wensum.

2.7.3.21 Blackwater Drain is tree-lined in places and flows in a westerly direction within the Hornsea Three hydrology and flood risk study area along the boundary with Booton Common. There are a number of field drains leading to Blackwater Drain including a feeder ditch that runs south of Blackwater Drain, none of which drain into Booton Common.

2.7.4 Existing drainage

2.7.4.1 The Hornsea Three hydrology and flood risk study area crosses a number of existing field drains, ditches and irrigation channels. The majority of the surface water channels crossed are privately owned and maintained. Several channels fall under the jurisdiction of the IDB, LLFA or EA and therefore, fall under the requirements of the Environmental Permitting Regulations 2016. The onshore crossing schedule (volume 4, annex 3.5: Onshore Crossing Schedule) identifies all crossings along the onshore cable corridor.

2.7.4.2 A review of Ordnance Survey maps and Google Earth has not identified any existing ditches on the onshore HVAC booster station and HVDC converter/HVAC substation areas. There is the potential for minor field drains to be present and this would be confirmed at the detailed design stage.

2.7.5 Surface water abstractions

2.7.5.1 The abstraction licences taken from Groundsure data records identified six surface water abstractions within the Hornsea Three hydrology and flood risk study area. These are identified in volume 6, annex 2.3: Surface Water Abstraction Licences, Discharge Consents and Pollution Incidents and comprise:

- One abstraction licence related to C J C Lee Ltd for the abstraction of water from the River Bure for use in spray irrigation;
- Two abstraction licences related to Honingham Aktieselskab for the abstraction of water from the River Tud for use in spray irrigation;
- One abstraction licence related to Great Melton Farms Ltd for the abstraction of water from the River Yare for use in spray irrigation; and
- Two abstraction licences related to H W & H G Back for the abstraction of water from the River Yare for use in spray irrigation.

2.7.5.2 Only one of the above abstractions is located within the Hornsea Three onshore cable corridor (from the River Yare and related to Great Melton Farms Ltd (Abstraction Licence Number - 7/34/13/*S/0136)). None of the abstractions are located within the footprint of the onshore HVAC booster station or HVDC converter/HVAC substation. Abstraction licences are a good indication of how the surface watercourses in the Hornsea Three hydrology and flood risk study area are utilised.

2.7.6 Private water supply

2.7.6.1 Norfolk County Council and North Norfolk District Council have confirmed that there are no private water supplies within the Hornsea Three hydrology and flood risk study area.

2.7.6.2 Broadland District Council indicate that they hold no data regarding private water supplies (see section 2.7.12).

2.7.6.3 South Norfolk District Council indicate that there are a number of private water supplies within the Hornsea Three hydrology and flood risk study area. Private water abstractions in the Hornsea Three hydrology and flood risk study area are typically from groundwater resources and are identified in volume 6, annex 1.2: Abstraction Licences and Source Protection Zones.

2.7.7 Discharge consents

2.7.7.1 Discharges of liquid effluent or waste water into surface waters are regulated by the EA using discharge consents and environmental permits. A review of Groundsure data identified approximately 20 consented discharges to surface waters within the Hornsea Three hydrology and flood risk study area. The majority of the discharges related to final/treated effluent from domestic properties. Although the volume and parameters of the discharges are regulated (via the discharge consents and permits), the quality of the receiving surface water may potentially be affected.

2.7.7.2 The details and locations of the discharge consents and permits are provided within volume 6, annex 2.3: Surface Water Abstraction Licences, Discharge Consents and Pollution Incidents.

2.7.8 Pollution incidents

2.7.8.1 Pollution incident mapping has been used to identify if the quality of watercourses within the Hornsea Three hydrology and flood risk study area may have been affected by pollution. A review of Groundsure data identified approximately 10 pollution incidents in the Hornsea Three hydrology and flood risk study area, however all of the incidents were reported as category 4 (no impact), see annex 2.3: Surface Water Abstraction Licences, Discharge Consents and Pollution Incidents. This is defined by the EA, under the common incident classification scheme, as a substantiated incident with no impact to water quality (Further details regarding the common incident classification scheme can be found at www.gov.uk/government/organisations/environment-agency).

2.7.9 Surface water quality

2.7.9.1 Table 2.7 lists the watercourses and associated WFD classification grade within the Hornsea Three hydrology and flood risk study area. The objective dates in Table 2.7 are explained as follows:

- 2015: status matches the predicted future status or potential. The main environmental objective is to prevent deterioration in status between 2015 and 2021.
- 2021: there is confidence that as a result of the programme of measures, the water body will improve from its 2015 status to achieve the predicted future status by 2021. The environmental objective is for water bodies and elements to make an improvement from the reported 2015 status to achieve the predicted future status by 2021.
- 2027: the deadline for achieving the status or potential has been extended to 2027. For a 2027 date, there is currently not enough confidence that the improvement in status can be achieved by an earlier date.

Table 2.7: WFD water quality data.

Name of Catchment Waterbody	Specific Waterbodies present within the Hornsea Three hydrology and flood risk study area	Current Overall Status (2016)	Objective Status
Gunthorpe Stream	River Glaven (Gunthorpe Stream)	Moderate	Good (2027)
Glaven	Spring Beck	Moderate	Good (2027)
River Bure (Scarrow Beck to Horstead Mill)	River Bure	Poor	Poor (2015) Poor (2021) Poor (2027)

Name of Catchment Waterbody	Specific Waterbodies present within the Hornsea Three hydrology and flood risk study area	Current Overall Status (2016)	Objective Status
Blackwater Drain (Wensum)	Blackwater Drain	Moderate	Good (2021)
River Wensum (US Norwich)	River Wensum.	Moderate	Moderate (2015) Moderate (2021) Moderate (2027)
River Tud	River Tud	Moderate	Moderate (2015) Moderate (2021) Moderate (2027)
River Yare (Tiffey to Wensum)	River Yare	Moderate	Moderate (2021) Good (2027)
Intwood Stream	Intwood Beck	Moderate	Moderate (2015) Moderate (2021) Moderate (2027)
Swannington Beck	Swannington Beck	Poor	Good (2015)
Tas (Tasburgh to River Yare)	River Yare	Moderate	Moderate (2015) Moderate (2021) Moderate (2027)

2.7.9.2 In summary, the records show that the watercourses within the Hornsea Three hydrology and flood risk study area have a varying WFD status of Poor to Good. However, all lower status waterbodies (Poor) have objectives to improve, with most aiming to achieve Moderate status by 2027, and many of the measures needed to achieve the improvement in status are either already in place or will be in place by 2021.

2.7.9.3 A full description of the WFD classification process and associated definitions are available at: https://www.gov.uk/government/consultations/river-basin-management-planning-ministerial-guidance-and-standards.

2.7.10 Flood Zones and flood defences

2.7.10.1 The Hornsea Three landfall area is defined by exposed sands and gravels forming a shingle beach acting as a natural tidal defence. Publicly available online EA flood mapping indicates that there are no formal flood defences.

2.7.10.2 The EA Flood Zone risk maps use four categories to describe the risk of flooding. These categories are set out in Table 2.8 below.

Table 2.8: EA Flood Zone definitions.

Flood Zone	Flood Zone definition
Flood Zone 1	This land comprises land assessed as having a less than 1 in 1,000 annual probability of river or sea flooding (<0.1%).
Flood Zone 2	This zone comprises land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% - 0.1%), or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.5 – 0.1%) in any year.
Flood Zone 3(a)	This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%), or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.
Flood Zone 3(b)	This zone comprises land where water has to flow or be stored in times of flood.

2.7.10.3 Volume 6, annex 2.2: Environment Agency and IDB Watercourses and Flood Zones shows the EA flood zone risk map for the Hornsea Three hydrology and flood risk study area. The maps are the first stage in identifying the flood risk for a particular location and depict the 'no defence' scenario. A description of other flood sources (i.e. groundwater, direct runoff from fields or overflowing sewers) is presented in volume 6, annex 2.1: Onshore Infrastructure FRAs.

2.7.10.4 These flood maps (see volume 6, annex 2.2: Environment Agency and IDB Watercourses and Flood Zones) indicate that over 90% of the Hornsea Three hydrology and flood risk study area (approximately 49 km) is located within NPPF Undefended Flood Zone 1 'low probability'.

2.7.10.5 A small area (approximately 3 ha) of the Hornsea Three hydrology and flood risk study area, located close to the Hornsea Three landfall area, is shown as Flood Zone 3. The flood zone extents are associated with the flood envelope of Spring Beck, which flows in a south to north direction through Weybourne Village centre.

2.7.10.6 Other localised areas within the Hornsea Three hydrology and flood risk study area are shown as Flood Zone 3. The Flood Zone extents are associated with the unnamed stream near Salle, Blackwater Drain, Swannington Beck, River Wensum, River Tud, River Yare, unnamed tributary of the River Yare at Little Melton and Intwood Stream.

2.7.10.7 The EA's surface water flood mapping indicates that isolated localised areas of the onshore HVAC booster station and the HVDC converter/HVAC substation associated with low lying land are at 'low' risk of surface water flooding. The remainder of the onshore HVAC booster station and HVDC converter/HVAC substation areas are at 'very low' risk of surface water flooding. Further information is provided within volume 6, annex 2.1: Onshore Infrastructure FRAs.

2.7.11 Future baseline scenario

2.7.11.1 The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 requires that "*an outline of the likely evolution thereof without implementation of the development as far as natural changes from the baseline scenario can be assessed with reasonable effort on the basis of the availability of environmental information and scientific knowledge*" is included within the Environmental Statement.

2.7.11.2 In the event that Hornsea Three does not come forward, an assessment of the future baseline conditions has been carried out and is described within this section.

2.7.11.3 The main impact on the hydrology and flood risk future baseline is associated with the potential effects of climate change, which may impact on future peak river flow rates, rainfall intensity and sea levels. A summary of potential climate change allowances as outlined by the EA (February 2016, updated February 2017) is presented below. Further details of climate change allowances can be found at https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances.

2.7.11.4 The NPPF sets out how the planning system should help minimise vulnerability and provide resilience to the impacts of climate change. This includes demonstrating how flood risk will be managed now and over the development's lifetime, taking climate change into account. In response to this, EA guidance issued in February 2016, requires that FRAs and strategic FRAs assess both the central and upper end allowances (see Table 2.9 to understand the potential range of impacts associated with climate change).

2.7.11.5 The range of allowances (Table 2.9) is based on percentiles. The 50th percentile is the point at which half of the possible scenarios for peak rainfall intensity fall below it and half fall above it. The:

- central allowance is based on the 50th percentile; and
- upper end is based on the 90th percentile.

2.7.11.6 As an example, with a central allowance of 20%, scientific evidence suggests that it is just as likely that the increase in peak rainfall intensity will be more than 20% as less than 20%.

Table 2.9: Peak rainfall intensity allowance in small and urban catchments (use 1961 to 1990 baseline[1]).

Applies across all of England	Total potential change (increase) anticipated for 2010 to 2039	Total potential change anticipated for 2040 to 2059	Total potential change anticipated for 2060 to 2115
Upper End	10%	20%	40%
Central	5%	10%	20%

2.7.11.7 Guidance is also provided on increases in river flows as a consequence of climate change. The guidance provides central, upper central and higher central climate allowance bands which should be utilised within the assessment of flood risk, including the flood risk vulnerability classification, for sites in Flood Zones 2, 3a and 3b (at flood risk) (see Table 2.10).

Table 2.10: Peak river flow allowance by river basin district (use 1961 to 1990).

River basin district	Allowance category	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Anglian	Upper end	25%	35%	65%
	Higher central	15%	20%	35%
	Central	10%	15%	25%

2.7.11.8 Table 2.11 summarises potential sea level rise over various epochs (periods of time) for the east, east midlands, London and south east area as defined by the EA Sea Level Rise Boundaries maps (https://www.gov.uk/government/publications/flood-risk-assessments-river-basin-district-maps).

[1] Environment Agency, 2016. Flood Risk Assessments: Climate Change allowances, [Online]. [Accessed 01 November 2017]. Available from: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

Table 2.11: Sea level allowance for each epoch in millimetres (mm) per year with cumulative sea level rise for each epoch in brackets (use 1990 baseline).

Area of England	1990 to 2025	2026 to 2055	2056 to 2085	2086 to 2115	Cumulative rise 1990 to 2115
East, East Midlands, London, south east.	4 (140 mm)	8.5 (255 mm)	12 (360 mm)	15 (450 mm)	1.21 m

2.7.12 Data limitations

2.7.12.1 The assessment within this chapter is based on publicly available data obtained from the EA, Norfolk County Council, North Norfolk District Council, Broadland District Council and South Norfolk District Council, Norfolk Rivers IDB and commercial data supply companies, as well as additional information supplied from stakeholders during the scoping and consultation stages. Broadland District Council confirmed they hold no records of private water supplies within the district. The information has therefore been supplemented with publicly available data, Groundsure searches and public consultation such that it is considered sufficient to characterise the baseline environment.

2.7.12.2 It is also noted that the EA Flood Zone risk maps do not take into account the impact of local flood defences and climate change on flooding, and do not provide information on flood depth, speed or volume of flow. The maps do not show flooding from other sources such as groundwater, direct runoff from fields or overflowing sewers. However, a description of these sources of flooding is provided in the FRAs (see volume 6, annex 2.1: Onshore Infrastructure FRAs), such that sufficient baseline information is available.

2.7.12.3 The assessment is limited by a lack of detailed information on:

- Flow data for watercourses and drainage channels; and
- Water quality data for specific locations.

2.7.12.4 Notwithstanding the above, overall a moderate to high level of certainty has been applied to the baseline and assessment presented in this chapter. Where available, catchment data regarding water quality has been used to inform the assessment, with a hydrological site walkover undertaken for all EA designated main river and IDB watercourse crossings within the Hornsea Three hydrology and flood risk study area. The information which was available is considered sufficient to establish the baseline within the Hornsea Three hydrology and flood risk study area, therefore, there are no data limitations that would affect the conclusions of this assessment.

2.8 Key parameters for assessment

2.8.1 Maximum design scenario

2.8.1.1 The maximum design scenarios identified in Table 2.12 have been selected as those having the potential to result in the greatest effect on an identified receptor or receptor group. These scenarios have been selected from the details provided in the project description (volume 1, chapter 3: Project Description). Effects of greater significance are not predicted to arise should any other development scenario, based on details within the project Design Envelope, to that assessed here be taken forward in the final design scheme.

2.8.2 Impacts scoped out of the assessment

2.8.2.1 On the basis of the baseline environment and the project description outlined in volume 1, chapter 3: Project Description, a number of impacts are proposed to be scoped out of the assessment for hydrology and flood risk. These impacts are outlined, together with a justification for scoping them out, in Table 2.13.

Table 2.12: Maximum design scenario considered for the assessment of potential impacts on hydrology and flood risk.

Potential impact	Maximum design scenario	Justification
Construction phase		
The impacts of construction may lead to increased flood risk.	<u>Hornsea Three landfall area</u> Open cut at the Hornsea Three landfall area including: • Up to 42,000 m^2 compound area including up to 1,500 m^2 from transition joint bays (based on 250 m^2 x 6); • Up to six cables; and • Corridor width up to 240 m wide (comprising six cables (with installation area up to 15 m) plus up to 20 m separation between each cable). The maximum duration over which works could occur at the landfall would be 5.5 years (assuming a three-year gap between the two phases. <u>Hornsea onshore cable corridor</u> • Up to 1,650,000 m^2 (5 m x 55,000 m x 6) from installation of up to six cable trenches; • On average 0.6 m stabilised backfill in each 2 m deep trench; • Up to 99,000 m^2 from jointing bays (based on 440 jointing bays (each jointing bay is 9 m x 25 m)). • Up to 3,960 m^2 from link boxes (based on 440 link boxes (each link box: is 3 m x 3 m)). Link boxes are permanent sub surface structures; • Up to 396,000 m^2 from installation of temporary haul road/accesses (6 m x 66,000 m per phase); • Up to 120 HDD locations per phase (up to 105 minor HDDs and 15 major HDDs per phase), up to 54,000 m^2 from major HDD compounds (based on 15 HDD compounds (each compound is 60 m x 60 m)); • Up to five secondary compounds; • Up to 55 storage areas; and • The haul road would be surfaced with aggregate on geotextile and would be removed at the end of each construction phase. The maximum duration over which construction could occur at the onshore cable corridor would be 5.5 years incorporating two phases (assuming a three-year gap between the two phases). The work in each phase is expected to progress along the Hornsea Three onshore cable corridor with a typical active construction works duration of three months at any particular location. <u>Onshore HVAC booster station</u> Up to 30,407 m^2 for permanent area of site plus a temporary works area up to 25,000 m^2. Maximum building footprint of 9,000 m^2 (based on single building scenario (120 m length and 75 m width) and height up to 12.5 m). Up to 30,000 m^3 excavated for basement (based on 5 m deep and area of 6,000 m^2). The maximum duration over which construction could occur at the onshore HVAC booster station would be five years incorporating two phases assuming a three-year gap with no active construction activity between the two phases.	The maximum design scenario for flood risk at the Hornsea Three landfall area would result from the use of open cut techniques at the landfall area as this involves trenching across the shingle beach which currently provides a natural flood defence. Open trenching has the potential to disrupt or damage the integrity of the natural flood defence and increasing the impacts of coastal erosion. The HVAC transmission presents the maximum design scenario at the Hornsea Three landfall area due to the greater number of cables and therefore, a wider corridor and trench are required. The maximum design scenario for flood risk on the Hornsea Three onshore cable corridor is the HVAC transmission due to the greater number of cable trenches required and therefore, the greatest area of land disturbance. The use of open cut crossings represents the maximum design scenario for flood risk due to the change in the channel dimensions and pumping. The maximum design scenario for flood risk in terms of the onshore HVAC booster station is associated with the HVAC transmission as the booster station is not required for the HVDC transmission. The dimensions of the main buildings at the onshore HVDC converter/HVAC substation represent the maximum design scenario for flood risk as it results in the largest possible area of disturbance and flood storage.
	<u>Onshore HVDC converter/HVAC substation</u> Up to 149,302 m^2 for permanent area of site (including an area which may be used for landscaping) plus a temporary works area of 91,000 m^2. Maximum building dimensions: up to 220 m length, 75 m width and 25 m height for main buildings.	

Potential impact	Maximum design scenario	Justification
	The maximum duration over which construction could occur at the onshore HVDC converter/HVAC substation would be six years incorporating two phases assuming a three-year gap with between the two phases. Construction programme The maximum duration of construction for all onshore elements of Hornsea Three would be eight years, which assumes construction across two phases with a three-year gap in-between, as a result of staggered construction of the components (onshore HVAC booster station, onshore HVDC converter/HVAC substation and Hornsea Three onshore cable corridor) and each phase would be preceded by pre-construction activities such as borehole investigations at HDD crossing points.	
The impacts of HDD may affect main surface watercourses.	HDD crossings across main surface watercourses Up to 120 HDD locations per phase (up to 105 minor HDDs and 15 major HDDs per phase), up to 54,000 m^2 from major HDD compounds (based on 15 HDD compounds (each compound is 60 m x 60 m)). Construction programme The maximum duration of construction for all onshore elements of Hornsea Three would be eight years, which assumes construction across two phases with a three-year gap in-between, as a result of staggered construction of the components (onshore HVAC booster station, onshore HVDC converter/HVAC substation and Hornsea Three onshore cable corridor) and each phase would be preceded by pre-construction activities such as borehole investigations at HDD crossing points	The maximum design scenario for indirect effects to surface water quality would result from the use of HDD methods. HDD presents a risk of indirectly contaminating surface watercourses where they are hydraulically connected with surface runoff caused by spillages and the movement of sediment.
The impacts of open cut, temporary bridging and culverts may affect surface watercourses.	Open cut crossings across minor surface watercourses (including drainage channels) • Up to five open cut crossings (see volume 4, annex 3.5: Onshore Crossing Schedule); and • Up to five secondary compounds.	The maximum design scenario for disturbance to surface water resources would result from the use of open cut, temporary bridging and culverts. The HVAC transmission represents the maximum design scenario due to the greater number of cables required as this would result in the largest possible area of disturbance to surface water resources. Any increase in less permeable area/disruption to local surface watercourses may affect the hydrological regime of the area, increasing turbid runoff into the watercourses, leading to a reduction in WFD classification.
The impacts of construction may affect drainage pipeline infrastructure.	Hornsea onshore cable corridor • Up to 1,650,000 m^2 (5 m x 55,000 m x 6) from installation of up to six cable trenches; • On average 0.6 m stabilised backfill in each 2 m deep trench; • Up to 99,000 m^2 from jointing bays (based on 440 jointing bays (each jointing bay is 9 m x 25 m)); • Up to 3,960 m^2 from link boxes (based on 440 link boxes (each link box: is 3 m x 3 m)). Link boxes are permanent sub surface structures; • Up to 396,000 m^2 from installation of temporary haul road/accesses (6 m x 66,000 m per phase); • Up to 120 HDD locations per phase (up to 105 minor HDDs and 15 major HDDs per phase), up to 54,000 m^2 from major HDD compounds (based on 15 HDD compounds (each compound is 60 m x 60 m)); • Up to five secondary compounds; and • Up to 55 storage areas. • The haul road would be surfaced with aggregate on geotextile and would be removed at the end of each construction phase. The maximum duration over which construction could occur at the onshore cable corridor would be 5.5 years incorporating two phases (assuming a three-year gap between the two phases). The work in each phase is expected to progress along the Hornsea Three onshore cable corridor with a typical active construction works duration of three months at any particular location. Construction programme The maximum duration of construction for all onshore elements of Hornsea Three would be eight years, which assumes construction across two phases with a three-year gap in-between, as a result of staggered	The maximum design scenario for disturbance or damage to drainage pipeline infrastructure would be the HVAC transmission due to the greater number of cable trenches required and therefore the greatest area of land disturbance. The construction of the cable trenches, link boxes and junction bays may result in the removal or temporary blockage of existing drainage pipeline infrastructure. A loss of the drainage network would lead to the backing up of gullies and surface water systems leading to potential surcharging and flood risk.

Potential impact	Maximum design scenario	Justification
	construction of the components (onshore HVAC booster station, onshore HVDC converter/HVAC substation and Hornsea Three onshore cable corridor) and each phase would be preceded by pre-construction activities such as borehole investigations at HDD crossing points	
The impacts of construction may affect field drainage and irrigation.	<u>Hornsea onshore cable corridor</u> • Up to 1,650,000 m² (5 m x 55,000 m x 6) from installation of up to six cable trenches; • On average 0.6 m stabilised backfill in each 2 m deep trench; • Up to 99,000 m² from jointing bays (based on 440 jointing bays (each jointing bay is 9 m x 25 m)); • Up to 3,960 m² from link boxes (based on 440 link boxes (each link box: is 3 m x 3 m)). Link boxes are permanent sub surface structures; • Up to 396,000 m² from installation of temporary haul road/accesses (6 m x 66,000 m per phase); • Up to 120 HDD locations per phase (up to 105 minor HDDs and 15 major HDDs per phase), up to 54,000 m² from major HDD compounds (based on 15 HDD compounds (each compound is 60 m x 60 m)); • Up to five secondary compounds; and • Up to 55 storage areas. • The haul road would be surfaced with aggregate on geotextile and would be removed at the end of each construction phase. The maximum duration over which construction could occur at the onshore cable corridor would be 5.5 years incorporating two phases (assuming a three-year gap between the two phases). The work in each phase is expected to progress along the Hornsea Three onshore cable corridor with a typical active construction works duration of three months at any particular location. <u>Onshore HVAC booster station</u> Up to 30,407m² for permanent area of site plus a temporary works area up to 25,000 m². Maximum building footprint of 9,000 m² (based on single building scenario (120 m length and 75 m width) and height up to 12.5 m). Up to 30,000 m³ excavated for basement (based on 5m deep and area of 6,000 m²). The maximum duration over which construction could occur at the onshore HVAC booster station would be five years incorporating two phases assuming a three-year gap with no active construction activity between the two phases. <u>Onshore HVDC converter/HVAC substation</u> Up to 149,302 m² for permanent area of site (including an area which may be used for landscaping) plus a temporary works area of 91,000 m². Maximum building dimensions: up to 220 m length, 75 m width and 25 m height for main buildings. The maximum duration over which construction could occur at the onshore HVDC converter/HVAC substation would be six years incorporating two phases assuming a three-year gap with between the two phases. <u>Construction programme</u> The maximum duration of construction for all onshore elements of Hornsea Three would be eight years, which assumes construction across two phases with a three-year gap in-between, as a result of staggered construction of the components (onshore HVAC booster station, onshore HVDC converter/HVAC substation and Hornsea Three onshore cable corridor) and each phase would be preceded by pre-construction activities such as borehole investigations at HDD crossing points.	The maximum design scenario for disturbance or damage to field drainage would be the HVAC transmission due to the greater number of cable trenches required and the construction of the onshore HVAC booster station (and therefore, the greatest area of land disturbance). The construction of the cable trenches, link boxes and junction bays may result in the removal or temporary blockage of existing field drainage. The construction of the onshore HVAC booster station and onshore HVDC converter/HVAC substation may result in the permanent removal of existing field drainage infrastructure. A loss of the drainage network would lead to the backing up of field drainage channels and surface water systems leading to potential surcharging and flood risk.

Potential impact	Maximum design scenario	Justification
Operation and maintenance phase		
The impacts of operation and maintenance may lead to increased flood risk.	<u>Onshore HVDC converter/HVAC substation</u> Up to 149,302 m^2 for permanent area of site (including an area which may be used for landscaping). Maximum building dimensions: up to 220 m length, 75 m width and 25 m height for main buildings. Up to 60,000 m^2 will comprise of the permanent footprint of the onshore HVDC converter/HVAC substation site will be constructed of impermeable material. <u>Onshore HVAC booster station</u> Up to 30,407 m^2 for permanent area of site. Maximum building footprint of 9,000 m^2 (based on single building scenario (120 m length and 75 m width and height up to 12.5 m)). Up to 10,000 m^2 of the permanent footprint will be constructed of impermeable material.	The maximum design scenario for flood risk is the HVAC transmission as it requires the construction of the onshore HVAC booster station. The dimensions of the main buildings at the onshore HVDC converter/HVAC substation represent the maximum design scenario for flood risk as they result in the biggest building footprint and area of impermeable surfacing.
The impacts of routine maintenance operations may affect ordinary watercourses.	Routine maintenance of the onshore HVDC converter/HVAC substation and HVAC booster station. • Inspections by light vehicles weekly; • Preventative (routine service) maintenance up to quarterly; and • Corrective maintenance as required.	The maximum design scenario for water quality of main watercourses during operation is that chemicals and oils would be used in the routine maintenance of the onshore HVDC converter/HVAC substation. An onshore HVAC booster station would also be required for the HVAC transmission (in addition to a HVAC substation) which would also require maintenance and therefore, represents the maximum design scenario.
Decommissioning phase		
The impacts of decommissioning may affect temporary flood risk.	Surface features of the link boxes may be removed and made safe. Removal of onshore HVDC converter/HVAC substation and onshore HVAC booster station including areas of hardstanding.	The maximum design scenario for flood risk on the surrounding environment during decommissioning is the removal of the link boxes surface features, onshore HVDC converter/HVAC substation and onshore HVAC booster station. The removal of attenuation storage associated with the onshore HVDC converter/HVAC substation and onshore HVAC booster station could affect flood risk as it would take the natural environment a period of time to re-establish itself and regenerate to providing natural attenuation.
The impacts of decommissioning may affect main rivers and ordinary watercourses.	Removal of the onshore HVDC converter/HVAC substation and onshore HVAC booster station including areas of hardstanding.	The maximum design scenario for water quality of main rivers and ordinary watercourses during decommissioning is the removal of the onshore HVDC converter/HVAC substation and onshore HVAC booster station as this presents the greatest disturbance and potential risk of sediment and contaminants being released.

Table 2.13: Impacts scoped out of the assessment for hydrology and flood risk.

Potential impact	Justification
Operation and Maintenance phase	
The impacts of routine maintenance operations (for the Hornsea Three onshore cable corridor) may affect main rivers and ordinary watercourses.	There are no proposed routine maintenance operations for the Hornsea Three onshore cable corridor.
The impacts of routine maintenance operations (for the onshore HVAC booster station and HVDC converter/HVAC substation) may affect main rivers.	There are no main rivers on or adjacent to the onshore HVAC booster station or HVDC converter/HVAC substation.
Decommissioning phase	
The impacts of decommissioning the onshore cable corridor may affect main rivers and ordinary watercourses.	There are no main rivers or ordinary watercourses within the Hornsea Three hydrology and flood risk study areas that would be affected by the decommissioning of the Hornsea Three onshore cable corridor as the cable would remain in situ (surface features of the link boxes may be removed and made safe).
The impacts of decommissioning the onshore HVAC booster station and HVDC converter/HVAC substation may affect main rivers.	There are no main rivers on or adjacent to the onshore HVAC booster station or HVDC converter/HVAC substation.

2.9 Impact assessment methodology

2.9.1 Overview

2.9.1.1 The hydrology and flood risk EIA has followed methodology set out in volume 1, chapter 5: Environmental Impact Assessment Methodology. Specific to the hydrology and flood risk EIA, the following guidance documents have also been considered:

- Highways Agency (2009) DMRB Volume 11, Section 10 Road Drainage and the Water Environment;
- Non-statutory technical standards for sustainable drainage systems (Defra, 2015); and
- Report C753: The SuDS manual (CIRIA, 2015).

2.9.1.2 In addition, the hydrology and flood risk EIA has considered the legislative framework as defined by the following legislation set out below:

- Water Resources Act 1991 allows the EA to create byelaws for flood defence and drainage purposes (paragraph 5 of Schedule 25 of the Water Resources Act 1991);
- The Environmental Permitting (England and Wales) Regulations 2016 applies in relation to flood risk activity in, over or under a watercourse. Consent is required from the EA to undertake works or to erect structures within 8 m of a non-tidal water body (and 16 m of a tidal body). An environmental permit is also required for any discharges to surface watercourses (Schedule 25 EPR 2016;
- Land Drainage Act 1991 – (under section 23) requires consent from the relevant DB for any works likely to obstruct, or affect the flow of, a watercourse. Under byelaws, consent is required from the relevant drainage authority for any development within a particular distance of a drainage work. This distance varies between drainage authorities but in the case of Norfolk Rivers IDB, consent is required for works within 9 m of the edge of drainage/flood risk management features (Section 66 of the LDA 1991). The relevant drainage authorities are the EA, Norfolk County Council, North Norfolk District Council, Broadland District Council, South Norfolk District Council and Norfolk Rivers IDB;
- The Flood and Water Management Act 2010 designated Norfolk County Council as the LLFA and places a series of responsibilities to improve flood risk management to surface water, groundwater and ordinary watercourses across their jurisdictional area; and
- The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 establishes a legislative framework for the protection of surface waters and groundwater. The Regulations place a general duty of the Secretary of State and the EA to exercise their 'relevant functions' so as to secure compliance with the WFD (2000/60/EC).

2.9.2 Impact assessment criteria

2.9.2.1 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 on those receptors. This section describes the criteria applied in this chapter to assign values to the sensitivity of receptors and the magnitude of potential impacts. The terms used to define sensitivity and magnitude are based on those used in the Design Manual for Road and Bridges methodology (DMRB, 2009), which is described in further detail in volume 1, chapter 5: Environmental Impact Assessment Methodology. The criteria for defining sensitivity in this chapter are outlined in Table 2.14.

Table 2.14: Definition of terms relating to the sensitivity of the receptor.

Sensitivity	Definition used in this chapter
Very High	Receptor is high value or critical importance to local, regional or national economy. Receptor is highly vulnerable to impacts that may arise from the project and recoverability is long term or not possible. Surface water: WFD Current Overall Status of High. Flood risk: Land within Flood Zone 3 or more than one hundred residential properties protected from flooding by flood defence infrastructure or by natural floodplain storage.
High	Receptor is of moderate value with reasonable contribution to local, regional or national economy. Receptor is generally vulnerable to impacts that may arise from the project and recoverability is slow and/or costly. Surface water: WFD Current Overall Status of Good. Flood risk: Land within Flood Zone 3 and/or 2 or between one and one hundred residential properties or industrial premises protected from flooding by flood defence infrastructure or by natural floodplain storage.
Medium	Receptor is of minor value with small levels of contribution to local, regional or national economy. Receptor is somewhat vulnerable to impacts that may arise from the project and has moderate to high levels of recoverability. Surface water: WFD Current Overall Status of Moderate. Flood risk: Flood plain within Flood Zone 2 and/or 1 or limited constraints and a low probability of flooding of residential and industrial properties.
Low	Receptor is of low value with little contribution to local, regional or national economy. Receptor is not generally vulnerable to impacts that may arise from the project and/or has high recoverability. Surface water: WFD Current Overall Status of Poor. Flood risk: Flood plain within Flood Zone 2 and/or 1 or limited constraints and a very low probability of flooding of residential and industrial properties.
Negligible	Receptor is of negligible value with no contribution to local, regional or national economy. Receptor is not vulnerable to impacts that may arise from the project and/or has high recoverability. Surface water: WFD Current Overall Status of Bad. Flood risk: Area outside flood plain (Flood Zone 1) or flood plain with very low probability of flooding industrial properties.

2.9.2.2 The criteria for defining magnitude in this chapter are outlined in Table 2.15.

Table 2.15: Definition of terms relating to the magnitude of an impact.

Magnitude of impact	Definition used in this chapter
Major	Total loss of ability to carry on activities. Impact is of extended temporal or physical extent and of long term duration (i.e., up to 10 years duration).
	Significant observable degradation in water resource quality and/or increase in flood risk (i.e., up to 10 years duration).
Moderate	Loss of or alteration to significant portions of key components of current activity. Impact is of moderate temporal or physical extent and of medium term duration (i.e., up to 5 years).
	Observable degradation in water resource quality and/or increase in flood risk (i.e., up to 5 years).
Minor	Small reduction in baseline conditions, leading to a reduction in level of activity that may be undertaken. Impact is of limited temporal or physical extent and of short term duration (i.e., up to 2 years).
	Degradation in water resource quality and/or slight increase in flood risk (i.e., up to 2 years).
Negligible	Very small reduction in baseline condition. Physical extent of impact is negligible and of short term duration (i.e., less than 1 year).
	No observable degradation in water resource quality and/or flood risk (i.e., less than 1 year).
No change	No change from baseline conditions.

2.9.2.3 The significance of the effect upon hydrology and flood risk is determined by correlating the magnitude of the impact and sensitivity of the receptor. The particular method employed for this assessment is presented in Table 2.16. Where a range of significance is presented in Table 2.16, the final assessment for each effect is based upon expert judgement.

2.9.2.4 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 2.16: Matrix used for the assessment of the significance of the effect.

		Magnitude of impact				
Sensitivity of receptor		***No change***	***Negligible***	***Minor***	***Moderate***	***Major***
	Negligible	Negligible	Negligible	Negligible or minor	Negligible or minor	Minor
	Low	Negligible	Negligible or minor	Negligible or minor	Minor	Minor or moderate
	Medium	Negligible	Negligible or minor	Minor	Moderate	Moderate or major
	High	Negligible	Minor	Minor or moderate	Moderate or major	Major or substantial
	Very high	Negligible	Minor	Moderate or major	Major or substantial	Substantial

2.10 Measures adopted as part of Hornsea Three

2.10.1.1 As part of the project design process, a number of designed-in measures have been proposed to reduce the potential impacts for hydrology and flood risk (see Table 2.17). As there is a commitment to implementing these measures, they are considered inherently part of the design of Hornsea Three and have therefore been considered in the assessment presented in section 2.11 (i.e. the determination of magnitude and therefore significance assumes implementation of these measures). These measures are considered standard industry practice for this type of development and would be secured through the CoCP (document reference A8.5), of which an outline version accompanies the DCO application.

Table 2.17: Designed-in measures adopted as part of Hornsea Three.

Measures adopted as part of Hornsea Three	Justification
Construction	
<u>Surface water drainage scheme</u> The proposed development of the onshore HVDC converter/HVAC substation and HVAC booster station will result in the construction of low permeability surfacing, increasing the rate of surface water runoff from the site. A surface water drainage scheme is required to ensure the existing runoff rates to the surrounding water environment are maintained at pre-development rates. Outline drainage strategies have been prepared and accompany the flood risk assessments (see volume 6, annex 2.1: Onshore Infrastructure Flood Risk Assessments). The detailed design of the surface water drainage scheme would be based on a series of infiltration/soakaway tests carried out on site and the attenuation volumes outlined in supporting FRAs (volume 6, annex 2.1: Onshore Infrastructure FRAs). The tests will be undertaken prior to construction and in accordance with the BRE Digest 365 Guidelines. The strategy will ensure that the current mean annual runoff rate at the onshore HVDC converter/HVAC substation and HVAC booster station is maintained at the current 1 in 1 year runoff rate, and is monitored to ensure that the agreed rate of discharge is maintained. Measures to mitigate against water pollution will also apply to the onshore HVDC converter/HVAC substation and HVAC booster station, and will include measures as set out for the Hornsea Three onshore cable corridor router below to minimise the risk of water pollution.	To address the requirements of NPS EN-1, the NPPF, EA, Natural England Section 42 response and Norfolk County Council surface water runoff requirements.
<u>Flood control measures</u> Cable trenching and construction site accesses widening across surface water courses will require measures to ensure that the water quality and flow rates are unaffected either directly or indirectly. The Hornsea Three onshore cable corridor and the construction site accesses will be designed to minimise land take and to avoid, where possible, impacts on existing drainage networks and features. The onshore construction compounds and construction accesses and haul roads would comprise permeable gravel overlying a permeable geotextile membrane of an appropriate standard. Where the Hornsea Three onshore cable corridor crosses smaller watercourses and land drainage ditches measures would be discussed with the relevant stakeholders (e.g. for temporary culvert crossings, appropriately sized flume pipes, equal to or greater than the diameter of the flume upstream and to an agreed length, will be placed on or below the hard bed of the watercourse). An outline method statement for open cut and HDD crossing techniques is contained within the Outline CoCP (document reference A8.5). These method statements will be developed in more detail with the EA following submission of the Environmental Statement. In some cases, crossing specific method statements will be developed. Cable entry and exit points within transition pits, junction bays and link boxes will be sealed with an appropriate water proofing material to mitigate flood risk. At the Hornsea Three landfall area, construction measures would be adopted to maintain the existing level of flood protection during construction. These measures would be discussed with the EA during detailed design. Drainage would be installed either side of the Hornsea Three onshore cable corridor to ensure existing land drainage flow is maintained and is not altered and channelled by the corridor. Surface water flowing into the trenches during the construction period will be pumped via settling tanks or ponds to remove sediment and potential contaminants, before being discharged into local ditches or drains via temporary interceptor drains. Where gradients on site are significant, cable trenches will include a hydraulic brake (bentonite or natural clay seals) to reduce flow along trenches and hence reduce local erosion. Any field drainage intercepted during the cable installation will either be reinstated following the installation of the cable or diverted to a secondary channel. Any works undertaken will be in agreement with the appropriate stakeholders.	To control flood risk.
<u>Pollution prevention measures</u>: Refuelling of machinery will be undertaken within designated areas where spillages can be easily contained. Machinery will be routinely checked to ensure it is in good working condition. Any tanks and associated pipe work containing oils and fuels will be double skinned and be provided with intermediate leak detection equipment. The following specific mitigation measures for the protection of surface water during construction activities will be implemented: • Management of construction works to comply with the necessary standards and consent conditions as identified by the EA; • A briefing highlighting the importance of water quality, the location of watercourses and pollution prevention included within the site induction; • Areas with prevalent runoff to be identified and drainage actively managed (e.g. through bunding and/or temporary drainage); • Vegetated strip to be left adjacent to the watercourse during construction; • Bankside vegetation will be reinstated following the construction phase; • Areas at risk of spillage, such as vehicle maintenance areas and hazardous substance stores (including fuel, oils and chemicals) to be bunded and carefully sited to minimise the risk of hazardous substances entering the drainage system or the local watercourses. • Additionally, the bunded areas will have impermeable bases to limit the potential for migration of contaminants into groundwater following any leakage/spillage. Bunds used to store fuel, oil etc. to have a 110% capacity; • Disturbance to areas close to watercourses reduced to the minimum necessary for the work; • Excavated material to be placed in such a way as to avoid any	To prevent pollution of water courses and address stakeholder concerns for the construction of the onshore elements of Hornsea Three.

Measures adopted as part of Hornsea Three	Justification
disturbance of areas near to the banks of watercourses and any spillage into the watercourses; • Construction materials to be managed in such a way as to effectively minimise the risk posed to the aquatic environment; • All plant machinery and vehicles to be maintained in a good condition to reduce the risk of fuel leaks; • Drainage works to be constructed to relevant statutory guidance and approved via the LLFA prior to the commencement of construction; and • Consultation with the EA and Natural England to be ongoing throughout the construction period to promote best practice and to implement proposed mitigation measures.	
Best practice measures All construction work will be undertaken in accordance with the Outline CoCP (document reference A8.5), and good practice guidance including, but not limited to: • Control of Water Pollution from Construction Sites – Guidance for Consultants and Contractors CIRIA (C650); • CIRIA – SuDS Manual (CIRIA, 2015); • No discharge to surface watercourses will occur without permission from the EA (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 • A construction method statement to be submitted for approval by the responsible authority (SuDS Manual).	To accord with guidance and best practice for construction works.
Operation and Maintenance phase	
Operational practices to incorporate measures to prevent pollution and increased flood risk, to include emergency spill response procedures, clean up and remediation of contaminated water runoff.	To reduce the risk of surface water pollution.
Decommissioning phase	
Decommissioning practices to incorporate measures to prevent pollution and increased flood risk, Exposed cables ducts will be sealed with an appropriate water proofing material to mitigate flood risk.	To protect surface water based on guidance that will be appropriate at the time of decommissioning.

2.11 Assessment of significance

2.11.1 Construction Phase

2.11.1.1 The impacts of the onshore construction of Hornsea Three have been assessed on hydrology and flood risk. The potential environmental impacts arising from the construction of Hornsea Three are listed in Table 2.12 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 hydrology and flood risk receptors caused by each identified impact is given below.

Impacts of construction may lead to increased flood risk.

Magnitude of impact

2.11.1.3 At the Hornsea Three landfall area, the shingle beach provides a natural flood defence. The use of open cut techniques across the beach has the potential to create a pathway for flood water and lead to a slight increase in flood risk in-land. However, by virtue of the current onshore land elevations the risk is low, in addition the construction process would include, but not be limited to, measures such as coffer dams and raised sheet piling to stabilise intertidal excavation to maintain the existing level of protection from tidal flood risk. These measures are outlined in the project description (volume 1, chapter 3: Project Description). The magnitude of impact is predicted to be of local spatial extent, short term duration and reversible. The impact magnitude is therefore predicted to be minor.

2.11.1.4 In other parts of the Hornsea Three hydrology and flood risk study area, impacts on flood risk would arise from any temporary change in runoff over the areas affected during construction, such as construction compounds, haul road, construction accesses and the Hornsea Three onshore cable corridor. Construction methodologies (as set out in Table 2.17) will be implemented to ensure the risk of flooding is not increased (e.g. permeable gravel overlying a permeable geotextile membrane of an appropriate standard for construction compounds, haul road and construction accesses and drainage features to maintain land drainage flow). In terms of crossings, all major crossings (such as major roads, rivers and rail crossings) would be undertaken using HDD techniques (full details provided within the volume 1, chapter 3: Project Description). An outline method statement for the proposed crossing methodologies is included in the Outline CoCP (document reference A8.5). This method statement will be developed further (in discussion with the EA) during the detailed design stage.

2.11.1.5 The impacts on flood risk from the temporary change in runoff are only likely to affect the surrounding local receptors and, assuming that designed-in and construction measures (see Table 2.17) are implemented, there is unlikely to be any observable degradation in flood risk. The magnitude is therefore, considered to be negligible.

Sensitivity of receptor

2.11.1.6 The Hornsea Three landfall area comprises a shingle beach which provides a natural flood defence. It has a local importance and a high recoverability and therefore is considered to have a low sensitivity.

2.11.1.7 The Hornsea Three onshore cable corridor, onshore HVDC converter/HVAC substation and HVAC booster station are situated within a mainly rural area, with limited residential properties within the surrounding area. Due to the low percentage of the onshore cable corridor situated within Flood Zone 3 and the limited residential or industrial properties within the Hornsea Three study area, the land adjoining the Hornsea Three hydrology and flood risk study area is of low vulnerability, high recoverability and low value. The sensitivity of the receptor is therefore, considered to be low.

Significance of the effect

2.11.1.8 Overall, the sensitivity of the Hornsea Three landfall area is considered to be low and the magnitude of the impact is deemed to be minor. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

2.11.1.9 The sensitivity for the rest of the Hornsea Three hydrology and flood risk study area is considered to be low and the magnitude of the impact is deemed to be negligible. The effect will, therefore, be of **negligible** significance, which is not significant in EIA terms.

Impacts of HDD may affect main surface watercourses.

Magnitude of impact

2.11.1.10 All major watercourses will be crossed using HDD techniques (see volume 1, chapter 3: Project Description). The impacts on major watercourses from construction activities involving the use of HDD techniques and associated machinery could lead to an increase in turbid runoff, bentonite breakouts during drilling and spillages/leaks of fuel, oil etc. affecting nearby watercourses. There is the potential for this to impact on water quality and therefore cause a reduction in the WFD classification.

2.11.1.11 Similarly, the Hornsea Three onshore cable corridor itself could act as a drainage channel, leading to runoff from construction areas affecting nearby watercourses. However, the construction process will include measures to intercept runoff and ensure that discharges are controlled in quality and volume causing no degradation in WFD classification. This would include the use of settling tanks or ponds to remove sediment, temporary interceptors and a hydraulic brake, as set out in Table 2.17 . The impact is predicted to be of local spatial extent, short term duration, intermittent occurrence and high reversibility. The magnitude is therefore, considered to be negligible.

Sensitivity of receptor

2.11.1.12 As noted in section 2.7.9, taking a precautionary approach in assuming all watercourses have achieved 'Good' status at the time when construction begins, the surface watercourses within the Hornsea Three hydrology and flood risk study area have been assessed with a WFD status of 'Good'. The watercourses crossed via HDD techniques are therefore, considered to be highly vulnerable in relation to WFD classification status, but of moderate recoverability and moderate value in relation to the local economy. The sensitivity of the receptor is therefore, considered to be high.

Significance of the effect

2.11.1.13 Overall, the sensitivity of the receptor is considered to be high and the magnitude of the impact is deemed to be negligible. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

2.11.1.14 Effects in relation to runoff from construction sites and spillages for main watercourses, which includes the integration of measures adopted in Table 2.17, would be of **minor adverse** significance.

Impacts of open cut, temporary bridging and culverts may affect surface watercourses.

Magnitude of impact

2.11.1.15 A number of minor watercourses and drains may be crossed by the Hornsea Three onshore cable corridor, within which would be located up to one temporary haul road (per phase) associated construction could lead to damage to the banks along the watercourses, an increase in turbid runoff, spillages/leaks of fuel, oil etc. and an alteration in surface water flow pathways that could affect nearby watercourses. Similarly, the Hornsea Three onshore cable corridor itself could act as a drainage channel, leading to runoff from construction affecting nearby watercourses.

2.11.1.16 An outline method statement for crossing watercourses and other mitigation measures to reduce and manage runoff in terms of volume and quality have been outlined in Table 2.17 and the Outline CoCP (document reference A8.5) and will be developed further in discussion with the EA and Natural England during the detailed design stage. These measures would include the use of settling tanks or ponds to remove sediment and the installation of pre-installed culvert (flume) pipes in the watercourse under the construction accesses and haul road. The pipe would be of suitable size to accommodate the water volumes and flows, or temporary bridging may be installed. The accesses and haul roads would be removed at the end of the construction programme and measures would be implemented to ensure that watercourses, including their banks, are reinstated to their previous condition where possible.

2.11.1.17 The impact is predicted to be of local spatial extent, short term duration, intermittent occurrence and high reversibility. The magnitude is therefore, considered to be negligible.

Sensitivity of receptor

2.11.1.18 Minor watercourses' WFD status is determined by the WFD classifications of surrounding main waterbodies. Taking this into consideration, the minor watercourses are considered to be of high vulnerability, moderate recoverability and moderate value. The sensitivity of the receptor is therefore, considered to be high.

Significance of the effect

2.11.1.19 Overall, the sensitivity of the setting is considered to be high and the magnitude of the impacts is deemed to be negligible. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Impacts of construction may affect drainage infrastructure.

Magnitude of impact

2.11.1.20 The impact on drainage pipeline infrastructure from open cut and HDD techniques during the construction phase could temporarily disrupt local drainage infrastructure, impacting on water quality, potential flow rates and local water supply networks.

2.11.1.21 The routing and refinement of the Hornsea Three onshore cable corridor has taken into account the location of major services utilities (see volume 1, chapter 4: Site Selection and Consideration of Alternatives) and is identified on the onshore crossing schedule (volume 4, annex 3.5), however the presence of local drainage (e.g. soakaways) cannot be discounted as it is not always mapped by regulators. For example, the hydrology characterisation survey of the main river crossing locations identified the presence of an Anglian Water service pipe in the vicinity of the River Yare.

2.11.1.22 Discussions with Anglian Water and other service companies will be undertaken at the detailed design stage to confirm the location of local services. Micro-routing or appropriate construction techniques will be employed where required.

2.11.1.23 Any impacts of construction which affect drainage supply infrastructure are likely to cause temporary disruption of water supply to residents/businesses in the local surrounding area. The impact would be of limited temporal extent and short-term duration. It is predicted that any impact will affect the receptor directly. The magnitude is therefore, considered to be minor.

Sensitivity of receptor

2.11.1.24 Drainage pipeline infrastructure comprises water supply pipelines operated by Anglian Water, which are considered to have a moderate value and contributes to the local and regional economy. It is vulnerable to the construction impacts of Hornsea Three and its recoverability may be costly. The sensitivity of the receptor is therefore considered to be high.

Significance of the effect

2.11.1.25 Overall, the sensitivity of the setting is considered to be high and the magnitude of the impact is deemed to be minor. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms. This is due to the short-term duration of the impact that receptors in the local area (i.e. local residents and businesses) would be affected with regards to water supply.

Impacts of construction may affect field drainage and irrigation.

Magnitude of impact

2.11.1.26 The impact on field drainage and irrigation from open cut techniques and the installation of link boxes and jointing bays during the construction phase could temporarily affect surface water flow pathways, impacting on water quality and potential flow rates.

2.11.1.27 The removal of field drains within the onshore HVAC booster station and onshore HVDC converter/HVAC substation sites may cause a backup on surrounding field drains, in turn increasing the flood risk to the site and surrounding receptors. Measures to manage surface water flows include the restoration field drainage following the installation of the Hornsea Three onshore cable corridor and techniques to disrupt surface water runoff along the corridor. These measures are included in Table 2.17.

2.11.1.28 With the incorporation of appropriate construction mitigation techniques and Drainage Management Plan (see Outline CoCP, document reference A8.5) (at the onshore HVAC booster station and onshore HVDC converter/HVAC substation sites) the impact is predicted to be of local spatial extent with a minor shift away from existing hydrological environment of local receptors, short term duration, intermittent occurrence and reversible with field drains to be re-established where appropriate. It is predicted that any impact will affect the receptor directly. The magnitude is therefore, considered to be minor.

Sensitivity of receptor

2.11.1.29 Field drains are considered to be of moderate vulnerability along the onshore cable corridor, moderate to high recoverability and minor value. The sensitivity of the receptor, is therefore considered to be medium.

Significance of the effect

2.11.1.30 Overall, the sensitivity of the receptor is considered to be medium and the magnitude of impact is deemed to be minor. The effect will therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Future monitoring

2.11.1.31 No hydrology and flood risk monitoring to test the predictions made within the construction phase impact assessment is considered necessary.

2.11.2 Operation and maintenance phase

2.11.2.1 The impacts of the onshore operation and maintenance of Hornsea Three have been assessed on hydrology and flood risk conditions. The potential environmental impacts arising from the operation and maintenance of Hornsea Three are listed in Table 2.12 along with the maximum design scenario against which each operation and maintenance phase impact has been assessed.

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

Impacts of operation may lead to increased flood risk.

Magnitude of impact

2.11.2.3 The proposed onshore HVAC booster station, onshore HVDC converter/HVAC substation and onshore cable corridor have been subject to an FRA (volume 6, annex 2.1: Onshore Infrastructure FRAs) in order to meet the requirements of planning policy and best practice. The onshore HVAC booster station and onshore HVDC converter/HVAC substation sites would be designed to ensure no increase in the greenfield rate of runoff. With the incorporation of mitigation measures outlined in Table 2.17 and the outline drainage strategy within the FRA, it has been determined that there will be no change from the baseline hydrological environment. The magnitude is therefore, considered to be negligible.

2.11.2.4 As the Hornsea Three onshore cable corridor will be underground and will incorporate drainage either side of the cable corridor to ensure existing land drainage flow is maintained, it is determined that there will be no increase in flood risk due to operation and maintenance of the cable.

Sensitivity of receptor

2.11.2.5 The proposed onshore HVAC booster station and onshore HVDC converter/HVAC substation areas are located within Flood Zone 1 and therefore are not directly at risk of flooding from all sources. The land adjoining the onshore HVAC booster station and onshore HVDC converter/HVAC substation areas are of low flood risk vulnerability within the rural landscape, high recoverability and low value with limited residential, commercial or industrial properties in the vicinity. The sensitivity of the receptor is therefore, considered to be low.

Significance of the effect

2.11.2.6 Overall, the sensitivity of the receptor is considered to be low and the magnitude of the impact is deemed to be negligible due to the incorporation of mitigation measures and an outline drainage strategy. The effect will therefore, be of **negligible** significance, which is not significant in EIA terms.

The impacts of routine maintenance operations may affect ordinary watercourses.

Magnitude of impact

2.11.2.7 The operation of the onshore HVAC booster station and onshore HVDC converter/HVAC substation will involve routine maintenance. Maintenance may involve the use of chemicals, oils and greases and therefore, there is the potential for spillages to occur which may affect the water quality of ordinary watercourses.

2.11.2.8 With the incorporation of mitigation measures outlined in Table 2.17, the impact to ordinary watercourses are predicted to be of local spatial extent only impacting on surrounding receptors, short term duration, intermittent occurrence and reversible. The magnitude is therefore, considered to be negligible.

Sensitivity of receptor

2.11.2.9 The ordinary watercourses in the vicinity of the onshore HVAC booster station and HVDC converter/HVAC substation are considered to be of high vulnerability, moderate recoverability and moderate value. The sensitivity of the receptor is therefore, considered to be high.

Significance of the effect

2.11.2.10 Overall, the sensitivity of the receptors is considered to be high and the magnitude of the impact is deemed to be negligible. The effect on main and ordinary watercourses will therefore be of **minor adverse** significance, which is not significant in EIA terms.

Future monitoring

2.11.2.11 No hydrology and flood risk monitoring to test the predictions made within the operation and maintenance phase impact assessment is considered necessary.

2.11.3 Decommissioning phase

2.11.3.1 The impacts of the onshore decommissioning of Hornsea Three have been assessed on hydrology and flood risk receptors. The potential impacts arising from the decommissioning of Hornsea Three are listed in Table 2.12 along with the maximum design scenario against which each decommissioning phase impact has been assessed.

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

Impacts of decommissioning may lead to increased flood risk.

Magnitude of impact

2.11.3.3 The decommissioning of the onshore HVAC booster station and onshore HVDC converter/HVAC substation will involve the demolition of buildings as well as removal of foundations and the attenuation storage provided during construction and operation. The natural attenuation of the sites will be restored over time. Surface features of the link boxes may be removed and made safe.

2.11.3.4 The impacts of decommissioning of the Hornsea Three components will be reduced through the incorporation of management measures (outlined in Table 2.17), including emergency spill response procedures including clean up and remediation of contaminated soils, appropriate water proofing of exposed cable ducts and the continued maintenance of on-site drainage and therefore are predicted to be of local spatial extent, short term duration, intermittent and high reversibility indicating that any impacts on decommissioning which affect flood risk vulnerability are likely to only affect the surrounding local receptors. The magnitude is therefore, considered to be minor.

Sensitivity of receptor

2.11.3.5 Over 90% of the Hornsea Three hydrology and flood risk study area is shown as Flood Zone 1 with localised areas of Flood Zone 2 and 3. The Hornsea Three onshore cable corridor, onshore HVDC converter/HVAC substation and HVAC booster station are situated within a mainly rural area, with limited residential properties within the surrounding area. The onshore HVAC booster station and onshore HVDC converter/HVAC substation areas and the Hornsea Three onshore cable corridor where the surface features of link boxes may be removed are of low vulnerability, high recoverability and low value. The sensitivity of the receptor is therefore, considered to be low.

Significance of the effect

2.11.3.6 Overall the magnitude of impact is considered minor and the sensitivity of receptors is considered low. The effect of decommissioning on flood risk will therefore be of **minor adverse** significance, which is not significant in EIA terms.

The impacts of decommissioning may affect main rivers and ordinary watercourses.

2.11.3.7 The effects of decommissioning activities are expected to be the same or similar to the effects from construction. The significance of effect is therefore of **minor adverse** significance, which is not significant in EIA terms (see paragraphs 2.11.2.7 to 2.11.2.11).

Future monitoring

2.11.3.8 No hydrology and flood risk monitoring to test the predictions made within the decommissioning phase impact assessment is considered necessary.

2.12 Cumulative Effect Assessment methodology

2.12.1 Screening of other projects and plans into the Cumulative Effect Assessment

2.12.1.1 The Cumulative Effect Assessment (CEA) takes into account the impact associated with Hornsea Three together with other projects and plans. The projects and plans selected as relevant to the CEA presented within this chapter are based upon the results of a screening exercise undertaken as part of the 'CEA long list' of projects (see volume 4, annex 5.2: Cumulative Effects Screening Matrix and annex 5.3: Location of Cumulative Schemes). Each project on the CEA long list has been considered on a case by case basis for scoping in or out of this chapter's assessment based upon data confidence, effect-receptor pathways and the spatial/temporal scales involved.

2.12.1.2 In undertaking the CEA for Hornsea Three, it is important to bear in mind that other projects and plans under consideration will have differing potential for proceeding to an operational stage and hence a differing potential to ultimately contribute to a cumulative impact alongside Hornsea Three. For example, relevant projects and plans that are already under construction are likely to contribute to cumulative impact with Hornsea Three (providing effect or spatial pathways exist), whereas projects and plans not yet approved or not yet submitted are less certain to contribute to such an impact, as some may not achieve approval or may not ultimately be built due to other factors. For this reason, all relevant projects and plans considered cumulatively alongside Hornsea Three have been allocated into 'Tiers', reflecting their current stage within the planning and development process. This allows the CEA to present several future development scenarios, each with a differing potential for being ultimately built out. Appropriate weight may therefore be given to each Tier in the decision making process when considering the potential cumulative impact associated with Hornsea Three (e.g. it may be considered that greater weight can be placed on the Tier 1 assessment relative to Tier 2). An explanation of each tier is included below:

- Tier 1: Hornsea Three considered alongside:
  - Those with consent, and, where applicable (i.e. for low carbon electricity generation projects), that have been awarded a Contract for Difference but have not been implemented; and/or
  - Those currently operational that were not operational when baseline data was collected, and/or those that are operational but have an on-going impact.
- Tier 2: All projects/plans considered in Tier 1, as well as:
  - Those project/plans that have consent but, where relevant (i.e. for low carbon electricity generation projects) have no Contract for Difference; and/or
  - Submitted but not yet determined.
- Tier 3: All projects/plans considered in Tier 2, as well as those on relevant plans and programmes likely to come forward but have not yet submitted an application for consent (the PINS programme of projects and the adopted development plan including supplementary planning documents are the most relevant sources of information from the relevant planning authorities regarding planned major works being consulted upon, but not yet the subject of a consent application). Specifically,

this Tier includes all projects where the developer has advised PINS in writing that they intend to submit an application in the future, those projects where a Scoping Report is available and/or those projects which have published a PEIR.

2.12.1.3 It is noted that offshore wind farms seek consent for a maximum design scenario and the as built offshore wind farm will be selected from the range of consented scenarios. In addition, the maximum design scenario quoted in the application (and the associated Environmental Statement) are often refined during the determination period of the application. For example, it is noted that the Applicant for Hornsea Project One considered a maximum of 332 turbines within the Environmental Statement, but has gained consent for 240 turbines. Similarly, Hornsea Project Two has gained consent for an overall maximum number of turbines of 300, as opposed to 360 considered in the Environmental Statement and the as built number of turbines is likely to be less than this. A similar pattern of reduction in the project envelope from that assessed in the Environmental Statement, to the consented envelope and the 'as built' project is also seen across other offshore wind farms of relevance to this CEA. This process of refinement can result in a reduction to associated project parameters, for example, the number of cable trenches or the height of onshore substations. The CEA presented in this hydrology and flood risk chapter has been undertaken on the basis of information presented in the Environmental Statements for the other projects, plans and activities. Given that this broadly represents a maximum design scenario, the level of impact on hydrology and flood risk would likely be reduced from those presented here.

2.12.1.4 The specific projects scoped into this CEA and the tiers into which they have been allocated, are outlined in Table 2.18 ordered on the distance of each specific project from the onshore elements of Hornsea Three (as defined in 2.1.1.1). The projects included as operational in this assessment have been commissioned since the baseline studies for Hornsea Three were undertaken and as such were excluded from the baseline assessment.

2.12.1.5 No Tier 1 projects have been identified and therefore, only tier 2 and tier 3 assessments have been undertaken.

2.12.1.6 The 250 m and 1 km hydrology and flood risk study areas identified in Figure 2.1 have been used in the CEA.

Table 2.18: List of other projects and plans considered within the CEA

Tier	Hornsea Three Phase	Project/Plan	Closest distance from Hornsea Three	Details	Date of Construction (if applicable)	Overlap of construction phase with Hornsea Three construction phase	Overlap of operation phase with Hornsea Three operation phase	Drainage Strategy
2	Construction/Operation and Maintenance/Decommissioning.	C/7/2014/7030	0 m	(I) For a southern extension to Mangreen Quarry and ancillary works with progressive restoration to agriculture and nature conservation by the importation of inert restoration materials; (II) Retention of existing consented facilities at Mangreen Quarry; (III) Establishment of crossing point over Mangreen Lane; and (IV) Proposed variation to approved restoration scheme at Mangreen Quarry.	Approved 2 October 2015 2017 to 2024.	Yes	Yes	A hydrological and hydrogeological impact assessment (November 2014) including surface water management has been undertaken for the site.
	Construction/Operation and Maintenance/Decommissioning.	2011/1804/O	0 m	Residential led mixed use development of 1196 dwellings and associated uses including Primary School, Local Services (up to 1,850 m^2 (GIA) of A1, A2, A3, A4, A5, D1 & B1 uses) comprising shops, small business units, community facilities/ doctors' surgeries, sports pitches, recreational space, equipped areas of play and informal recreational spaces. Extension to Thickthorn Park and Ride including new dedicated slip road from A11. Reserved matters (2017/0151)- proposed residential development (phase A1-B) comprising 91 dwellings including 20% affordable housing and associated open space and infrastructure.	Approved 17 May 2017	Yes	Yes	Adoptable Drainage Layouts (Ref E3507/516/D) and a Drainage Area Plan (Ref 20835/195) was submitted for the development.
	Construction/Operation and Maintenance/Decommissioning.	2013/0092	7 m	Outline application for up to 20 residential units and associated highways works with all matters reserved	Approved 20 March 2014 2020 to 2021.	Yes	Yes	A FRA and Surface Water Drainage Strategy (Ref 121232 SK-01) have been undertaken for the site including soakaways.
	Construction/Operation and Maintenance/Decommissioning.	2014/2611	21 m	The erection of 890 dwellings; the creation of a village heart to feature an extended primary school, a new village hall, a retail store and areas of public open space; the relocation and increased capacity of the allotments; and associated infrastructure including public open space and highway works.	Approved 1 November 2016 2018 to 2028.	Yes	Yes	The Environmental Statement Chapter 7: Appendix 7.2 of the ES relates to the FRA and Surface Water Drainage Strategy (Ref 60328033-INF-001) for the site. Appendix 7.2 Section 2 & 5 outlines a concept drainage strategy for the development.
	Construction/Operation and Maintenance/Decommissioning.	20170789	55 m	Erection of a Grain Store (Revised Proposal).	Approved 19 July 2017 2020	Yes	Yes	No

Tier	Hornsea Three Phase	Project/Plan	Closest distance from Hornsea Three	Details	Date of Construction (if applicable)	Overlap of construction phase with Hornsea Three construction phase	Overlap of operation phase with Hornsea Three operation phase	Drainage Strategy
3	Construction/Operation and Maintenance/Decommissioning.	EN010079 Norfolk Vanguard	0 m	Norfolk Vanguard is a proposed offshore windfarm with an approximate capacity of 1800MW off the coast of Norfolk.	Pre-application stage PEIR October 2017 2020 to 2024	Yes	Yes	Volume 4, annex 5.5: Scoping Report and PINS Scoping Opinion outlines pre-construction and operational drainage will be installed.

2.12.2 Maximum design scenario

2.12.2.1 A review of cumulative projects has been carried out and is presented in Table 2.19. This review identified that there is a number of different development types that may cause cumulative effects to hydrology and flood risk receptors. Each cumulative project has only been assessed for effects which are relevant to the development type, therefore developments which are not relevant to the specific impact have been scoped out of the assessment. For example, developments located beyond land assessed at flood risk (Flood Zone 2 and/or 3), and those which do not include HDD or open cut excavation techniques have been scoped out from further assessment (i.e. residential, commercial and industrial units and holiday caravan sites).

2.12.2.2 One cumulative project has been determined to require further assessment; the onshore elements of offshore windfarm development Norfolk Vanguard (EN010079). A description of the significance of cumulative effects upon hydrology and flood risk arising from each is presented below.

2.12.2.3 The maximum design scenarios identified in Table 2.19 have been selected as those having the potential to result in the greatest effect on an identified receptor or receptor group. The cumulative impact presented and assessed in this section have been selected from the details provided in the Hornsea Three project description (volume 1, chapter 3: Project Description), as well as the information available on other projects and plans, in order to inform a 'maximum design scenario'. Effects of greater adverse significance are not predicted to arise should any other development scenario, based on details within the project Design Envelope, to that assessed here be taken forward in the final design scheme.

Table 2.19: Maximum design scenario considered for the assessment of potential cumulative impacts on hydrology and flood risk.

Potential impact	Cumulative projects considered as part of the maximum design scenario	Justification
Construction phase		
The impacts of construction may affect flood risk.	Tier 3 – EN010079	The construction phases of these schemes potentially overlap with the construction phase of Hornsea Three. When considering this scheme in combination with Hornsea Three, there may be a cumulative effect in relation to surface water runoff on hydrology and flood risk receptors.
The impacts of HDD techniques may affect main surface watercourses.	Tier 3 - EN010079	The construction phases of these schemes potentially overlap with the construction phase of Hornsea Three. When considering this scheme in combination with Hornsea Three, there may be a cumulative effect on the potential deterioration of local surface watercourses through turbid runoff.
The impacts of open cut, temporary bridging and culverts may affect surface watercourses.	Tier 3 - EN010079	The construction phases of these schemes potentially overlap with the construction phase of Hornsea Three. When considering these schemes in combination with Hornsea Three, there may be a cumulative effect on the potential deterioration of local surface watercourses through turbid runoff.
The impacts of construction may affect drainage pipeline infrastructure.	Tier 3 – EN010079	The construction phases of these schemes potentially overlap with the construction phase of Hornsea Three. When considering these schemes in combination with Hornsea Three, there may be a cumulative effect on hydrology and flood risk receptors.
The impacts of construction may affect field drainage and irrigation.	Tier 3 – EN010079	The construction phases of these schemes potentially overlap with the construction phase of Hornsea Three. When considering this scheme in combination with Hornsea Three, there may be a cumulative effect on hydrology and flood risk receptors.
Operation and maintenance phase		
The impacts of routine maintenance operations may affect main and ordinary surface watercourses.	Tier 3 – EN010079	The operation and maintenance phase of these schemes overlap with the operation and maintenance phase of Hornsea Three. When considering this scheme in combination with Hornsea Three, there may be a cumulative effect in relation to an increase in pollution incidents on main watercourses.
Decommissioning phase		
The impacts of decommissioning may affect temporary flood risk.	Tier 3 – EN010079	The decommissioning phase of this scheme may overlap with the decommissioning phase of Hornsea Three. When considering the scheme in combination with Hornsea Three, there may be a cumulative effect in relation to an increase in local surface runoff and flooding on hydrology and flood risk receptors.
The impacts of decommissioning may affect main and ordinary surface watercourses.	Tier 3 – EN010079	The decommissioning phase of this scheme may overlap with the decommissioning phase of Hornsea Three. When considering the scheme in combination with Hornsea Three, there may be a cumulative effect in relation to an increase in turbid runoff affecting the WFD status of local main surface watercourses.

2.13 Cumulative Effect Assessment

2.13.1.1 A description of the significance of cumulative effects upon hydrology and flood risk arising from each identified impact is given below.

2.13.2 Construction Phase

Impacts of construction may lead to increased flood risk.

Tier 3

Magnitude of impact

2.13.2.1 A review of the schemes against the EA Flood Zone Maps indicate that one of the schemes (Norfolk Vanguard) is partially situated within an area defined as Flood Zone 3, and therefore at higher risk of flooding. However, as part of their planning applications, all cumulative schemes within the 250 m hydrology and flood risk CEA study area would require a surface water drainage scheme/assessment to be conducted for the development in line with the NPPF and PPG (ID7). Therefore, in line with national and local planning policy the developments will not increase flood risk to the site or the surrounding areas. Consequently, it is unlikely that these schemes would cause cumulative flood risk impacts on the construction of the onshore elements of Hornsea Three and/or the surrounding area.

2.13.2.2 The impact is predicted to be of local spatial extent and of short term duration during the construction period. It is also considered that the impact will be intermittent during the construction period and will be of high reversibility. Over 90% of the Hornsea Three project is located within Flood Zone 1 and all developments require a drainage strategy to be presented. It is predicted that the impact will affect surrounding local receptors directly. The magnitude is therefore, considered to be minor.

Sensitivity of receptor

2.13.2.3 The land within the Hornsea Three hydrology and flood risk CEA study area where Norfolk Vanguard crosses the Hornsea Three onshore cable corridor at Salle is primarily farmland and therefore is of low vulnerability, high recoverability and low value. The sensitivity of the receptor is therefore, considered to be low.

Significance of Effect

2.13.2.4 Overall, the sensitivity of the surrounding areas is considered to be low and the magnitude of the impact is deemed to be minor. The significance of the effect on flood risk based on the scenario which includes measures adopted in Table 2.17 and those incorporated within the cumulative assessed projects under the NPPF and PPG is deemed to be negligible significance, which is not significant in EIA terms.

2.13.2.5 Overall, it is predicted that the sensitivity of the receptor is considered to be no change and the magnitude is deemed to be low. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

The impacts of HDD may affect main surface watercourses.

Tier 3

2.13.2.6 As a scheme to construct the onshore elements of an offshore windfarm, Norfolk Vanguard may use HDD techniques to cross major surface watercourses as identified in Scoping Report PB4476-102-001, October 2016. The scheme is in close proximity to crossing points within the Hornsea Three hydrology and flood risk study area and therefore has the potential to cause cumulative effects.

Magnitude of impact

2.13.2.7 The impact to main watercourses takes into account the WFD classification of surrounding watercourses and the mitigation measures presented within Table 2.17 and measures adopted within the Norfolk Vanguard offshore windfarm project. As a minimum requirement, Norfolk Vanguard will require a surface water management strategy and drainage scheme (see volume 6, annex 2.1: Onshore Infrastructure Flood Risk Assessments) to limit any dirty surface water runoff from the onshore scheme to surrounding watercourses. Therefore, the magnitude of impacts on major surface watercourses are predicted to be of local spatial extent, short term duration, intermittent occurrence and high reversibility. It is predicted that the impact will affect the receptor indirectly. The magnitude is therefore, considered to be negligible.

Sensitivity of receptor

2.13.2.8 The sensitivity of watercourses is dependent on the nature of the specific watercourse. WFD classification obtained from the EA website and mapping for water quality (Table 2.7) shows that the main rivers 'crossed' are considered to be of medium sensitivity based on water quality data supplied by the EA. The watercourses crossed via HDD techniques are considered to be highly vulnerable, but of moderate to high recoverability and moderate value. The sensitivity of the receptor is therefore, considered to be high.

Significance of Effect

2.13.2.9 Overall, the sensitivity of major watercourses/rivers is considered to be high and the magnitude of the impact is deemed to be negligible. The effect which includes the integration of measures adopted in Table 2.17 will, therefore be of **minor adverse** significance, which is not significant in EIA terms.

The impacts of open cut, temporary bridging and culverts may affect surface watercourses.

Tier 3

2.13.2.10 Norfolk Vanguard may also use open cut techniques to cross surface watercourses. The scheme is in close proximity to crossing points within the Hornsea Three hydrology and flood risk study area and therefore has the potential to cause cumulative effects.

Magnitude of impact

2.13.2.11 The impact is predicted to be of local spatial extent, short to medium term duration, intermittent occurrence and high reversibility. The magnitude is therefore, considered to be minor.

2.13.2.12 The impact to surface watercourses from open cut techniques takes into account the WFD classification of surrounding main watercourses and the mitigation measures presented Table 2.17 and measures adopted within the Norfolk Vanguard and Dudgeon offshore windfarm projects. A cumulative impact caused by open cut techniques would only occur where excavations of a specific watercourse coincide. All projects as a minimum requirement will require a surface water management strategy and drainage scheme to limit any dirty surface water runoff from the onshore scheme to surrounding watercourses. Hornsea Three crossing schedule will be designed so no overlap (in terms of construction duration at specific watercourses) with other onshore cable corridor developments will occur. Therefore, the magnitude of impacts on major surface watercourses are predicted to be of local spatial extent, short to medium term duration, intermittent occurrence and high reversibility. It is predicted that the impact will affect the receptor indirectly. The magnitude is therefore, considered to be minor.

Sensitivity of receptor

2.13.2.13 Ordinary watercourses are generally considered to be of low to medium sensitivity based on EA WFD classifications. The ordinary watercourses are considered to be of high vulnerability, moderate recoverability and moderate value. The sensitivity of the receptor is therefore, considered to be high.

Significance of effect

2.13.2.14 Overall, the sensitivities of surface watercourses are considered to be high and the magnitude of the impact is deemed to be minor. The effect including the integration measures adopted in Table 2.17, will therefore be of **minor adverse** significance, which is not significant in EIA terms.

The impacts of construction may affect drainage pipeline infrastructure.

Tier 3

Magnitude of impact

2.13.2.15 Cumulative impacts on drainage pipeline infrastructure would only occur where water and sewer pipelines were located in proximity to the onshore cable corridor of Hornsea Three and Norfolk Vanguard. Site selection seeks to avoid major pipelines, however impacts with local infrastructure may occur.

2.13.2.16 The impact is predicted to be of local spatial extent, of short term duration, of intermittent occurrence and high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be minor.

Sensitivity of receptor

2.13.2.17 Drainage pipeline infrastructure comprises water supply pipelines operated by Anglian Water, which are considered to be of moderate vulnerability and high value, impacting the local and regional economy. The sensitivity of the receptor is therefore considered to be high.

Significance of Effect

2.13.2.18 Overall, the sensitivity of the receptor is considered to be high and the magnitude is deemed to be minor. The effect will, therefore, be of **minor adverse** significance, which is not significant in EIA terms.

The impacts of construction may affect field drainage and irrigation.

Tier 3

Magnitude of impact

2.13.2.19 Cumulative impacts on field drainage and irrigation would only occur where development limits coincide. Projects as a minimum, require as surface water management strategy and drainage scheme to limit any increase in surface water runoff from the site, and to mimic (as close as practicable) the current hydrological regime. It is assumed that Norfolk Vanguard and the Hornsea Three onshore cable corridor will be constructed using industry best practice and therefore should limit any effect on field drainage and irrigation.

2.13.2.20 The impact is predicted to be of local spatial extent, short term duration, of intermittent occurrence and reversible. It is predicted that any impact will affect the receptor directly. The magnitude is therefore, considered to be minor.

Sensitivity of receptor

2.13.2.21 Field drainage and irrigation which form part of the hydrological environment are deemed to be of moderate vulnerability, moderate to high recoverability and medium value. The sensitivity of the receptor is therefore, considered to be medium.

Significance of effects

2.13.2.22 Overall, the sensitivity of field drainage and irrigation is considered to be medium and the magnitude of impact is deemed to be minor. The effect will therefore, be of **minor adverse** significance, which is not significant in EIA terms.

Future monitoring

2.13.2.23 No hydrology and flood risk monitoring to test the predictions made within the construction phase cumulative impact assessment is considered necessary.

2.13.3 Operation and maintenance phase

The impacts of routine maintenance operations may affect main and ordinary surface watercourses.

Tier 3

Magnitude of impact

2.13.3.1 During the operation and maintenance phase the main impacts would be the accidental spillage of oils and/or chemicals. A cumulative impact would therefore only occur where a spillage event transpired along the Hornsea Three onshore elements and at a cumulative site at the same time. Mitigation measures outlined in Table 2.17 will be in place during the operation and maintenance phase of the Hornsea Three onshore elements to limit any potential adverse impacts for spillage events. It is assumed that the cumulative sites identified within the 250 m hydrology and flood risk CEA study area will be designed to local and national planning policy and industry best practice and therefore are likely to incorporate mitigation measures. The impact is predicted to be of local spatial extent, short term duration, intermittent occurrence and reversible. The magnitude is therefore, considered to be negligible.

Sensitivity of receptor

2.13.3.2 The main and ordinary watercourses in the Hornsea Three hydrology and flood risk study area are assessed to be of high vulnerability, moderate to high recoverability and moderate value based on the EA's WFD classification. The sensitivity of the receptor is therefore, considered to be high.

Significance of the effect

2.13.3.3 Overall, the sensitivity of the receptor is considered to be high and the magnitude of impact is deemed to be negligible. The effect will, therefore, be of **minor adverse** significance which is not significant in EIA terms.

Future monitoring

2.13.3.4 No hydrology and flood risk monitoring to test the predictions made within the operation and maintenance phase cumulative impact assessment is considered necessary.

2.13.4 Decommissioning phase

2.13.4.1 As it has been assumed that the onshore HVAC booster station and onshore HVDC converter/HVAC substation would be removed and that the onshore export cables would remain in-situ, no additional effects above those detailed under the construction and operation and maintenance phase are predicted. It is therefore determined that the cumulative effects from decommissioning of Hornsea Three would be similar and no worse than the construction and operation and maintenance phase effects of **minor adverse** significance to **negligible**, which is not significant in EIA terms.

Future monitoring

2.13.4.2 No hydrology and flood risk monitoring to test the predictions made within the decommissioning phase cumulative impact assessment is considered necessary.

2.14 Transboundary effects

2.14.1.1 A screening of transboundary impacts has been carried out and is presented in volume 4, annex 5.4: Transboundary Impacts Screening Note. This screening exercise identified that there was no potential for significant transboundary effects with regard to hydrology and flood risk conditions from Hornsea Three upon the interests of other European Economic Area States.

2.15 Inter-related effects

2.15.1.1 Inter-relationships are considered to be the impacts and associated effects of different aspects of the proposal on the same receptor. These are considered to be:

- Project lifetime effects: Assessment of the scope for effects that occur throughout more than one phase of the project (construction, operation and maintenance, and decommissioning) to interact to create a potentially greater effect on a receptor than if just assessed in isolation in these three key project stages (e.g., construction phase noise, operational noise and noise during decommissioning and dismantling at the onshore HVAC booster station and HVDC converter/HVAC substation site); 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 receptor group. As an example, all effects on a given receptor such as local residents – construction dust and noise, increased traffic and visual change etc. may interact to produce a greater effect on this receptor than when the effects are considered in isolation. Receptor-led effects might be short term, temporary or transient effects, or incorporate longer term effects.

2.15.1.2 A description of the likely inter-related effects arising from Hornsea Three on hydrology and flood risk conditions is provided in volume 3, chapter 11: Inter-Related Effects (Onshore).

2.16 Conclusion and summary

2.16.1.1 Over 90% of the Hornsea Three hydrology and flood risk study area is shown on EA flood maps as being located within Flood Zone 1 (i.e. low probability of flooding) and is not directly at risk of flooding. However, there are localised areas of Flood Zone 2 and 3 (see volume 6, annex 2.2: EA and IDB Watercourses and Flood Zones) where the corridor crosses main and ordinary watercourses.

2.16.1.2 The Hornsea Three hydrology and flood risk study area includes a number of catchments associated with EA designated main rivers and ordinary watercourses (see volume 6, annex 2.2: EA and IDB Watercourses and Flood Zones). Some of these rivers are associated with designated ecological habitats or are designated for their own ecological importance (see volume 3, chapter 3: Ecology and Nature Conservation). The effect is considered to be of **minor adverse** significance near the Hornsea Three landfall area and **negligible** for the remainder of the Hornsea Three hydrology and flood risk

2.16.1.3 Although construction has the potential to cause a degradation of water quality to main and ordinary watercourses through increase in soil erosion and accidental release of sediment, appropriate mitigation measures have been identified within this chapter and within the Outline CoCP (document reference A8.5) which accompanies the DCO application to minimise potential impacts. Furthermore, HDD methods or similar trenchless technologies will be used to cross main rivers (see volume 1, chapter 3: Project Description). The effect is considered to be of **minor adverse** significance.

2.16.1.4 The operation of the development has the potential to increase the surface water runoff rate from the onshore HVAC booster station and HVDC converter/HVAC substation sites, in turn increasing the flood risk to the site and the surrounding areas. Appropriate operational management measures will be incorporated into the construction process in order to mitigate against any increase in runoff, including an outline drainage strategy. The effects during the operation and maintenance phase are therefore considered to be of **negligible** significance.

2.16.1.5 The operation of the HVAC booster station and HVDC converter/HVAC substation would involve routine maintenance of key elements. Maintenance may involve the use of chemicals, oils and greases and therefore, there is the potential for spillages to occur which may affect the water quality of ordinary watercourses. Operational practices will involve management plans including spill procedures, clean up and remediation of contaminated water runoff and water quality monitoring (if required) in order to mitigate against any decrease in water quality status. The effects of operation maintenance are therefore considered to be **minor adverse** significance.

2.16.1.6 A FRA has been prepared for the onshore HVAC booster station, the onshore HVDC converter/HVAC substation and locations of the Hornsea Three onshore cable corridor which fall within Flood Zones 2 and 3. The onshore HVAC booster station FRA indicates the site is located at low risk of fluvial flooding, very low risk of surface water flooding and at no risk of flooding from reservoir failure. The main risk of flooding to the onshore HVAC booster station has been determined to be from groundwater flood risk which is considered to be low to medium. The onshore HVDC converter/HVAC substation FRA indicates the site is at low risk of fluvial flooding, very low risk of surface water flooding and at no risk of flooding from reservoir failure. As with the onshore HVAC booster station area, the main flood risk is from groundwater flooding which is considered to be at low to medium risk. The onshore HVAC booster station and onshore HVDC converter/HVAC substation have both been defined as 'Essential infrastructure' and suitable for the present Flood Zones including climate change. Therefore, there is no requirement for either a Sequential or Exception Test.

2.16.1.7 The onshore infrastructure FRA indicates the majority of the Hornsea Three onshore cable corridor is located within Flood Zone 1 at 'low' risk of flooding. The main risk to the site is from groundwater flooding, assessed to be at low to medium risk. However, given that some areas of the Hornsea Three onshore cable corridor are within areas defined as Flood Zone 3, an Exception Test is required. As the development is needed to connect the landfall and onshore HVDC converter/HVAC substation, it is therefore unable to be routed without crossing areas within Flood Zone 3, and as such the Sequential Test and Exception Test are determined to be passed.

2.16.1.8 The FRA demonstrates that appropriate mitigation measures will reduce the adverse impacts caused by the onshore elements of Hornsea Three and an appropriate drainage strategy will be incorporated into the onshore HVAC booster station and onshore HVDC converter/HVAC substation design to attenuate any increase in surface water runoff, in turn increase in flood risk. The FRA's therefore demonstrate that the onshore elements of Hornsea Three meet the requirements of NPS EN-1 and the NPPF.

2.16.1.9 The decommissioning of the onshore HVAC booster station and onshore HVDC converter/HVAC substation will involve the demolition of buildings as well as removal of foundations and the attenuation storage provided during construction and operation. The impacts of decommissioning of the Hornsea Three components will be reduced through the incorporation of management measures (outlined in Table 2.17). The effect is considered to be of **minor adverse** significance.

2.16.1.10 Cumulative impacts from projects screened into the assessment have been assessed using a tiered approach. It is assumed that each development would be constructed in line with the requirements of the NPPF and PPG ID7 – Flood Risk and Coastal Change, (and where relevant the NPSs) requiring that new developments attenuate surface water runoff to where practicable to the greenfield runoff rate through a surface water management plan and/or drainage scheme. The impacts are predicted to result in effects of **negligible** or **minor adverse** significance.

2.16.1.11 Screening of potential transboundary impacts (as presented in volume 4, annex 5.4: Transboundary Impacts Screening Note) has identified that there was no potential for significant transboundary effects with regard to hydrology and flood risk.

2.16.1.12 A summary of the findings of the hydrology and flood risk EIA are presented in Table 2.20.

Table 2.20: Summary of potential environmental effects, mitigation and monitoring.

Description of impact	Measures adopted as part of Hornsea Three	Magnitude of impact	Sensitivity of receptor	Significance of effect	Additional measures	Residual effect	Proposed monitoring
Construction Phase							
The impacts of construction may lead to increased flood risk.	Construction measures, surface water drainage scheme, best practice measures (see Table 2.17)	Negligible – remainder of onshore elements Minor – Hornsea Three landfall area	Low – Hornsea Three landfall area and remainder of onshore elements	**Negligible** (not significant in EIA terms) - remainder of onshore elements **Minor Adverse** (not significant in EIA terms) - Hornsea Three landfall area	None.	N/A	None
The impacts of HDD may affect main surface watercourses.	Surface water drainage scheme, pollution prevention measures, best practice measures (see Table 2.17).	Negligible	High	**Minor Adverse** (not significant in EIA terms)	None	N/A	None
The impacts of open cut, temporary bridging and culverts may affect surface watercourses.	Surface water drainage scheme, pollution prevention measures, best practice measures (see	Negligible	High	**Minor Adverse** (not significant in EIA terms)	None	N/A	None
The impacts of construction may affect drainage infrastructure.	Surface water drainage scheme, pollution prevention measures, best practice measures (see Table 2.17)	Minor	High	**Minor Adverse** (not significant in EIA terms)	None	N/A	None
The impacts of construction may affect field drainage and irrigation.	Surface water drainage scheme, pollution prevention measures, best practice measures (see Table 2.17).	Minor	Medium	**Minor Adverse** (not significant in EIA terms)	None	N/A	None
Operation and Maintenance Phase							
The impacts of operation and maintenance may lead to increased flood risk.	Operational measures (see Table 2.17).	No change	Low	**Negligible** (not significant in EIA terms)	None	N/A	None
The impacts of route maintenance operations may affect ordinary watercourses.	Operational measures (see Table 2.17).	Negligible	High	**Minor Adverse** (not significant in EIA terms)	None	N/A	None
Decommissioning Phase							
The impacts of decommissioning may lead to increased flood risk.	Decommissioning measures (see Table 2.17).	Minor	Low	**Minor Adverse** (not significant in EIA terms)	None	N/A	None
The impacts of decommissioning may affect main and ordinary watercourses.	Decommissioning measures (see Table 2.17).	Negligible	High	**Minor Adverse** (not significant in EIA terms)	None	N/A	None

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