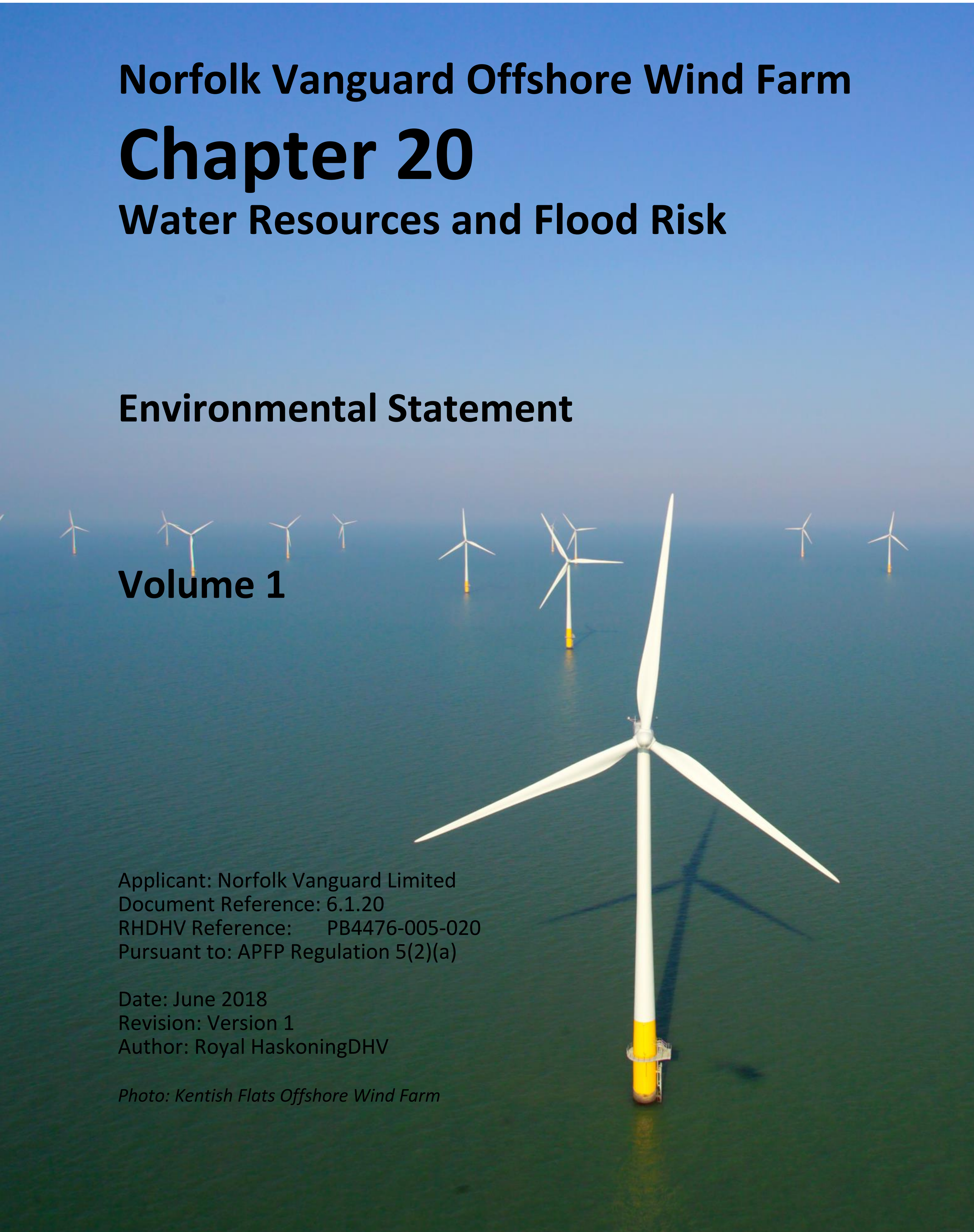
Norfolk Vanguard Offshore Wind Farm

Chapter 20

Water Resources and Flood Risk

Environmental Statement

Volume 1



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Environmental Impact Assessment
Environmental Statement

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For and on behalf of Norfolk Vanguard Limited

Approved by: Ruari Lean, Rebecca Sherwood

Signed: [redacted]

Date: 8th June 2018

For and on behalf of Royal HaskoningDHV

Drafted by: Jack Douglas, Natalie James, Ian Dennis

Approved by: Jon Allen

Signed: [redacted]

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Glossary

A/HMWB	Artificial or Heavily Modified Water Body
AIS	Air Insulation Switchgear
CoCP	Code of Construction Practice
CIA	Cumulative Impact Assessment
CIRIA	Construction Industry Research and Information Association
CMS	Construction Method Statement
DCLG	Department for Communities and Local Government
DCO	Development Consent Order
Defra	Department for Environment, Food & Rural Affairs
DMRB	Design Manual for Roads and Bridges
EA	Environment Agency
EC	European Commission
EIA	Environmental Impact Assessment
ES	Environmental Statement
ETG	Expert Topic Group
EU	European Union
FRA	Flood Risk Assessment
FWMA	Flood and Water Management Act
GEP	Good Ecological Potential
GES	Good Ecological Status
HDD	Horizontal Directional Drilling
HDPE	High Density Polyethylene
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IDB	Internal Drainage Board
LNR	Local Nature Reserve
NPPF	National Planning Policy Framework
NPPG	National Planning Practice Guidance
NPS	National Policy Statement
NV	Norfolk Vanguard
O&M	Operations and Maintenance
PDS	Project Design Statement
PEIR	Preliminary Environmental Information Report
PPG	Planning Practice Guidance
RBD	River Basin District
RBMP	River Basin Management Plan
RIGS	Regionally Important Geological Site
SAC	Special Area of Conservation
SNCI	Site of Nature Conservation Interest
SPA	Special Protection Area
SPZ	Source Protection Zone
SSSI	Site of Special Scientific Interest
SuDS	Sustainable Drainage System
WCS	Worst Case Scenario
WFD	Water Framework Directive

WMA	Water Management Alliance (comprising a group of 5 Internal Drainage Boards (IDBs) operating in the Anglian Region. WMA members include Broads IDB, East Suffolk IDB, King's Lynn IDB, Norfolk Rivers IDB and South Holland IDB)

Terminology

Cable Relay Station	Primarily comprised of an outdoor compound containing reactors (also called inductors, or coils) and switchgear to increase the power transfer capability of the cables under the HVAC technology scenario as considered in the PEIR. This is no longer required for the project as the HVDC technology has been selected.
Jointing pit	Underground structures constructed at regular intervals along the cable route to join sections of cable and facilitate installation of the cables into the buried ducts.
Landfall	Where the offshore cables come ashore at Happisburgh South.
Link boxes	Underground chambers or above ground cabinets next to the cable trench housing low voltage electrical earthing links.
Mobilisation area	Areas approx. 100 x 100m used as access points to the running track for duct installation. Required to store equipment and provide welfare facilities. Located adjacent to the onshore cable route, accessible from local highways network suitable for the delivery of heavy and oversized materials and equipment.
Mobilisation zone	Area within which the mobilisation area will be located.
National Grid overhead line modifications	The works to be undertaken to complete the necessary modification to the existing 400kV overhead lines
National Grid substation extension	The permanent footprint of the National Grid substation extension.
National Grid temporary works area	Land adjacent to the Necton National Grid substation which would be temporarily required during construction of the National Grid substation extension.
Necton National Grid substation	The existing 400kV substation at Necton, which will be the grid connection location for Norfolk Vanguard.
Onshore 400kV cable route	Buried high-voltage cables linking the onshore project substation to the Necton National Grid substation
Onshore cable route	The 45m easement which will contain the buried export cables as well as the temporary running track, topsoil storage and excavated material during construction.
Onshore cables	The cables which take the electricity from landfall to the onshore project substation.
Onshore project area	All onshore electrical infrastructure (landfall; onshore cable route, accesses, trenchless crossing technique (e.g. Horizontal Directional Drilling (HDD)) zones and mobilisation areas; onshore project substation and extension to the Necton National Grid substation and overhead line modification).
Onshore project substation	A compound containing electrical equipment to enable connection to the National Grid. The substation will convert the exported power from HVDC to HVAC, to 400kV (grid voltage). This also contains equipment to help maintain stable grid voltage.

Running track	The track along the onshore cable route which the construction traffic would use to access workfronts.
The Applicant	Norfolk Vanguard Limited
The project	Norfolk Vanguard Offshore Wind Farm, including the onshore and offshore infrastructure.
Transition pit	Underground structures that house the joints between the offshore export cables and the onshore cables.
Trenchless crossing zone (e.g. HDD)	Temporary areas required for trenchless crossing works.
Workfront	The 150m length of onshore cable route within which duct installation would occur.

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20 WATER RESOURCES AND FLOOD RISK

20.1 Introduction

1. This chapter of the Environmental Statement (ES) considers the potential impacts of the Norfolk Vanguard Offshore Wind Farm (hereafter 'the project') on water resources and flood risk. The chapter provides an overview of the existing baseline where the onshore project area is proposed, followed by an assessment of the potential impacts and associated mitigation for the construction, operation and decommissioning of the project.

2. The assessment also considers cumulative impacts of other proposed projects. The proposed methodology adhered to for the Environmental Impact Assessment (EIA) and Cumulative Impact Assessment (CIA) is discussed in section 20.4.

3. Figures which accompany the text in this chapter are provided in Volume 2 Figures.

4. Because of the close association between water resources and flood risk, onshore ecology and ground conditions and contamination topics, this chapter should also be read in conjunction with the other related ES chapters (and their appendices and supporting documents). The relevant chapters are:

- Chapter 19 Ground Conditions and Contamination; and
- Chapter 22 Onshore Ecology.

20.2 Legislation, Guidance and Policy

5. There are a number of pieces of legislation, policy and guidance applicable to water resources and flood risk. The following sections provide detail on key pieces of international and UK legislation, policy and guidance which are relevant to this chapter.

6. Legislation and policy has been considered on an international, national, regional and local level. The following legislation and policy is considered to be relevant to water resources and the Flood Risk Assessment (FRA) as it has influenced the sensitivity of receptors and requirements for mitigation or the scope and/or methodology of the ES.

7. Further detail on legislation and policy in relation to the wider project is provided in Chapter 3 Policy and Legislative Context.

20.2.1 International

20.2.1.1 Water Framework Directive (2000/60/EC)

8. The Water Framework Directive (WFD) (Council Directive 2000/60/EC establishing a framework for community action in the field of water policy) was adopted by the European Commission (EC) in December 2000.

9. The WFD requires that all European Union (EU) Member States must prevent deterioration and protect and enhance the status of aquatic ecosystems. This means that Member States must ensure that new schemes do not adversely impact upon the status of aquatic ecosystems, and that historical modifications that are already impacting it need to be addressed.

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

11. There are two separate classifications for surface water bodies (rivers, lakes, estuaries and coastal waters); ecological and chemical. The ecological status of a surface water body is assessed according to the condition of the:

- Biological quality elements, including fish, benthic invertebrates and aquatic flora;
- Hydromorphological quality elements, including morphological conditions, hydrological regime and tidal regime; and
- Physico-chemical quality elements, including thermal conditions, salinity, pH, nutrient concentrations and concentrations of specific pollutants such as copper.

12. The ecological status of surface waters is recorded on a scale of ‘high’, ‘good’, ‘moderate’, ‘poor’ and ‘bad’. The ecological status of a water body is determined by the worst scoring quality element, which means that the condition of a single quality element can cause a water body to fail to reach its WFD classification objectives. The overall environmental objective of reaching Good Ecological Status (GES) applies to these water bodies.

13. The chemical status of surface waters is assessed by compliance with environmental standards that are listed in the EC Environmental Quality Standards Directive (4) (2008/105/EC). These chemicals include priority substances and priority hazardous substances. Chemical status is recorded as either ‘good’ or ‘fail’, and is determined by the lowest scoring chemical.

14. Where the hydromorphology of a surface water body has been significantly altered as a result of anthropogenic activities, it can be designated as an Artificial or Heavily Modified Water Body (A/HMWB). An alternative environmental objective, Good Ecological Potential (GEP), applies in these cases.

15. Groundwaters are assessed in a different way to surface waters, and are classified as either ‘good’ or ‘poor’ in terms of quantity (groundwater levels, flow directions) and chemical quality (pollutant concentrations and conductivity).

20.2.2 National

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

16. The WFD was transposed into national law in the UK by means of the Water Environment (Water Framework Directive) (England and Wales) Regulations 2003. These regulations were updated by the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017. The Regulations provide for the implementation of the WFD, from designation of all surface waters (rivers, lakes, estuarine waters, coastal waters and ground waters) as water bodies, and set objectives for the achievement of GES or GEP.

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

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

20.2.2.3 National Planning Policy Framework (2012) and supporting guidance

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

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

- Flood Zone 3 represents land with a “high” flood risk classification. Flood Zone 3a comprises land 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 3b comprises land where water has to flow or be stored in times of flood;

- Flood Zone 2 represents land with a "medium" flood risk classification and refers to land 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 1000 annual probability of sea flooding (0.5%-0.1%) in any year; and
- Flood Zone 1 represents land with a "low" flood risk classification and refers to land having a less than 1 in 1,000 annual probability of river or sea flooding in any year (<0.1%).

20. The NPPF directs development away from areas at highest risk of flooding via the application of the Sequential Test. If, following application of the Sequential Test, it is not possible for the project to be located in zones with a lower probability of flooding; the Exception Test can be applied if appropriate.

20.2.2.4 National Policy Statements

21. The assessment of potential impacts upon water resources and flood risk has been made with specific reference to the relevant National Policy Statements (NPS). These are the principal decision making documents for Nationally Significant Infrastructure Projects (NSIPs). Those relevant to the project are:

- Overarching NPS for Energy (EN-1) (DECC, 2011a);
- NPS for Renewable Energy Infrastructure (EN-3) (DECC, 2011b); and
- NPS for Electricity Networks Infrastructure (EN-5) (DECC, 2011c).

22. Chapter 3 Policy and Legislative Context provides further detail with regards to these NPSs.

23. The specific assessment requirements for water resources and flood risk, as detailed in the NPSs, are summarised in Table 20.1, together with an indication of the paragraph numbers of the ES chapter where each is addressed.

Table 20.1 NPS assessment requirements

NPS Requirement	NPS Reference	ES Reference
EN-1 Overarching NPS for Energy		
'Where the development is subject to EIA [Environmental Impact Assessment] the applicant should ensure that the ES [Environmental Statement] clearly sets out any effects on internationally, nationally and locally designated sites of ecological or geological conservation importance, on protected species and on habitats and other species identified as being of principal importance for the conservation of biodiversity. The applicant should provide environmental information proportionate to the infrastructure where EIA is not required to help the Infrastructure Planning Commission (IPC) consider	Section 5.3	Existing environment is discussed in section 20.6. Impacts are set out in sections 20.7 and 20.8.

NPS Requirement	NPS Reference	ES Reference
thoroughly the potential effects of a proposed project.'		
'Where a proposed development on land within or outside an SSSI is likely to have an adverse effect on an SSSI (either individually or in combination with other developments), development consent should not normally be granted. Where an adverse effect, after mitigation, on the site's notified special interest features is likely, an exception should only be made where the benefits (including need) of the development at this site clearly outweigh both the impacts that it is likely to have on the features of the site that make it of special scientific interest and any broader impacts on the national network of SSSIs.'	Section 5.3	Impacts on surface water habitats which support SSSIs are set out in sections 20.7 and 20.8.
'Applications for energy projects of 1 hectare or greater in Flood Zone 1 in England or Zone A in Wales and all proposals for energy projects located in Flood Zones 2 and 3 in England or Zones B and C in Wales should be accompanied by a flood risk assessment (FRA). An FRA will also be required where an energy project less than 1 hectare may be subject to sources of flooding other than rivers and the sea (for example surface water), or where the EA, Internal Drainage Board or other body have indicated that there may be drainage problems. This 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.'	Section 5.7	Impacts on flood risk are set out in sections 20.7 and 20.8, and Appendix 20.1.
'Where the project is likely to have effects on the water environment, the applicant should undertake an assessment of the existing status of, and impacts of the proposed project on, water quality, water resources and physical characteristics of the water environment as part of the ES or equivalent. The ES 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 and source protection zones (SPZs) around	Section 5.15	Impacts on surface and groundwater resources are set out in sections 20.7 and 20.8. Impacts under the WFD are assessed in Appendix 20.2.

NPS Requirement	NPS Reference	ES Reference
potable groundwater abstractions.'		

20.2.2.5 Flood and Water Management Act 2010

24. The Flood and Water Management Act (FWMA) was passed in 2010. It aims to improve both flood risk management and the way the UK manages water resources by creating clearer roles and responsibilities. This includes a new lead role for local authorities in managing local flood risk (from surface water, ground water and ordinary watercourses) and a strategic overview role of all flood risk for the Environment Agency. The implications of the FWMA provide opportunities for a more comprehensive, risk-based approach on land use planning and flood risk management by local authorities and other key partners.

20.2.3 Regional

20.2.3.1 Anglian River Basin District: River Basin Management Plan (2015)

25. The River Basin District Management Plan (RBMP) is a strategic document that sets out the objectives that have been set for implementation of the WFD at a regional (River Basin District (RBD)) level. The purpose of a RBMP is to provide a framework for protecting and enhancing the benefits provided by the water environment. To achieve this, and because water and land resources are closely linked, it also informs decisions on land-use planning.

26. The second RBMP for the Anglian RBD was finalised by Defra and the Environment Agency in December 2015 and published in February 2016. This document sets out the current state of the water environment according to WFD parameters, pressures affecting the water environment, environmental objectives for protecting and improving the waters, a programme of measures to improve the water environment and deliver WFD objectives, actions needed to achieve the objectives, progress since the 2009 RBMP, and also informs decisions on land-use planning because water and land resources are closely linked.

20.2.3.2 Preliminary and Strategic Flood Risk Assessments

27. The project onshore cable route is approximately 60km and as such falls within a number of local authority boundaries.

28. The onshore project area falls wholly under the jurisdiction of Norfolk County Council and the following local authorities:

- Broadland District Council;
- North Norfolk District Council; and
- Breckland Council.

29. Breckland Council produced its own updated Stage 1 Strategic FRA for its council area in February 2017, whilst North Norfolk District Council and Broadland District Council worked together and with others to produce a Partnership Strategic FRA in December 2007 covering both Districts. Norfolk County Council produced a Preliminary FRA for the entire county in July 2011.

20.2.3.3 Local Flood Risk Management Strategy

30. Norfolk County Council produced the Norfolk Local Flood Risk Management Strategy in 2015 which outlines the aims and objectives the council has as Lead Local Flood Authority and provides policies based on these aims. As Lead Local Flood Authority, Norfolk County Council sets flood risk policy and produces strategic documents that are relevant to the entire county. Local district councils produce more localised policies (specific to the flood risk posed to their geographical boundaries) that sit within the county wide strategy.

20.2.4 Local

31. Table 20.2 provides details of the local planning policy documents and the policies contained within these relevant to water resources and flood risk.

Table 20.2 Relevant local planning policies

Document	Policy/guidance	Policy/guidance purpose
North Norfolk District Council		
Local Development Framework, comprising a number of Development Plan Documents, including a Core Strategy and Development Management Policies document (North Norfolk District Council, 2012)	Development Management Policy EN10 – 'Development 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 (xii); • Changes of use (to an equal or lower risk category in the flood risk vulnerability classification) where there is no operational development (xiii); and • 'Less vulnerable' uses where the sequential test has been passed."
	Strategic Policy	In addition, the adopted Core Strategy includes the following Strategic Policy, relevant for the project: "Renewable energy proposals will be supported and considered in the context of sustainable development and climate change, taking account of the wide environmental, social and economic benefits of renewable energy gain and their contribution to overcoming energy

Document	Policy/guidance	Policy/guidance purpose
		supply problems in parts of the District.”
	Appendix B (North Norfolk Ecological Network) of North Norfolk District Council’s Policy EN 9 on Biodiversity	The policy identifies the Rivers Wensum, Bure and Ant, their tributaries and floodplains as a core area for biodiversity, where protection, enhancement and expansion of the existing resource will be a priority. Chalk river BAP habitat in the Wensum and Bure is identified as being a particular priority in the county. The policy also sets out four objectives for river habitats: • Produce river restoration plans; • Create habitat ecotones from wet to dry habitat; • Buffer floodplains by encouraging low input agricultural systems or semi-natural habitats; and • Enhance connectivity through creating new wetland linkages and enhancing the matrix (land uses surrounding a wetland).
Breckland Council		
The Breckland Council Core Strategy and Development Control Policies Development Plan Document (2012)	Strategic Objectives (SO13).	This Core Strategy document highlights delivering development within sustainable locations that are “not at risk of flooding” as a priority, with the minimisation of the risk of flooding to existing and new developments.
	Strategic Objective 12 (SO12)	“Promote renewable energy to reduce carbon emissions.”
Broadland District Council		
Broadland District Council Local Plan (Joint Core Strategy DPD for Broadland, Norwich and South Norfolk District Councils (2014))	Objective 1 of the Spatial Planning Objectives	This Strategy recognises flooding as a key concern, where it states: “New development will generally be guided away from areas with a high probability of flooding. Where new development in such areas is desirable for reasons of sustainability (e.g. in the city centre), flood mitigation will be required and flood protection will be maintained and enhanced.”

20.3 Consultation

32. Consultation is a key driver of the EIA and ES, and is an ongoing process throughout the lifecycle of the project, from the initial stages through to consent and post-consent. To date, consultation regarding water resources and flood risk has been conducted through Expert Topic Group (ETG) meetings (held in July 2017 and January and March 2018), the Scoping Report (Royal HaskoningDHV, 2016), and the

Preliminary Environmental Information Report (PEIR) (Norfolk Vanguard Limited, 2017).

33. Full details of the project consultation process are presented within Chapter 7 Technical Consultation.

34. Feedback received during the process to date has been incorporated into the ES, where possible.

35. Appendix 20.5 provides a full account of all consultation responses received to date with regards to water resources and flood risk. A summary of the consultation that has been undertaken to date with respect to water resources and flood risk is provided in Table 20.3.

Table 20.3 Consultation response summary

Consultee	Document / date received	Comment	Response / where addressed in the ES
Secretary of State	11th November 2016 Scoping Opinion	A WFD compliance assessment should form an appendix to the ES. The FRA should take into account the most up to date climate change allowances and should cover tidal flood risk as well as fluvial impacts under present and projected sea level scenarios. Consideration should be given to the potential impacts on the coastal defence works proposed around Bacton. In relation to trenchless crossing (e.g. HDD) activities, the ES 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.	Comments addressed in: • FRA (Appendix 20.1). • WFD Compliance Assessment (Appendix 20.2). • Description of embedded mitigation measures (section 20.7.1). • Assessment of potential impacts (sections 20.7.4, 20.7.6 and 20.7.7).
Norfolk County Council	11th November 2016 Scoping Opinion	FRA's and surface water drainage strategies should 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 • 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.	Comments addressed in: • FRA (Appendix 20.1). • Description of embedded mitigation measures (section 20.7.1). • Assessment of potential impacts (sections 20.7.4, 20.7.6 and 20.7.7). A Surface Water and Drainage Plan will be prepared (as part of the final CoCP) (DCO

Consultee	Document / date received	Comment	Response / where addressed in the ES
		• The requirement to seek consent from Norfolk County Council (NCC) for works that affect the flow in ordinary watercourses outside of the control of an IDB. The County Council note the following criteria from the Scoping report and welcome these considerations that are applicable to Flood and Water Management issues. • Proximity to residential properties; • Proximity to Source Protection Zones (SPZ); • Flood risk; • Minimise requirement for complex crossing arrangements, e.g. road, river and rail crossings; and • Avoiding ponds and agricultural ditches. Further to the criteria mentioned above it is noted the following settlements have historical flooding issues and are likely to be sensitive to disruptions to the wider drainage networks: • North Walsham - Drains to the North east (North Walsham and Dilham Canal) and South West (Skeyton Beck); • Dereham - Drains to the East (via Dereham Stream to Wendling Beck); • Necton - Drains to the South (River Wissey). In line with good practice, 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. Drainage strategy to assess and justify compliance with the SuDS hierarchy for surface water disposal location. This would include: (a) Demonstration of infiltration testing (b) If site wide infiltration is not appropriate due to unfavourable rates, demonstration with evidence as to why there cannot be a connection made to the nearest watercourse. (c) As a final option, demonstration with evidence that Anglian Water would accept a connection to a surface water sewer. The drainage strategy should also contain a maintenance and management plan detailing the activities required and details of who will adopt and maintain all the surface water drainage features for	requirement 20) which will ensure delivery of the required surface water drainage features.

Consultee	Document / date received	Comment	Response / where addressed in the ES
		the lifetime of the development.	
Environment Agency	25th January 2017 Expert Topic Group Meeting 1	Raised concerns over the impact assessment methodology within the method statement regarding the sensitivity for surface water receptors. Table 4.1 within method statement. Highlighted risk of biosecurity and pollution which should be included within the assessment.	Wording for sensitivity updated (section 20.4). Biosecurity risk is assessed in Chapter 22 Onshore Ecology and Chapter 21 Land Use and Agriculture.
Norfolk County Council	25th January 2017 Expert Topic Group Meeting 1	Agree with suggested approach for a proportionate catchment based assessment to focus the attention on the key areas for flood risk. Highlighted: • Change in land use will increase surface flows • Potential to alter existing drainage patterns • Risks around temporary water crossings • More risk in winter months and also intense summer storms • Consent will be required for working in the watercourse • How climate change will be assessed within the EIA • Drainage strategy in relation to land use and inclusion of SuDS (Sustainable Urban Drainage Devices) Also highlighted that the following need to be considered within the FRA: • Surface catchments <$3km^2$ • Flooding from pluvial (surface rainfall) sources • Groundwater flooding	Comments addressed in: • FRA (Appendix 20.1). • Assessment of potential impacts (sections 20.7.4, 20.7.6 and 20.7.7).
Water Management Alliance (WMA) (Internal Drainage Board)	20th April 2017	Confirmed that all works within 9m of an IDB watercourse will need to be consented by the IDB under Byelaw 10. Utilities would ideally be buried at least 2m below the hard bed of a watercourse, and would need to be able to withstand crossing by a 30t tracked excavator. Each watercourse crossing will also require a licence agreement. Sediment management is a significant issue. The timing of works will need to be considered, to avoid impacts from sediment supply on trout spawning habitats and dissolved oxygen levels in the water. The IDB use multiple silt curtains to contain fine sediments, as do the local Environment Agency teams. Sedimats have not been found to be effective.	Sediment management has been recognised as an important focus area for the assessment. Sediment supply from all working areas (not just adjacent to watercourses) has been considered. (section 20.7.4) Cable burial depth will typically be 1.5m for trench crossings and 2m for trenchless crossings. However, this is dependent upon

Consultee	Document / date received	Comment	Response / where addressed in the ES
			geology and other associated risks.
Environment Agency	26th May 2017	Comfortable with the proposed trenchless crossing techniques (e.g. HDD for the River Wensum, River Bure, King's Beck and North Walsham & Dilham Canal), and trenched for the other watercourses (including Wendling Beck and the Blackwater Drain). Incision rates in the channels are low, and 1.5m should be regarded as a suitable minimum burial depth. Noted several issues that should be considered: • River Wensum: The Environment Agency operate a rolling programme of restoration on the Wensum. The reach that will be crossed has not yet been restored. Although the proposed use of trenchless crossing techniques (e.g. HDD) will minimise potential for impact, it may be beneficial to discuss the plans with the Environment Agency PM. • River Bure: Recovering habitats should be preserved where possible (also applies to other watercourses). • Wendling Beck: The river reacts quickly to rainfall, and flood risk implications of trenching need to be considered (particularly in relation to the town of Dereham). The timing of trenching needs to be considered to minimise risks (e.g. during periods of higher flow). Asked whether there would be any scope for channel restoration as part of the reinstatement process, e.g. bank reprofiling, the introduction of gravel substrates. General pollution prevention measures should be sufficient in most cases. Cumulative impacts from multiple crossings in the same catchment should be considered.	The potential impacts of crossing techniques are discussed in section 20.7. Specific discussions regarding each watercourse have also been taken into consideration in this section. Wendling Beck will be crossed using trenchless techniques. Channel restoration will be considered and agreed on a case by case basis, and any works would have to be limited to within the onshore project area DCO red line boundary. Pollution prevention measures embedded into the scheme design are discussed in section 20.7.1. Further discussion is provided in sections 20.7.4, 20.7.6 and 20.7.7. Cumulative impacts are assessed in section 20.8. Cable burial depth will typically be 1.5m for trench crossings and 2m for trenchless crossings. However, this is dependent upon geology and other associated risks.
Environment Agency, Anglian Water, Internal Drainage Board, Norfolk County	11th December 2017 PEIR Response	Key comments on the PEIR include: • Receptors grouped according to scale of watercourse, but this underestimates the value and sensitivity of headwater streams • WFD status should not be used to define receptor sensitivity. • Secondary aquifers are defined as low sensitivity - this is incorrect.	Impacts have been re-assessed based on sensitivity of catchment rather than type of watercourse, taking into account multiple factors, including the presence of priority

Consultee	Document / date received	Comment	Response / where addressed in the ES
Council		• Unlicensed water abstractions should not be low value. • Embedded mitigation measures for trenched watercourse crossings and temporary construction-phase impacts are not adequate. • Damming and diverting could result in temporary impacts (flow, WQ and therefore biology, plus transfer of invasive non-native species (INNS)) – these need to be assessed. • Potential impacts on priority habitats and species (e.g. brown trout, brook lamprey and bullhead) should be considered. • Mitigation measures to prevent spread of INNS and crayfish plague required. • Potential impacts on shallow aquifers and associated abstractions should be clarified. • No reference is made to existing sewers within the cable corridor. • It is unclear whether there is a requirement for water and wastewater services.	species (section 20.6.4). References to WFD status as a proxy for sensitivity of receptor has been removed, with aquifer designation or known watercourse characteristics now used to establish sensitivity and value. The sensitivity and value of groundwater receptors has been reassessed in section 20.7.1. Embedded mitigation has been updated and are described in section 20.7.1. Impacts associated with damming and diverting are assessed in section 20.7.5.1. Potential impacts on priority habitats are assessed in Chapter 22 Onshore Ecology and considered within in sections 20.7.5, 20.7.6 and 20.7.7. Reference has been made to measures to prevent the spread of INNS in section 20.7.5.3, with cross-reference to Chapter 22 Onshore Ecology. Crossing techniques for buried services (including water mains and sewers) are outlined in section 20.7.1. Water and wastewater requirements have been confirmed in Chapter 5.

20.4 Assessment Methodology

20.4.1 Impact Assessment Methodology

36. Chapter 6 EIA Methodology details the general impact assessment method, and the following sections describe more specifically the methodology used to assess the potential impacts of the project on water resources and flood risk, as consulted on and agreed via ETG meetings held throughout the Evidence Plan Process, the Scoping Report (Royal HaskoningDHV, 2016) and the PEIR (Norfolk Vanguard Limited, 2017). Separately, more detailed methodologies for the FRA and WFD compliance assessment can be found in Appendix 20.1 and Appendix 20.2, respectively.

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

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

38. Whilst there are clear links between the two impact groups, the assessment of receptor sensitivity and the magnitude of effect may differ.

20.4.1.1 Sensitivity

39. Receptor sensitivity has been defined with reference to the adaptability, tolerance, recoverability and value of individual receptors. Table 20.4 provides the criteria for appraisal of the sensitivity of water resources and flood risk receptors based on professional judgement.

Table 20.4 Definitions of sensitivity for water resources and flood risk receptors

Sensitivity	Definition	Criteria
High	Receptor has no or very limited capacity to accommodate changes to hydrology, geomorphology, water quality or flood risk.	*Water resources* Controlled waters with an unmodified, naturally diverse hydrological regime, a naturally diverse geomorphology with no barriers to the operation of natural processes, and good water quality. Supports habitats or species that are highly sensitive to changes in surface hydrology, geomorphology or water quality. Supports Principal Aquifer with public water supply abstractions by provision of recharge. Site is within Inner or Outer Source Protection Zones.
		Flood risk Highly Vulnerable Land Use, as defined by NPPF PPG (DCLG, 2015). Land with more than 100 residential properties (after DMRB, 2009).
Medium	Receptor has limited capacity to accommodate changes to hydrology, geomorphology, water quality or flood risk.	*Water resources* Controlled waters with hydrology that sustains natural variations, geomorphology that sustains natural processes, and water quality that is not contaminated to the extent that habitat quality is constrained. Supports or contributes to habitats or species that are sensitive to changes in surface hydrology, geomorphology and/or water quality. Supports Secondary A or Secondary B Aquifer with water supply abstractions. Site is within a Catchment Source Protection Zone.
		Flood risk More Vulnerable Land Use, as defined by NPPF PPG (DCLG, 2015). Land with between 1 and 100 residential properties or more than 10 industrial premises (after DMRB, 2009).
Low	Receptor has moderate capacity to accommodate changes to hydrology, geomorphology, water quality or flood risk.	*Water resources* Controlled waters with hydrology that supports limited natural variations, geomorphology that supports limited natural processes, and water quality that may constrain some ecological communities. Supports or contributes to habitats that are not sensitive to changes in surface hydrology, geomorphology or water quality. Supports Secondary A or Secondary B Aquifer without abstractions.
		Flood risk Less Vulnerable Land Use, as defined by NPPF PPG (DCLG, 2015). Land with 10 or fewer industrial properties (after DMRB, 2009).

Sensitivity	Definition	Criteria
Negligible	Receptor is generally tolerant of changes to hydrology, geomorphology, water quality or flood risk.	*Water resources* Controlled waters with hydrology that does not support natural variations, geomorphology that does not support natural processes, and water quality that constrains ecological communities. Aquatic or water-dependent habitats and/or species are tolerant to changes in hydrology, geomorphology or water quality. Non-productive strata that does not support groundwater resources.
		Flood risk Water Compatible Land Use, as defined by NPPF PPG (DCLG, 2015). Land with limited constraints and a low probability of flooding of residential and industrial properties (after DMRB, 2009).

20.4.1.2 Value

40. It should be noted that high value and high sensitivity are not necessarily linked with respect to a particular impact. A receptor could be of high value but have a low sensitivity to an effect. It is therefore important not to inflate the significance of an impact due to the value of the receptor. Instead, the value can be used as a modifier for the sensitivity assigned to the receptor. Definitions for the value of surface waters are provided in Table 20.5.

Table 20.5 Definitions of value levels for water resources and flood risk receptors

Value	Criteria
High Receptor is an internationally or nationally important resource with limited potential for offsetting / compensation.	*Water resources* • Supports or contributes to designated habitats or species of international importance (e.g. Special Area of Conservation (SAC), Special Protection Area (SPA), Ramsar site)); and/or • Licensed potable abstractions (surface water and groundwater).
	Flood Risk • Nationally significant infrastructure; and/or • Internationally or nationally designated planning policy areas.
Medium Receptor is a regionally important resource with limited potential for offsetting / compensation.	*Water resources* • Supports or contributes to habitats with high biodiversity or species of national importance (e.g. Site of Special Scientific Interest (SSSI)); and/or • Licensed non-potable abstractions and unlicensed potable abstractions (surface water and groundwater).
	Flood Risk • Locally significant infrastructure; and/or • Local planning policy designated sites.
Low Receptor is a locally important resource.	*Water resources* • Supports or contributes to habitats or species of UK regional or local value (Local Nature Reserve (LNR), Site of Nature Conservation Interest (SNCI), Regionally Important Geological Site (RIGS)); • Unlicensed non-potable abstractions (surface water and groundwater).
	Flood Risk • Drainage that does not discharge to Critical Drainage Areas.
Negligible Receptor is not considered to be an important resource.	*Water resources* • Aquatic or water-dependent habitats and/or species are not sensitive to changes in hydrology, geomorphology or water quality. The waters are tolerant to the proposed changes; and/or • No abstractions (surface water and groundwater).
	Flood Risk • No significant infrastructure.

20.4.1.3 Magnitude

41. Receptor magnitude has been defined with consideration to the spatial extent, duration, frequency and severity of the effect. Impact magnitude is defined in Table 20.6.

Table 20.6 Definitions of magnitude of effect for water resources and flood risk receptors

Magnitude	Definition	Criteria
High	Permanent or large-scale change affecting usability, risk, or value over a wide area.	*Water resources* Permanent changes to geomorphology and/or hydrology that prevent natural processes operating. Permanent and/or wide scale effects on water quality or availability. Permanent loss or long-term degradation of a water supply source resulting in prosecution. Permanent or wide scale degradation of habitat quality.
		Flood risk Permanent or major change to existing flood risk. Reduction in on-site flood risk by raising ground level in conjunction with provision of compensation storage. Increase in off-site flood risk due to raising ground levels without provision of compensation storage. Re-location of development outside floodplain or flood zone. Failure to meet either sequential or exception test (if applicable).
Medium	Moderate permanent or long-term reversible change affecting usability, value, or risk, over the medium- term or local area.	*Water resources* Medium-term effects on water quality or availability. Medium-term degradation of a water supply source, possibly resulting in prosecution. Habitat change over the medium-term.
		Flood risk Medium-term or moderate change to existing flood risk. Possible failure of sequential or exception test (if applicable). Reduction in off-site flood risk within the local area due to the provision of a managed drainage system.
Low	Minor permanent change over the short-term or within the site boundary with minimal effect on usability, risk or value.	*Water resources* Short-term or local effects on water quality or availability. Short-term degradation of a water supply source. Habitat change over the short-term.
		Flood risk Short-term temporary or minor change to existing flood risk. Localised increase in on-site or off-site flood risk due to increase in impermeable area. Passing of sequential and exception test.
Negligible	Temporary change, undiscernible over the medium- to long-term, with no effect on usability, risk or value.	*Water resources* Intermittent impact on local water quality or availability. Intermittent or no degradation of a water supply source. Very slight local changes to habitat that have no observable impact on dependent receptors.
		Flood risk Intermittent or very minor change to existing flood risk. Highly localised increase in on-site or off-site flood risk due to increase in impermeable area.

20.4.1.4 Impact significance

42. The potential significance of an impact is a function of the sensitivity and value of the receptor and the magnitude of the effect. It should be noted that value and sensitivity are not necessarily linked with respect to a particular impact. A receptor could be of high value but have a low sensitivity to an effect. The value is therefore used as a modifier for the sensitivity assigned to the receptor.

43. The significance is derived using an impact significance matrix, as shown in Table 20.7. Definitions of each level of significance are provided in Table 20.8.

44. Assessment of impact significance is qualitative and reliant on professional experience, interpretation and judgement. The matrix should therefore be viewed as a framework to aid understanding of how a judgement has been reached, rather than as a prescriptive, formulaic tool.

45. Effects that result in major or moderate impacts are usually considered to be 'significant' in EIA terms. Adverse significant impacts may require mitigation; beneficial significant impacts contribute to the case in favour of the project.

Table 20.7 Impact significance matrix

		Negative magnitude				Beneficial magnitude			
		High	Medium	Low	Negligible	Negligible	Low	Medium	High
Sensitivity	High	*Major*	*Major*	*Moderate*	*Minor*	*Minor*	*Moderate*	*Major*	*Major*
	Medium	*Major*	*Moderate*	*Minor*	*Minor*	*Minor*	*Minor*	*Moderate*	*Major*
	Low	*Moderate*	*Minor*	*Minor*	*Negligible*	*Negligible*	*Minor*	*Minor*	*Moderate*
	Negligible	*Minor*	*Negligible*	*Negligible*	*Negligible*	*Negligible*	*Negligible*	*Negligible*	*Minor*

Table 20.8 Impact significance definitions

Impact significance	Definition
Major	Very large or large change in receptor condition, both adverse or beneficial, which are likely to be important considerations at a regional or district level because they contribute to achieving national, regional or local objectives, or, could result in exceedance of statutory objectives and / or breaches of legislation.
Moderate	Intermediate change in receptor condition, which are likely to be important considerations at a local level.
Minor	Small change in receptor condition, which may be raised as local issues but are unlikely to be important in the decision-making process.
Negligible	No discernible change in receptor condition.
No impact	No change, therefore no impact on receptor condition.

20.4.2 Cumulative Impact Assessment

46. Chapter 6 EIA Methodology provides a general methodology with regards to the CIA.

47. The potential for cumulative effects has been considered for the construction, operation and decommissioning of the onshore project area cumulatively with the offshore project area as well as with other onshore projects.

48. Cumulative impacts are discussed where the project has the potential to overlap with similar effects arising from:

- Recent development, either built or under construction (which is not considered as part of the baseline);
- Approved development, awaiting implementation; and
- Proposals awaiting determination within the planning process with design information in the public domain.

49. The onshore CIA involves consideration of whether impacts on a receptor can occur on a cumulative basis between the project and other activities, projects and plans for which sufficient information regarding location and scale exist.

50. The strategy recognises that data and information sufficient to undertake an assessment will not be available for all potential projects, activities, plans and/or parameters, and seeks to establish the 'confidence' which may be placed in the data and information available.

20.4.3 Transboundary Impact Assessment

51. There are no transboundary impacts with regards to water resources and flood risk as the onshore project area is not sited in close proximity to any international boundaries. Transboundary impacts are therefore scoped out of this assessment and will not be considered further, as agreed during the scoping stage.

20.5 Scope

20.5.1 Study Area

52. The onshore footprint is referred to hereafter as the onshore project area and is shown on Figure 20.1. The onshore project area considered includes the following elements:

- Landfall;
- Onshore cable route (including running track), accesses, trenchless crossing (e.g. HDD) zones and mobilisation areas;
- Onshore project substation; and
- National Grid substation extension and overhead line modification.

53. A full description and associated information for the onshore project area is provided in Chapter 5 Project Description.

54. The study area for this assessment is defined on the basis of surface hydrological catchments, whereby catchments have been included in the study area if they contain, or are hydrologically connected to (i.e. upstream or downstream where the potential for wider impacts have been identified), the onshore project area. The Environment Agency's WFD river water body catchments are based on surface hydrological catchments and have therefore been used to delineate the boundaries of the study area and define surface water receptors (Figure 20.1). This approach was agreed through consultation with the regulators at the PEIR stage.

55. For the purposes of the WFD Compliance Assessment, the study area encapsulates all the surface (rivers, lakes, transitional and coastal water bodies) and groundwater bodies that are potentially hydrologically connected to both the onshore and offshore infrastructure associated with the project. This WFD study area is discussed further in Appendix 20.2.

20.5.2 Data Sources

56. The data sources used to inform the water resources and flood risk baseline, and the confidence levels associated with each data source, are listed in Table 20.9.

Table 20.9 Data sources

Data	Source	Year	Coverage	Confidence	Notes
Flood Map for Planning	Environment Agency	2017	Nationwide	High	N/A
Product 4 data	Environment Agency	2017	Landfall, onshore cable route, onshore project substation	High	Environment Agency Product 8 data was also requested, but this is unavailable in the area.
Risk of Flooding from Surface Water	Environment Agency	2017	Nationwide	High	N/A
Risk of Flooding from Rivers and Sea	Environment Agency	2017	Nationwide	High	N/A
Catchment Data Explorer for WFD River Basin Districts Management Catchments, Operational	Environment Agency	2017	Nationwide	High	N/A

Data	Source	Year	Coverage	Confidence	Notes
Catchments and WFD water bodies					
Classification of drains within the North Rivers and Broads IDB regions	Internal Drainage Board (IDB)	2017	Landfall, onshore cable route, onshore project substation	High	N/A

20.5.3 Assumptions and Limitations

57. This assessment is based on a range of publicly available information and data. Although it is considered that the individual datasets provided are robust, there is a level of uncertainty associated with their use in this impact assessment. For example, the known characteristics of the drainage network and watercourse specific attributes and conditions have been used as a proxy to assign value and sensitivity to the wider catchment. This represents a precautionary approach that ensures that value and sensitivity has not been under-assessed within the assessment. This approach was agreed with the Environment Agency as part of the PEIR process.

20.6 Existing Environment

20.6.1 Surface Water

20.6.1.1 Surface water drainage

58. The project is located within three main surface water catchments (Figure 20.2, which only labels the main drainage catchments, and not the tributaries):

- The River Bure catchment;
- The River Wensum catchment; and
- The River Wissey catchment.

59. The River Bure and several of its tributaries in the upper catchment, including the New Cut, East Ruston Stream, North Walsham and Dilham Canal (formerly known as the River Ant) and King's Beck would be crossed by the onshore cable route (Figure 20.2). The main river rises near Briston, from where it flows in an easterly direction until it reaches Aylsham. From here, it continues to flow to the south east until it enters the sea at Great Yarmouth. The downstream reaches of the river include a wide range of wetland features, including Hoveton Great Broad and Marshes, Woodbastwick Fens and Marshes, Bure Marshes and the Norfolk Broads. A small proportion of the cable route also crosses the northern part of the New Cut catchment.

60. The River Wensum and several of its tributaries, including the Wendling Beck and Blackwater Drain, would be crossed by the onshore cable route (Figure 20.2). The

river rises near Whissonsett, from where it flows north towards Fakenham before continuing in a broadly south easterly direction towards Norwich. The River Wensum is designated as a Special Area of Conservation (SAC) and Site of Special Scientific Interest (SSSI).

61. The National Grid substation extension and onshore project substation are located within the headwaters of the River Wissey (Figure 20.2). The Wissey rises to the south of Dereham, from where it drains in a westerly direction towards Necton before eventually joining the River Great Ouse at Denver Sluice, near Downham Market.

62. The study area comprises a number of surface sub-catchments (Figure 20.3 and Table 20.10), which are analogous to the WFD water body catchments identified by the Environment Agency. These are themselves divided into a range of different watercourses.

63. There are also a number of Internal Drainage Board (IDB) channels of importance (as shown on Figure 20.4), which in general follow the main river catchments.

64. Furthermore, there are a large number of ordinary watercourses and agricultural drainage channels that are unnamed and due to the number within the study area cannot be individually listed here. These are shown on Figure 20.4.

Table 20.10 Surface water catchments

Catchment	Sub-catchment	Watercourse	Primary IDB Drains	WFD water body
Bure	New Cut	New Cut	-	New Cut
	East Ruston Stream	Hundred Stream	BG1301	East Ruston Stream
	North Walsham & Dilham Canal (Ant)	North Walsham & Dilham Canal	AG1216	N Walsham & Dilham Canal
		Unnamed (Brick Kiln Farm)	-	
		Unnamed (Grammar School Farm)	-	
	King's Beck	Unnamed (Cooke's Bottoms)	-	King's Beck
		Suffield Beck	Boundary Farm Spur (19a)	
		Blackwater Beck	Blackwater Beck	
			Low Level Drain – Colby to Suffield Hall (18)	
		Unnamed (Colby Hall)	-	
	Mermaid Stream	Mermaid Stream	The Mermaid	Mermaid Stream
	River Bure	River Bure	-	Bure (Scarrow-Horstead)
		Unnamed (Silvergate)	Blickling to Silvergate (28)	
Wensum	Blackwater	Unnamed (Southgate)	MN 16 – Reepham	Blackwater Drain (Wensum)
		Booton Watercourse	MN 16 – Reepham	
		Unnamed (Bath Plantation)	-	
		Reepham Stream (east)	-	
		Unnamed (Kerdiston)	MN 16 – Reepham	

Catchment	Sub-catchment	Watercourse	Primary IDB Drains	WFD water body
		Reepham Stream (west)	MN 16 – Reepham	
		Unnamed (Jordan Green)	-	
		Unnamed (Sparham House)	-	
	River Wensum	River Wensum	MN 25 – Bylaugh Meadows	Wensum us Norwich
			MN 12 – Swanton Morley	
	Penny Spot Beck	Penny Spot Beck	MN 26 – Pennyspot Farm	
		Unnamed (Frog’s Hall)	-	
	Wendling Beck	Wendling Beck	-	Wendling Beck
		Unnamed (Little Wood)	-	
		Unnamed (Bushy Common)	-	
		Unnamed (Bradenham)	-	
Wissey	River Wissey	Upper Wissey	-	Wissey – Upper
		Unnamed (Lodge Farm))	-	

20.6.1.2 Geomorphology

65. A geomorphological survey of the accessible main river watercourses that would be crossed by the onshore cable route was undertaken in April 2017, as detailed in Appendix 20.3 Geomorphological Walkover Survey. The methodology and scope of the walkover survey was agreed with the Environment Agency at the beginning of the PEIR process. This survey identified the main geomorphological characteristics, including flow conditions, channel form, floodplain characteristics and any evidence of channel modification, of the following watercourse crossing points:

- North Walsham and Dilham Canal at Little London;
- King's Beck at Colby Corner;
- River Bure at Abbot's Hall Farm, Drabblegate;
- Blackwater Drain at Salle Park;
- River Wensum at Old Hall Farm, Mill Street;
- Wendling Beck at Old Brigg, Gressenhall; and
- Wendling Beck at Bushy Common.

66. Table 20.11 provides an overview of the geomorphological characteristics of each of these watercourses, as identified during the walkover in April 2017 (Appendix 20.3).

Table 20.11 Geomorphological overview of watercourse crossing locations

Water body	Geomorphological overview
North Walsham and Dilham Canal	The North Walsham and Dilham Canal is a heavily modified watercourse with a straight planform and uniformly graded banks. The channel is dominated by low energy glide flows and appears to support very little geomorphological diversity.
King's Beck	King's Beck is a uniform, incised channel that has been artificially straightened and re-sectioned. The channel is dominated by glide flows and there is extensive in-channel vegetation growth. In addition to the main channel, there are several connected channels that have similar characteristics. These are largely artificial, although some reaches may represent a re-sectioned historical course of the watercourse.
River Bure	The River Bure is a moderately sinuous watercourse that has been historically re-sectioned and enlarged. The channel has largely uniform banks and flow conditions are dominated by uniform glides. Evidence of lateral accretion (in the form of low berms within the re-sectioned bank line) suggests that the channel is naturally recovering from historical modifications.
Blackwater Drain	The Blackwater Drain is a narrow, meandering channel that supports a range of different flow types and geomorphological habitat niches. Exposed tree roots in the bed indicate that the channel has recently incised.
River Wensum	The River Wensum is a gently meandering chalk river, with a wide, deep channel and very shallow banks. Flows are dominated by uniform, low energy glides, and siltation appears to be the dominant geomorphological process. The channel is fringed by low embankments which may reduce floodplain connectivity but are likely to be frequently overtopped.
Wendling Beck at Bushy Common	Wendling Beck is a gently meandering chalk river that has been historically straightened. The channel is shallow, with steep, low banks and swift flows. These maintain the natural coarse substrate along the majority of the reach, although there

Water body	Geomorphological overview
	is evidence of fine sedimentation along the channel margins and upstream of a twin pipe culvert.
Wendling Beck at Old Brigg	Wendling Beck is a gently meandering channel with low energy glide flows and extensive siltation which obscures the coarse substrate that would typically be associated with chalk rivers. The deep, narrow channel has steep banks, and much of the watercourse is likely to have been historically re-sectioned.

20.6.1.3 Water quality

67. A review of the Environment Agency's Catchment Data Explorer WFD water quality data for the surface water bodies identified predominantly good physico-chemical and chemical water quality conditions across the main surface water catchments.

68. However, the East Ruston Stream (GB105034055670), which drains into the North Walsham and Dilham Canal, has low concentrations of dissolved oxygen. This is attributed by the Environment Agency (2016) to continuous sewage effluent discharges from a waste water treatment plant.

69. In addition, the Wissey – Upper (GB105033047890) water body has elevated levels of phosphate. This is attributed by the Environment Agency (2016) to inputs of phosphate fertilisers from agricultural areas via surface runoff draining into the watercourse.

20.6.1.4 Flood risk

70. Environment Agency flood zone maps (Environment Agency, 2012) (Figure 20.5) indicate that the majority of the study area is located within an area of low flood risk (Flood Zone 1). Flood Zone 1 is defined as land as having a less than 1 in 1,000 annual probability of river flooding (<0.1%). However, any onshore infrastructure located closer to the main rivers of the River Bure and the River Wensum and their tributaries (as identified above) have a higher risk of flooding (up to Flood Zone 3 – high risk of flooding).

71. The FRA, Appendix 20.1, provides a detailed description of the baseline flood risk of the study area.

20.6.2 Groundwater

20.6.2.1 Groundwater bodies

72. The Crag and the Chalk aquifers are classified as Principal Aquifers by the Environment Agency. The superficial deposits are classified as Secondary A, B and undifferentiated aquifers (Chapter 19 Ground Conditions and Contamination, Figure 19.4). The Environment Agency's groundwater vulnerability maps indicate the study area is located within an area of high groundwater vulnerability (overlying a permeable aquifer). This indicates soils which may be able to transmit a wide range of pollutants into any groundwater stored in the underlying strata.

73. The WFD defines groundwater bodies as distinct volumes of groundwater within an aquifer or aquifers. It requires that groundwater bodies are designated as drinking water protected areas (DrWPAs) based on their use for human consumption. Regionally, the principal groundwater body covering the majority of the onshore project area is the Broadland Rivers Chalk & Crag (Figure 20.6). The chalk bedrock is designated as a Principal Aquifer and a number of groundwater Source Protection Zone (SPZ) areas are identified within the study area, with both inner and outer zones of the SPZ areas extending across the eastern section of the onshore cable route. There are small sections of the onshore project area close to the coast, north of North Walsham that is underlain by the North Norfolk Chalk groundwater body. Some areas of the western extent of the project area are underlain by the North Norfolk Chalk and North West Norfolk Chalk groundwater bodies.

20.6.2.2 Groundwater abstractions

74. There are a number of licensed groundwater abstractions within the study area which are mostly associated with agriculture. Broadland District Council, North Norfolk District Council and Breckland Council were contacted in May 2017 to obtain information regarding private water supplies located within the study area. There are 101 private water supplies within the study area in the areas administered by North Norfolk District Council and Breckland Council. Broadland District Council does not hold records regarding private water supply and no information is available for this area. The precise location of private water supplies will be confirmed as part of the pre-construction works (e.g. through landowner consultation).

75. There are a number of groundwater SPZ areas within the onshore project area (Chapter 19 Ground Conditions and Contamination, Figure 19.5). Trenchless crossing techniques (e.g. HDD) activities are proposed in the following areas:

- SPZ3 in the area of Scarning;
- SPZ2 and SPZ3 north of Dereham;
- SPZ1 and SPZ2 in the area of North Walsham;
- SPZ3 under the River Wensum;
- SPZ2 and SPZ3 north of Aylsham;
- SPZ3 under the Cromer Road (A149); and
- SPZ3 south of Edingthorpe.

76. Safeguard Zones (SgZs) are non-statutory WFD designations by the Environment Agency for potable abstractions where the water quality is poor and where additional measures are needed to bring about improvement. SgZs are typically based on existing SPZ1 and SPZ2 areas. Designation means that there will be strict enforcement of existing measures for particular pollutants and activities, and possibly new voluntary measures. The study area does not cross any groundwater

SgZs, and as such these receptors are therefore not considered further in this impact assessment.

20.6.3 Designated Sites

77. The River Wensum is designated as a SAC and SSSI on account of the water-dependent features and habitats that it supports.

78. The river was designated as a SSSI because it provides an exceptional example of an enriched, calcareous lowland river, supporting a diverse assemblage of plants and invertebrates. The SSSI is currently in unfavourable condition due to hydrological pressures, high phosphate concentrations, high turbidity and siltation-related issues.

79. The Wensum was also designated as a SAC because it supports Annex 1 habitats with river water-crowfoot (*Ranunculion fluitantis*) and *Callitricho-Batrachion* (water-starworts) vegetation communities. It also supports Annex II species such as white clawed crayfish (*Austropotamobius pallipes*), Desmoulin's whorl snail (*Vertigo moulinsiana*), brook lamprey (*Lampetra planeri*) and bullhead (*Cottus gobio*).

80. Further details regarding designated sites can be found within Chapter 22 Onshore Ecology, with designated sites shown in Figure 22.2.

20.6.4 Sensitivity and Value of Receptors

20.6.4.1 Surface water receptors

81. As described in section 20.6.1, there are three main surface water catchments in the study area, each composed of several sub-catchments and individual watercourses. A value and sensitivity has been set for each catchment and applied to all natural watercourses within that catchment. All parts of the permanent drainage network that are not included in Ordnance Survey datasets will therefore be considered to be part of the nearest downstream watercourse that is included in the dataset.

82. The sensitivity of these receptors has been defined at a sub-catchment level based on the geomorphological (i.e. physical habitat) characteristics observed at key points within each catchment (based on the results of the walkover survey presented in Appendix 20.3 and additional site observations made during the site surveys undertaken to inform Chapter 22 Onshore Ecology).

83. The value of each receptor has been identified with reference to Environment Agency fisheries data and ecological designations. The results of this process are shown in Table 20.12.

Table 20.12 Sensitivity and value of surface water resources

Catchment	Sub-catchment	Watercourse	Physical characteristics	Sensitivity	Protected species and ecological designations	Value
River Bure	New Cut	New Cut	Largely artificial, highly straightened channel	Low	Supports Calthorpe Broad and Priory Meadows, Hickling SSSI Drains into The Broads SAC and Broadland SPA	High
	East Ruston Stream	Hundred Stream	Naturally meandering channel with good geomorphological diversity	High	Potentially supports habitat for water voles	High
	North Walsham & Dilham Canal	North Walsham & Dilham Canal	Extensively modified channel with limited geomorphological diversity	Low	None recorded	Low
		Unnamed (Brick Kiln Farm)				
		Unnamed (Grammar School Farm)				
	King's Beck	Unnamed (Cooke's Bottoms)	Uniform re-sectioned channel with some geomorphological diversity	Medium	Supports habitats for brown trout Potentially supports habitat for water voles	High
		Suffield Beck				
		Blackwater Beck				
		Unnamed (Colby Hall)				
	River Bure	River Bure	Modified channel with evidence of natural geomorphological recovery	Medium	Supports habitats for brown trout, brook lamprey and water voles	High
		Unnamed (Silvergate)				

<table>
<tr><th>Catchment</th><th>Sub-catchment</th><th>Watercourse</th><th>Physical characteristics</th><th>Sensitivity</th><th>Protected species and ecological designations</th><th>Value</th></tr>
<tr><td></td><td>Mermaid Stream</td><td>The Mermaid</td><td></td><td>Medium</td><td>Supports habitats for brown trout
Potentially supports habitat for water voles</td><td>High</td></tr>
<tr><td rowspan="9">River Wensum</td><td rowspan="8">Blackwater</td><td>Unnamed (Southgate)</td><td rowspan="8">Predominantly natural meandering channel with good geomorphological diversity</td><td rowspan="8">High</td><td rowspan="3">Supports habitats for brown trout
Potentially supports habitat for water voles</td><td rowspan="8">High</td></tr>
<tr><td>Booton Watercourse</td></tr>
<tr><td>Unnamed (Bath Plantation)</td></tr>
<tr><td>Reepham Stream (east branch)</td><td rowspan="3">Supports habitats for bullhead
Potentially supports habitat for water voles</td></tr>
<tr><td>Unnamed (Kerdiston)</td></tr>
<tr><td>Reepham Stream (west branch)</td></tr>
<tr><td>Unnamed (Jordan Green)</td><td>None recorded</td></tr>
<tr><td>Unnamed (Sparham House)</td><td>Supports habitats for bullhead
Potentially supports habitat for water voles</td></tr>
<tr><td>River Wensum</td><td>River Wensum</td><td>Gently meandering chalk river with uniform flows and extensive deposition over coarse substrates</td><td>High</td><td>Supports habitats for brown trout, brook lamprey, bullhead and water voles
Designated SAC and SSSI</td><td>High</td></tr>
</table>

Catchment	Sub-catchment	Watercourse	Physical characteristics	Sensitivity	Protected species and ecological designations	Value
	Penny Spot Beck	Penny Spot Beck	Uniform, straightened chalk stream that retains natural substrate in places	High	Supports habitats for brown trout, bullhead and water voles	High
		Unnamed (Frog's Hall)			None recorded	
	Wendling Beck	Wendling Beck	Meandering chalk river with some modifications, but good geomorphological diversity	High	Supports habitat for brown trout, bullhead and water voles Supports Dillington Carr SSSI	High
		Wendling Beck (Little Wood)				
		Wendling Beck (Bushy Common)				
		Wendling Beck (Bradenham)				
River Wissey	River Wissey	Upper Wissey	Narrow incised channel with clean gravel substrate and some geomorphological diversity	Medium	Supports habitat for water voles	Medium
		Unnamed (Lodge Farm)				

20.6.4.2 Groundwater receptors

84. The Broadland Rivers Chalk & Crag, Cam and Ely Ouse Chalk, and North Norfolk Chalk groundwater bodies are all designated as Principal Aquifers and contain a number of groundwater SPZ areas (intended to protect potable water abstractions). The Principal Aquifer which underlies the superficial deposits beneath the whole study area is deemed to be of high vulnerability. The sensitivity of groundwater receptors is therefore considered to be high.

20.6.5 Anticipated Trends in the Existing Environment

20.6.5.1 Surface waters

85. The baseline review presented in section 20.6.1 demonstrates that, although surface watercourses in the study area support large areas of high quality natural habitats, the geomorphology of many surface watercourses in the study area has been modified as a result of land drainage, flood risk management and navigation pressures. This section also demonstrates that surface water quality across the study area is predominantly good, although several watercourses are adversely affected by the supply of phosphate fertilisers and sewage effluent.

86. Ongoing initiatives by the Environment Agency and its partners to deliver the WFD and restore the River Wensum (see section 20.6.5.3 for further information) are likely to reduce the existing pressures on the geomorphology of the surface drainage network, and improve water quality. A steady improvement in the baseline condition of surface watercourses is therefore expected in the future.

87. Predicted climate changes are likely to result in wetter winters, drier summers and a greater number of convectional rain storms. This means that the hydrology of the surface drainage network could change, with higher winter flows, lower summer flows and a greater number of storm-related flood flows. This in turn could result in changes to the geomorphology of the river systems, with increased geomorphological activity (e.g. channel adjustment) occurring in response to storm events. This means that the surface drainage network is unlikely to remain stable, and when combined with the planned management changes outlined above, is likely to become more typical of the natural river types in the future.

20.6.5.2 Groundwater

88. Groundwater quality is affected by the combined pressures of intensive land use and highly permeable soils, which have resulted in substantial leaching of nitrate to groundwater. However, increased regulation of agricultural chemicals and catchment-wide initiatives to reduce pressures on groundwater to achieve compliance with the WFD suggest that baseline groundwater quality is likely to improve in the future. However, any improvements are likely to become apparent over long timescales.

89. As part of Defra’s Water Abstraction Plan (2017), the Environment Agency will review and amend all existing abstraction licenses by 2027. It is anticipated that abstraction will decrease and approximately 90% of surface water bodies and 77% of groundwater bodies will meet the required standards by 2021. Pressures on groundwater levels are therefore likely to decrease in the future.

20.6.5.3 Designated sites

90. The physical habitat characteristics of the River Wensum SAC and SSSI (section 20.6.3) could potentially be affected by the changes to the quantity and quality of surface and groundwaters described above.

91. The ongoing programme of river restoration and changes to catchment management that are being implemented by (among others) Natural England, the Environment Agency, the Norfolk Rivers Trust, the Water Level Management Alliance and local landowners are likely to result in a continued improvement of the physical habitats supported by the river. The geomorphology of the channel is likely to improve over time, as natural processes are restored within existing modified reaches. Furthermore, water quality is likely to improve as a result of a reduction in the supply of sediment, nutrients and other contaminants into the river system.

92. Further information regarding anticipated trends associated with the ecology of designated sites is provided in Chapter 22 Onshore Ecology.

20.7 Potential Impacts

93. This section details the impact assessment for the construction, operation and decommissioning phases of the project, based upon the interactions between the relevant worst case scenario assumptions for the project and embedded mitigation with regards to receptor sensitivity and value, and the magnitude of the potential effect (as detailed in section 20.4).

20.7.1 Embedded Mitigation

94. Norfolk Vanguard Limited has committed to a number of techniques and engineering designs/modifications inherent as part of the project, during the pre-application phase, in order to avoid a number of impacts or reduce impacts as far as possible. Embedding mitigation into the project design is a type of primary mitigation and is an inherent aspect of the EIA process.

95. A range of different information sources has been considered as part of embedding mitigation into the design of the project (for further details see Chapter 5 Project Description, Chapter 4 Site Selection and Assessment of Alternatives and the Consultation Report (Document reference 5.1)) including engineering requirements, and feedback from communities and landowners, ongoing discussions with

stakeholders and regulators, commercial considerations and environmental best practice.

96. The following sections outline the key embedded mitigation relevant for this assessment. These measures are presented in Table 20.13. Where embedded mitigation measures have been developed into the design of the project with specific regard to water resources and flood risk, these are described in Table 20.14. Any further mitigation measures suggested within this chapter are therefore considered to be additional.

Table 20.13 Embedded mitigation

Parameter	Mitigation measures embedded into the project design	Notes
Strategic approach to delivering Norfolk Vanguard and Norfolk Boreas	Subject to both Norfolk Vanguard and Norfolk Boreas receiving development consent and progressing to construction, onshore ducts will be installed for both projects at the same time, as part of the Norfolk Vanguard construction works. This would allow the main civil works for the cable route to be completed in one construction period and in advance of cable delivery, preventing the requirement to reopen the land in order to minimise disruption. Onshore cables would then be pulled through the pre-installed ducts in a phased approach at later stages. In accordance with the Horlock Rules, the co-location of Norfolk Vanguard and Norfolk Boreas onshore project substations will keep these developments contained within a localised area and, in so doing, will contain the extent of potential impacts.	The strategic approach to delivering Norfolk Vanguard and Norfolk Boreas has been a consideration from the outset.
Commitment to HVDC technology	Commitment to HVDC technology minimises environmental impacts through the following design considerations; • HVDC requires fewer cables than the HVAC solution. During the duct installation phase this reduces the cable route working width (for Norfolk Vanguard and Norfolk Boreas combined) to 45m from the previously identified worst case of 100m. As a result, the overall footprint of the onshore cable route required for the duct installation phase is reduced from approx. 600ha to 270ha; • The width of permanent cable easement is also reduced from 54m to 20m; • Removes the requirement for a CRS; • Reduces the maximum duration of the cable pull phase from three years down to two years; • Reduces the total number of jointing bays for Norfolk Vanguard from 450 to 150; and • Reduces the number of drills needed at trenchless crossings (including landfall).	Norfolk Vanguard Limited has reviewed consultation received and in light of the feedback, has made a number of decisions in relation to the project design. One of these decisions is to deploy HVDC technology as the export system.

Parameter	Mitigation measures embedded into the project design	Notes
Site Selection	The project has undergone an extensive site selection process which has involved incorporating environmental considerations in collaboration with the engineering design requirements. Considerations include (but are not limited to) adhering to the Horlock Rules for onshore project substations and National Grid infrastructure, a preference for the shortest route length (where practical) and developing construction methodologies to minimise potential impacts. Key design principles from the outset were followed (wherever practical) and further refined during the EIA process, including; • Avoiding proximity to residential dwellings; • Avoiding proximity to historic buildings; • Avoiding designated sites; • Minimising impacts to local residents in relation to access to services and road usage, including footpath closures; • Utilising open agricultural land, therefore reducing road carriageway works; • Minimising requirement for complex crossing arrangements, e.g. road, river and rail crossings; • Avoiding areas of important habitat, trees, ponds and agricultural ditches; • Installing cables in flat terrain maintaining a straight route where possible for ease of pulling cables through ducts; • Avoiding other services (e.g. gas pipelines) but aiming to cross at close to right angles where crossings are required; • Minimising the number of hedgerow crossings, utilising existing gaps in field boundaries; • Avoiding rendering parcels of agricultural land inaccessible; and • Utilising and upgrading existing accesses where possible to avoid impacting undisturbed ground.	Constraints mapping and sensitive site selection to avoid a number of impacts, or to reduce impacts as far as possible, is a type of primary mitigation and is an inherent aspect of the EIA process. Norfolk Vanguard Limited has reviewed consultation received to inform the site selection process (including local communities, landowners and regulators) and in response to feedback, has made a number of decisions in relation to the siting of project infrastructure. The site selection process is set out in Chapter 4 Site Selection and Assessment of Alternatives.
Duct Installation Strategy	The onshore cable duct installation strategy is proposed to be conducted in a sectionalised approach in order to minimise impacts. Construction teams would work on a short length (approximately 150m section) and once the cable ducts have been installed, the section would be back filled and the top soil replaced before moving onto the next section. This would minimise the amount of land being worked on at any one time and would also minimise the duration of works on any given section of the route.	This has been a project commitment from the outset in response to lessons learnt on other similar NSIPs. Chapter 5 Project Description provides a detailed description of the process.
Long HDD at landfall	Use of long HDD at landfall to avoid restrictions or	Norfolk Vanguard Limited

Parameter	Mitigation measures embedded into the project design	Notes
	closures to Happisburgh beach and retain open access to the beach during construction. Norfolk Vanguard Limited have also agreed to not use the beach car park at Happisburgh South.	has reviewed consultation received and in response to feedback, has made a number of decisions in relation to the project design. One of those decisions is to use long HDD at landfall.
Trenchless Crossings	Commitment to trenchless crossing techniques to minimise impacts to the following specific features; • Wendling Carr County Wildlife Site; • Little Wood County Wildlife Site; • Land South of Dillington Carr County Wildlife Site; • Kerdiston proposed County Wildlife Site; • Marriott's Way County Wildlife Site / Public Right of Way (PRoW); • Paston Way and Knapton Cutting County Wildlife Site; • Norfolk Coast Path; • Witton Hall Plantation along Old Hall Road; • King's Beck; • River Wensum; • River Bure; • Wendling Beck; • Wendling Carr; • North Walsham and Dilham Canal; • Network Rail line at North Walsham that runs from Norwich to Cromer; • Mid-Norfolk Railway line at Dereham that runs from Wymondham to North Elmham; and • Trunk Roads including A47, A140, A149.	A commitment to a number of trenchless crossings at certain sensitive locations was identified at the outset. However, Norfolk Vanguard Limited has committed to certain additional trenchless crossings as a direct response to stakeholder requests.

Table 20.14 Embedded mitigation for water resources and flood risk

Parameter	Mitigation measures embedded for water resources and flood risk	Notes
Sediment management	The area of open ground at any one time within one sub-catchment will be restricted, across a notional 5 km length, to 2 working areas (configured as 45m x 300m strips), 50% of one mobilisation area, 50% of one set of trenchless crossing compounds and 25% of 5km running track. Topsoil would be stripped from the entire width of the onshore cable route for the length of the workfront (150m), and stored and capped to minimise wind and water erosion. Once all the trenching is completed and back-filled, the stored topsoil will be re-distributed over the area of the workfront, with the exception of the running track and any associated drainage.	n/a

Parameter	Mitigation measures embedded for water resources and flood risk	Notes
	Temporary works areas (e.g. mobilisation areas and trenchless crossing areas) within the onshore project area will comprise hardstanding of permeable gravel aggregate underlain by geotextile, or other suitable material to a minimum of 50% of the total area to minimise the area of open ground.	
Watercourse crossings	Trenchless crossing techniques will be employed at the following major watercourses: River Wensum, River Bure, King's Beck, Wendling Beck (two crossing points), and the North Walsham and Dilham Canal. Stop ends would be employed on the running track at each of the trenchless crossing points outlined above, with the exception of the crossing of Wendling Beck at Bushy Common. Reinstatement of the channel would achieve the pre-construction depth of the watercourse, and the dams removed. The width of the running track at watercourse crossings will be minimised from 6m to 3m to limit the area of direct disturbance.	n/a
Surface drainage	Changes in surface water runoff as a result of the increase in impermeable area from the substation will be attenuated and discharged at a controlled rate, in consultation with the LLFA and Environment Agency. The controlled runoff rate will be equivalent to the greenfield runoff rate. An attenuation pond with a volume of 4,050m^3 (approximate dimensions of 58m x 58m x 1.2m) has been allowed for at the onshore project substation to provide sufficient attenuation to greenfield runoff rates into the closest watercourse or sewer connection. The full specification for the attenuation pond will be addressed as part of detailed design. Allowance for increased attenuation of surface water drainage (an extension to the existing pond or a new pond in proximity to the existing pond) at the Necton National Grid substation has also been included to accommodate additional impermeable ground associated with the National Grid substation extension for Norfolk Vanguard. During construction, the onshore cable route will be bounded by drainage channels (one on each side) to intercept drainage from within the working corridor. Additional drainage channels will be installed to intercept water from the cable trench. Depending upon the precise location, water from the channels will be infiltrated or discharged into the surface drainage network.	n/a
Foul drainage	During the construction phase, foul drainage at the onshore project substation and mobilisation areas will be collected through a mains connection to existing local authority sewer system (if available) or septic tanks located within the development boundary. Foul drainage from welfare facilities along the cable route will be collected in septic tanks and taken off site for disposal at a licensed site. During operation, foul drainage at the onshore project substation	n/a

Parameter	Mitigation measures embedded for water resources and flood risk	Notes
	will be collected through a mains connection to the existing local authority sewer system (if a suitable connection is available) or collected in a septic tank located within the development boundary and transported off site for disposal at a licensed facility.	

20.7.2 Worst Case

97. This section establishes the WCS for each key impact category, forming the basis for the subsequent impact assessment. For this assessment, this involves a consideration of the construction scenarios (i.e. the manner in which the project will be undertaken), as well as the particular design parameters (such as the maximum construction footprint at the landfall) that define the Rochdale Envelope.

98. Full details of the range of project options being considered are provided within Chapter 5 Project Description, including a detailed description of the embedded project mitigation. For the purpose of the water resources and flood risk chapter, only those design parameters with the potential to influence the level of impact to such receptors are identified. Therefore, if the design parameter is not described below, it is not considered to have a material bearing on the outcome of this assessment.

99. The realistic WCS identified in this section, as detailed in Table 20.15, are also applied to the CIA. When the WCS for the project in isolation does not result in the worst case for cumulative impacts, this is addressed within the cumulative impacts section of this chapter.

Table 20.15 Worst case assumptions

Worst case assumptions			
Parameter	Worst case criteria	Worst case definition	Notes
Landfall			
HDD compounds	Maximum number and maximum land take for temporary HDD compounds	Assumes 2 at 3,000m^2 each to support parallel drilling rigs	
Onshore cable route			
Construction	Construction method Maximum working width Trench depth Trench width Depth of cover above ducts	Use of open cut trenching along the majority of the route 45m 1.5m 1m Minimum 1.05m to top of duct	Where open cut trenching is employed at watercourses, the working width will be reduced to the running track and cable trenching areas only (20m) with soil storage areas retained immediately before and after the feature crossing. Trench depth and width

Worst case assumptions			
Parameter	Worst case criteria	Worst case definition	Notes
	Cable installation maximum footprint Onshore cable route maximum footprint Maximum area of disturbed ground within a catchment	447,688m^2 2,700,000m^2 Maximum working area (workfront) for one team will be 0.014km^2 (45m x 300m) Assuming a maximum of two workfronts, one mobilisation area, one set of trenchless crossing compounds and 5km of running track per 5km of cable, the maximum area of disturbed ground would be 0.068 km^2 per 5km of cable. Assumes a maximum of 75% of the running track and 50% of each mobilisation area and trenchless crossing compound will be covered with aggregate.	are indicative depending on ground conditions.
Permanent joint pits	Maximum number and required dimensions	Assume 150 at 90m^2 and 2m deep each	Norfolk Vanguard only, spaced approximately one per circuit per 800m cable.
Mobilisation areas	Maximum number and required dimensions	Assumes 14 at 10,000m^2	
Trenchless launch and reception sites	Maximum number and maximum land take for trenchless launch and reception sites	Assumes 17 pairs at 7,500m^2 and 5,000m^2 respectively	
Trenchless crossings	Locations required	Trenchless crossing of main watercourses: North Walsham & Dilham Canal, King's Beck, River Bure, Wendling Beck (downstream), Wendling Beck (upstream) and River Wensum.	With the exception of the Wendling Beck at Bushy Common, these watercourses will not be crossed by the running track.
Trenched watercourse crossings	Type of crossing	Where watercourses are shallower than 1.5m, temporary damming and diverting of the watercourse may be employed. Where watercourses are	All watercourses not specifically noted as being crossed using a trenchless technique will be crossed via trenched methods. Culverts will be used to allow the running track

Worst case assumptions			
Parameter	Worst case criteria	Worst case definition	Notes
		1.5m or deeper, culverting may be employed.	to cross all watercourses at trenched crossing points.
Decommissioning		To be determined but likely to result in joint pits and ducts left in situ	Where cables are in pre-installed ducts, cables may be extracted once de-energised.
Onshore project substation			
Construction	Maximum land take for temporary works area	20,000m^2 (200m x 100m) Assumes piling as part of construction of foundations	Norfolk Vanguard only.
Operation	Maximum land take for permanent footprint	75,000m^2	Norfolk Vanguard only.
Decommissioning	No decision has been made regarding the final decommissioning policy for the onshore project substation, as it is recognised that industry best practice, rules and legislation change over time. However, the onshore project equipment will likely be removed and reused or recycled. The detail and scope of the decommissioning works will be determined by the relevant legislation and guidance at the time of decommissioning and agreed with the regulator. A decommissioning plan will be provided. As such, for the purposes of a worst case scenario, decommissioning impacts are assumed to be no worse than construction impacts.		
National Grid substation extension and overhead line modification			
Construction	Maximum land take for temporary works area – substation extension Maximum land take for temporary works area – overhead line Maximum duration	67,500m^2 174,264m^2 30 months Assumes piling as part of construction of foundations	Indicative construction timing 24 months.
Operation	Maximum land take for substation extension permanent footprint Maximum land take for overhead line permanent footprint	49,300m^2 9,250m^2	Includes existing Necton National Grid substation area

20.7.3 Monitoring

100. The development of the detailed design and CoCP (DCO requirement 20) will refine the worst-case impacts assessed in this EIA. It is recognised that monitoring is an important element in the management and verification of the actual project

impacts. The requirement for and appropriate design and scope of monitoring will be agreed with the appropriate stakeholders and included within the CoCP (DCO requirement 20) and the Construction Method Statement (CMS) commitments prior to construction works commencing.

20.7.4 Assessment Scenarios

101. Chapter 5 Project Description outlines the scenarios to be assessed in relation to the phasing of the works. The phasing of the construction works is as follows:

- The offshore project may be constructed as one or two phases and elements of the onshore construction would also be phased to reflect this;
- Pre-construction works (e.g. hedgerow clearance) for the onshore cable route to be conducted over a two year period, prior to duct installation;
- Cable ducts would be installed in one operation over two years, regardless of the offshore strategy;
- Cable pull through would be done in either one or two phases;
- The onshore project substation ground preparation and enabling works would be done in one phase, anticipated to take two years for pre-construction works and two years for primary works;
- The required electrical infrastructure and plant within the onshore project substation would then be installed as required for each phase if the one or two phase options were adopted for offshore construction; and
- Total construction window for the one phase scenario is anticipated to be five years, and six years for the two phase scenario.

102. The alternative cable pull phasing options for the project (over one or two years) are not considered separately in this impact assessment. The construction methodology means that the area of ground disturbed at any one time will be minimised to within a constrained working area at any given time. Any differences in the phasing of works will not significantly affect the potential for impact, provided that this methodology is followed.

20.7.5 Potential Impacts during Construction

103. The following impacts consider all elements of the onshore cable route, onshore project substation, landfall and National Grid substation extension including overhead line modifications. The assessed mechanisms for impact (e.g. increased surface water runoff and flood risk) will not significantly differ in effect or magnitude in response to variations in the specific layout or positioning of components in each part of the project.

20.7.5.1 Impact 1: Direct disturbance of surface water bodies

20.7.5.1.1 Description of impacts

104. The onshore cable route will need to cross a number of surface watercourses, and therefore has the potential to impact upon the geomorphology, hydrology and physical habitats of these receptors. Table 20.16 provides a summary of the crossing methodologies proposed for each watercourse along the cable route. A detailed breakdown of the proposed crossing techniques for each watercourse, including location, crossing method, watercourse type, catchment and sub-catchment is provided in Appendix 20.4. A final scheme for crossing all watercourses will be approved in advance of construction, which will include a programme and methods for all watercourse crossings. This is secured through DCO Requirement 25.

105. Trenchless crossing techniques (e.g. HDD) have been embedded within the scheme design to avoid impacts on the larger and most sensitive watercourses, including the main channels of the River Wensum, River Bure, King's Beck, Wendling Beck (two crossings) and the North Walsham and Dilham Canal (section 20.7.1). The cable will be installed at least 2m beneath the watercourse using a technique such as HDD, micro-tunnelling or auger boring (Chapter 5 Project Description). Although these techniques will cause some surface disturbance at the entry and exit points, there will be no direct disturbance of the surface watercourses. Furthermore, the running track will not cross any of the watercourses that will be crossed by trenchless techniques, with the exception of Wendling Beck at Bushy Common. There are therefore no direct mechanisms to impact upon the geomorphology, hydrology and physical habitats of surface watercourses associated with trenchless techniques, and no further mitigation is proposed at trenchless crossing locations.

106. Although trenchless crossing techniques will be used for the larger and most sensitive watercourse crossings, open trench techniques will be used for the majority of crossings of smaller watercourses. Two potential trenched crossing techniques have been identified, depending upon the dimensions of the watercourse:

- Temporary dam and divert: For watercourses that are shallower than 1.5m, temporary dams (composed of either sand bags or straw bales and ditching clay) will be installed upstream and downstream of the cable crossing to allow works to be undertaken in dry conditions. A pump, temporary flume or bypass channel will be used to maintain flows downstream of the dams. Temporary culverts or bridges (with a width of up to 3m) may be required to allow the running track to cross the watercourse at these trenched crossing locations. Depending upon the location, it may be necessary for these to remain in place for up to 2 years during the duct installation works, with the potential for a further period during cable pulling; and

- Permanent culvert to allow the cable ducting to cross watercourses: For watercourses that are 1.5m or deeper, it may be possible to use the approach outlined above, however in some cases it may be necessary to install a pipe or box culvert.

107. In addition, temporary culverts will be required to allow the running track to cross surface watercourses. These will be used at the majority of crossing locations, including Wendling Beck at Bushy Common but excluding all other watercourses crossed using trenchless techniques.

108. The installation of cable trenches will directly disturb the bed and banks of the watercourse. This could potentially result in the direct loss of natural geomorphological features (and associated physical habitat niches) and geomorphological instability (e.g. due to enhanced scour and increased sediment supply). However, this would be a temporary impact provided that the bed and banks are reinstated to their original level, position, planform and profile. Note that subsequent cable pulling through the pre-installed ducting will not result in any further disturbance.

109. The presence of temporary dams and culverts (used for the running track) could potentially result in reduced flow and sediment conveyance (particularly of coarse sediment), create upstream impoundment, affect patterns of erosion and sedimentation, impede river continuity, increase turbidity and potentially encourage fine sedimentation on the bed upstream. Changes to flow conditions could also result in a reduction in the dissolved oxygen concentrations supported in the watercourses upstream of the impoundment. These activities could therefore reduce the physical habitat value of the watercourse for species such as brown trout, bullhead and brook lamprey. The temporary dams could also act as a barrier to the movement of fish and other aquatic organisms. However, these impacts are considered to be temporary (i.e. confined to the duration of construction) and would be reversed once the temporary impounding structures were removed.

110. However, the presence of permanent culverts installed to allow the cable ducting to cross watercourses could result in the same suite of impacts on a permanent and irreversible basis.

Table 20.16 Watercourse crossings in surface water catchments

Catchment	Sub-catchment	Watercourse	Sensitivity	Value	Number of crossings	
					Open cut	Trenchless
River Bure	New Cut	New Cut	Low	High	0	0
		Subtotal			**0**	**0**
	East Ruston Stream	Hundred Stream	High	High	2	0
				Subtotal	**2**	**0**
	North Walsham & Dilham Canal	North Walsham & Dilham Canal	Low	Low	0	4
		Unnamed (Brick Kiln Farm)	Low	Low	1	0
		Unnamed (Grammar School Farm)	Low	Low	1	0
				Subtotal	**2**	**4**
	King's Beck	Unnamed (Cooke's Bottoms)	Medium	High	1	0
		Suffield Beck	Medium	High	1	0
		Blackwater Beck	Medium	High	0	5
		Unnamed (Colby Hall)	Medium	High	2	0
				Subtotal	**4**	**5**
	River Bure	River Bure	Medium	High	0	2
		Unnamed (Silvergate)	Medium	High	5	0
				Subtotal	**5**	**2**

Catchment	Sub-catchment	Watercourse	Sensitivity	Value	Number of crossings	
					Open cut	Trenchless
	Mermaid Stream	The Mermaid	Medium	High	0	0
				Subtotal	**0**	**0**
				Total	**13**	**11**
River Wensum	Blackwater	Unnamed (Southgate)	High	High	1	0
		Booton Watercourse	High	High	2	0
		Unnamed (Bath Plantation)	High	High	2	0
		Reepham Stream (east branch)	High	High	1	0
		Unnamed (Kerdiston)	High	High	0	1
		Reepham Stream (west branch)	High	High	1	0
		Unnamed (Jordan Green)	High	High	1	0
		Unnamed (Sparham House)	High	High	2	0
				Subtotal	**10**	**1**
	River Wensum	River Wensum	High	High	0	3
				Subtotal	**0**	**3**
	Penny Spot Beck	Penny Spot Beck	High	High	1	2
		Unnamed (Frog's Hall)	High	High	4	0

Catchment	Sub-catchment	Watercourse	Sensitivity	Value	Number of crossings	
					Open cut	Trenchless
				Subtotal	**5**	**2**
	Wendling Beck	Wendling Beck	High	High	0	2
		Unnamed (Little Wood)	High	High	1	1
		Unnamed (Bushy Common)	High	High	1	0
		Wendling Beck (Bradenham)	High	High	3	0
				Subtotal	**5**	**3**
				Total	**20**	**9**
River Wissey	River Wissey	Upper Wissey	Medium	Medium	1	0
		Unnamed (Lodge Farm)	Medium	Medium	3	0
				Subtotal	**4**	**0**
				Total	**4**	**0**

20.7.5.1.2 Receptor i. River Bure catchment

Impacts prior to mitigation

111. There are six main sub-catchments in the River Bure catchment that could be impacted by watercourse crossings:

- The New Cut has been assigned a low sensitivity and high value;
- The East Ruston Stream has been assigned a high sensitivity and high value;
- The North Walsham and Dilham Canal has been assigned a low value and sensitivity; and
- The main River Bure, King's Beck and the Mermaid Stream have been assigned a medium sensitivity and high value.

112. In the East Ruston Stream sub-catchment, the East Ruston Stream (Crossing ID 10(3)(1)) and an IDB drain (Crossing ID 10(3)(2)) will both be crossed using trenched methods. The presence of a single crossing on each watercourse means that the impact would be of low magnitude, resulting in an impact of **moderate adverse** significance on the East Ruston Stream sub-catchment.

113. Trenchless crossing methods will be used to cross the main channel of the North Walsham and Dilham Canal (Crossing ID 23(11)(7)), the IDB drain (Crossing ID 23(11)(1)) and two ordinary watercourses adjacent to it (Crossing ID 23(11)(5) and 23(11)(11)). As described above, the use of a trenchless technique to cross these watercourses will avoid any direct disturbance. As such, this watercourse crossing technique is assessed to have a negligible magnitude of effect and would result in an overall impact of **negligible** significance for the North Walsham and Dilham Canal.

114. Two unnamed watercourses in the North Walsham and Dilham Canal sub-catchment, at Brick Kiln Farm (Crossing ID 26(1)(1)) and Grammar School Farm (Crossing ID 27(4)(3)) will be crossed using trenched methods and by the running track. The presence of a single crossing on each watercourse represents an effect of low magnitude, resulting in an impact of **minor adverse** significance on the North Walsham and Dilham Canal sub-catchment.

115. The main River Bure (Crossing ID 46(7)(4)) and adjacent ordinary watercourse (Crossing ID 46(7)(1)) will be crossed using a trenchless method. Four unnamed tributaries within the same sub-catchment (Crossing ID 51(11)(4), 51(11)(8), 51(11)(9), and 51(11)(10)) and an IDB drain (Crossing ID 51(11)(7)) near Silvergate will be crossed using a trenched technique. The use of a trenchless technique for the larger watercourses and trenched technique for multiple minor watercourses represents an effect of medium magnitude, resulting in a **major adverse** impact.

116. The King's Beck sub-catchment comprises trenchless crossings of the Blackwater Beck IDB Drain (Crossing ID 37(11)(9) and four connected ordinary watercourses

(Crossing ID 37(11)(1), 37(11)(4), 37(11)(7), and 37(11)(11)). However, several tributaries of the King's Beck will be crossed using trenched techniques; one at Suffield Beck IDB drain (Crossing ID 34(2)(2)), one on the unnamed ordinary watercourse near Cooke's Bottoms (Crossing ID 32(3)(3)) and two on the unnamed ordinary watercourses near Colby Hall (Crossing ID 40(6)(1) and 40(6)(3)). These crossings represent an effect of medium magnitude, and a **major adverse** impact.

117. There are no crossings of the New Cut or Mermaid Stream, and therefore no mechanism for impact on these watercourses.

Additional mitigation measures

118. In addition to the embedded measures described in section 20.7.1, the following additional measures would be applied to reduce the impacts associated with watercourse crossings in the River Bure catchment:

- The specific dam and divert method for larger watercourses will be agreed at detailed design with internal drainage boards and flood management agencies, as part of the relevant secondary consent processes;
- In order to ensure that there are no adverse impacts resulting from the installation of temporary dams, the following measures would be employed:
    - Restricting the amount of time that temporary dams are in place, e.g. typically no more than one week;
    - Fish rescue should be undertaken in the area between the temporary dams prior to dewatering;
    - Ensuring that any pumps, flumes (pipes) or diversion channels are appropriately sized to maintain flows downstream of the obstruction whilst minimising upstream impoundment;
    - Where appropriate, selecting a technique that can allow fish passage to be maintained in watercourses which support migratory fish species such as brown trout; and
    - Where diversion channels are used, geotextiles or similar techniques will be used to line the channel and prevent sediment entering the watercourse.
- Potential impacts resulting from the use of culverts at watercourse crossings would be mitigated through:
    - Ensuring that the culvert is adequately sized to avoid impounding flows (including an allowance for potential increases in winter flows as a result of projected climate change); and
    - Installing the culvert below the active bed of the channel, so that sediment continuity and movement of fish and aquatic invertebrates can be maintained.

- In addition to the general measures to mitigate the impacts of culverts noted above, in the case of temporary culverts for the running track, alternative techniques such as temporary bridges will be considered where appropriate (e.g. where culvert installation is likely to have an impact on channel morphology and ecology);
- Cable ducts would typically be installed 2m below the bed of the watercourse, allowing the necessary water volumes and flows (sufficient to account for climate-related changes in fluvial flows and erosion). This would be dependent upon local geology and geomorphological risks (e.g. bed scour and channel instability) and avoid exposure during periods of higher energy flow where the bed could be mobilised; and
- Where possible, localised improvements to the geomorphology and in-channel habitats will be considered where they are crossed using open cut techniques. This will include sympathetic reinstatement of banks (e.g. by replacing re-sectioned banks with more natural profiles that are typical of the natural geomorphology of the watercourse). Note that any improvements would be restricted to within the working area of the project.

Impacts following mitigation

119. Following the implementation of these additional mitigation measures, the potential for impacts associated with watercourse crossings would be reduced. The magnitude of effect would reduce to negligible in the North Walsham and Dilham Canal and East Ruston Stream sub-catchments, and low magnitude in the River Bure and King’s Beck sub-catchments.

120. The high value and sensitivity of the East Ruston Stream sub-catchment, with a negligible magnitude of effect, would result in an impact of **minor adverse** significance.

121. The low value and sensitivity of the North Walsham and Dilham Canal sub-catchment, with a negligible magnitude of effect, would result in a **negligible** impact.

122. The high value and medium sensitivity of the watercourses within the River Bure sub-catchment and a low magnitude of effect would result in an impact of **moderate adverse** significance.

123. The high value and medium sensitivity of the watercourses within the King’s Beck sub-catchment and a low magnitude of effect would result in a **moderate adverse** impact.

124. There will be **no impact** on the New Cut or Mermaid Stream.

125. It is important to note that this assessment is based on the cumulative effect of multiple crossings within each sub-catchment, rather than the impacts associated

with any single crossing, i.e. the magnitude of effect is larger in those sub-catchments with a larger number of crossings. Furthermore, this assessment is based on the worst case assumption that it will be necessary to install permanent culverts at a proportion of the trenched watercourse crossings in each sub-catchment (where the channel dimensions introduce this as an alternative trenched crossing option to dam and divert). However, every effort will be made to avoid the use of permanent culverts and use the alternative dam and divert crossing technique. Whilst the worst case of permanent culverts are considered to result in some significant impacts, as identified above, where permanent culverts can be avoided any changes occur as a result of temporary crossings (to maintain the running track during construction only) will be temporary and reversible and, with the mitigation identified above, would not result in significant residual impacts.

20.7.5.1.3 Receptor ii. River Wensum catchment

Impacts prior to mitigation

126. There are four sub-catchments in the part of the River Wensum catchment that would be crossed by the onshore cable route; the main River Wensum, the Blackwater Drain, Wendling Beck and Penny Spot Beck. Each sub-catchment has been assigned a high value and high sensitivity (section 20.7.4).

127. The main River Wensum (Crossing ID 82(7)(6)), and two adjacent IDB drains (Crossing ID 82(7)(3) and 83(7)(3)) will be crossed using a trenchless technique. This is likely to result in a negligible magnitude of effect, and a **minor adverse** impact due to the high value and high sensitivity of the watercourses.

128. The Blackwater Drain covers a large catchment, with several significant tributaries (including the Booton Watercourse and the east and west branches of the Reepham Stream). There will be a single trenchless crossing near Kerdiston (Crossing ID 70(3)(3)), and ten trenched crossings across the sub-catchment, including a trenched crossing of the main river at Sparham House (Crossing ID 58(2)(1), 61(8)(3), 61(8)(4), 64(2)(1), 64(2)(2), 68(3)(1), 71(4)(2), 75(2)(1), 76(4)(2) and 76(4)(4)). Due to the number of trenched crossings in the catchment, the magnitude of effect is considered to be high, which is likely to result in a **major adverse** impact due to the high value and high sensitivity of the watercourse.

129. The main channel of the Wendling Beck will be crossed twice using a trenchless technique (Crossing ID 98(7)(6) and 105(3)(1)), as well as the unnamed ordinary watercourse near Little Wood (Crossing ID 100(3)(1)). There will also be five crossings of unnamed tributaries of the Wendling Beck using an alternative trenched technique (Crossing ID 99(3)(1), 104(1)(1), 109(1)(1), 110(1)(1), and 114(2)(1)). The use of a trenchless technique for the larger watercourses, a culvert for the running track on the main river at Bushy Common, and a trenched technique for the smaller

watercourses will result in a medium magnitude of effect, resulting in a **major adverse** impact.

130. The Penny Spot Beck will be crossed at two locations with a trenchless technique (once on the main channel and a second on a tributary that drains into it; Crossing ID 84(4)(1) and Crossing ID 83(7)(5)), and one location with a trenched technique (Crossing ID 86(2)(1)). The headwaters of a small watercourse near Frog's Hall (Crossing ID 87(3)(1), 87(3)(3), 89(3)(2), and 90(7)(6)), which drains into the beck, will be crossed four times using a trenched technique. The use of a trenchless technique for the larger watercourses and a trenched technique for the minor watercourses will result in a medium magnitude of effect, representing a **major adverse** impact due to the high value and high sensitivity of the watercourse.

Additional mitigation measures

131. In addition to the embedded measures described in section 20.7.1, the additional measures described in section 20.7.5.1.2 would also be applied to reduce the impacts associated with watercourse crossings in the River Wensum catchment.

Impacts following mitigation

132. Following the implementation of these additional mitigation measures, the magnitude of effect associated with watercourse crossings would be reduced to low magnitude in the Penny Spot Beck, Blackwater Drain and Wendling Beck sub-catchments. Impacts within the main River Wensum sub-catchment will remain negligible as these watercourses will all be crossed using trenchless techniques.

133. The high value and high sensitivity of the watercourses within the Blackwater Drain sub-catchment and a low magnitude of effect represents an impact of **moderate adverse** significance.

134. The high value and high sensitivity of the watercourses within the Wendling Beck sub-catchment and a low magnitude of effect represents an impact of **moderate adverse** significance.

135. The high value and high sensitivity of the watercourses within the Penny Spot Beck sub-catchment and a negligible magnitude of effect represent an impact of **minor adverse** significance.

136. The high value and high sensitivity of the watercourses within the River Wensum sub-catchment and a negligible magnitude of effect represent an impact of **minor adverse** significance.

137. It is important to note that this assessment is based on the cumulative effect of multiple crossings within each sub-catchment, rather than the impacts associated with any single crossing, i.e. the magnitude of effect is larger in those sub-catchments with a larger number of crossings. Furthermore, this assessment is

based on the worst case assumption that it will be necessary to install permanent culverts at a proportion of the trenched watercourse crossings in each sub-catchment (where the channel dimensions introduce this as an alternative trenched crossing option to dam and divert). However, every effort will be made to avoid the use of permanent culverts and use the alternative dam and divert crossing technique. Whilst the worst case of permanent culverts are considered to result in some significant impacts, as identified above, where permanent culverts can be avoided and any changes occur as a result of temporary crossings (to maintain the running track during construction only) will be temporary and reversible and, with the mitigation identified above, would not result in significant residual impacts.

20.7.5.1.4 Receptor iii. River Wissey catchment

Impacts prior to mitigation

138. The onshore cable route is located within part of the upper River Wissey catchment, with activities confined to a single sub-catchment. This water body is assessed to be of medium sensitivity and medium value (section 20.7.4).

139. There will be three trenched crossings of an unnamed ordinary watercourse near Lodge Farm (Crossing ID 117(1)(1), 118(4)(1), and 118(4)(3)) and a single crossing of the Upper Wissey ordinary watercourse (Crossing ID 119(2)(1)). This activity represents an effect of medium magnitude, resulting in a **moderate adverse** impact.

Additional mitigation measures

140. In addition to the embedded measures described in section 20.7.1, the additional measures described in section 20.7.5.1.2 would also be applied to reduce the impacts associated with watercourse crossings in the River Wissey catchment.

Impacts following mitigation

141. Following the implementation of these additional mitigation measures, watercourse crossings would be reduced to a negligible magnitude of effect.

142. The medium value and medium sensitivity of the River Wissey, with a negligible magnitude of effect, represents an overall **minor adverse** impact.

20.7.5.2 Impact 2: Increased sediment supply

20.7.5.2.1 Description of impacts

143. Construction activities in the onshore project area (including excavation along the cable route and substation sites) will involve extensive earthworks and create areas of bare ground by removing surface vegetation cover. This could increase the potential for the erosion of soil particulates, resulting in an increase in the supply of fine sediment (e.g. clays, silts and fine sands) to surface watercourses through surface runoff and the erosion of exposed soils.

144. Increased sediment supply could affect the geomorphology of the watercourse by increasing turbidity in the water column and encouraging enhanced deposition of fine sediment on the bed of the channel. Furthermore, increased sediment loads could potentially smother existing bed habitats, reduce light penetration and reduce dissolved oxygen concentration, adversely affecting stream biota (e.g. macrophytes, aquatic invertebrates and fish such as brown trout, bullhead and brook lamprey) and adversely affecting the quality of in-channel habitats.

145. Any impacts of increased sediment supply would be particularly pronounced in chalk river catchments (such as the River Wensum and its tributaries), which naturally have low suspended sediment loads and coarse bed substrates (i.e. gravels and cobbles) with a low proportion of fine sediment. Species such as brown trout, bullhead, spawning adult brook lamprey require these “clean” substrates and as such in-channel habitats for these species could become degraded as a result of increased sediment supply. Note that further discussion on the potential impacts of the development on aquatic ecology is provided in Chapter 22 Onshore Ecology.

146. Site preparation, ground excavations and other construction activities which have the potential to increase sediment supply will take place across the onshore project area. The scale of the potential impact upon a sub-catchment is likely to be proportional to the area of each catchment that would be disturbed during construction.

147. The maximum total area that could potentially be disturbed in each catchment during the entire 2-year duct installation and primary works construction is summarised in Table 20.17. However, as highlighted in Table 20.14 and Table 20.15, it is important to note that each active working area at any one time will be restricted in spatial extent (0.014km^2) and duration (2 weeks). The worst case assumption is that, in a given 5km stretch of cable route, open ground will be restricted to a maximum of two workfronts (0.028km^2), one mobilisation area (no more than 50% open ground), one set of trenchless crossings (no more than 50% open ground) and 5km of running track (no more than 25% open ground). These areas have been scaled according to the length of cable route in each sub-catchment, and the results are shown in Table 20.17. Note that, where a sub-catchment contains less than 5km cable route, it is assumed that two workfronts, one mobilisation area and one set of trenchless crossings would still be worked on concurrently as a worst case (i.e. these elements have a fixed area and cannot be sub-divided).

148. Although in most cases the total working area at a single point in time could be considerably less (because it is unlikely that a large number of teams will be working in the same sub-catchment at the same time), these values have been included as a worst case scenario on which to base this assessment (section 20.7.2).

Table 20.17 Area of disturbed ground in surface water catchments

Catchment	Sub-catchment	Sensitivity	Value	Maximum total area of disturbed ground km^2	%	Maximum working area at any one time km^2	%
River Bure	New Cut	Low	High	0.19	0.93	0.08	0.24
	East Ruston Stream	High	High	0.32	1.26	0.07	0.32
	North Walsham & Dilham Canal	Low	Low	0.42	0.78	0.05	0.12
	King's Beck	Medium	High	0.37	0.52	0.08	0.11
	River Bure	Medium	High	0.39	1.03	0.08	0.22
	Mermaid Stream	Medium	High	0.12	0.57	0.05	0.23
			Total	**1.80**	**0.79**	-	-
River Wensum	Blackwater	High	High	0.71	1.09	0.16	0.24
	River Wensum	High	High	0.47	0.25	0.10	0.05
	Wendling Beck	High	High	0.87	1.10	0.17	0.22
			Total	**2.05**	**0.61**	-	-
River Wissey	River Wissey	Medium	Medium	0.77	0.87	0.06	0.06
			Total	**0.77**	**0.87**	-	-

20.7.5.2.2 Receptor i. River Bure catchment

Impacts prior to mitigation

149. The onshore project area will disturb a worst case maximum of 1.83km^2 (0.80%) of the River Bure catchment in total during the 2 year construction programme. This equates to 0.32km^2 (1.26%) in the East Ruston Stream sub-catchment, 0.42km^2 (0.78%) in the North Walsham and Dilham Canal sub-catchment, 0.19km^2 (0.93%) of the New Cut sub-catchment, 0.37km^2 (0.52%) in the King's Beck sub-catchment, 0.39km^2 (1.03%) of the River Bure sub-catchment, and 0.12km^2 (0.57%) in the Mermaid Stream sub-catchment.

150. However, the development will include a range of embedded mitigation measures to reduce the potential for an increase in the supply of fine sediment, including minimising the area of open ground, storing and reinstating topsoil and using hardstanding in mobilisation areas (section 20.7.1). This means that the working area will be restricted in each catchment at any one time (Table 20.17). Based on the assumptions set out above, this equates to 0.32% of the East Ruston Stream sub-catchment, 0.12% of the North Walsham and Dilham Canal sub-catchment, 0.24% of the New Cut sub-catchment, 0.11% of the King's Beck sub-catchment, 0.22% of the River Bure sub-catchment, and 0.23% of the Mermaid Stream sub-catchment.

151. As discussed in section 20.7.4, the East Ruston Stream has a high sensitivity and high value, and the North Walsham and Dilham Canal has a low sensitivity and low value. The New Cut has a high sensitivity and low value. The main River Bure, King's Beck and the Mermaid Stream sub-catchments have all been assigned a medium sensitivity and high value (section 20.7.4).

152. Based on the proportion of the catchment affected (with embedded measures to minimise the working area in place), the overall magnitude of effect is assessed to be low for the East Ruston Stream and River Bure, and negligible for the North Walsham and Dilham Canal, New Cut, King's Beck and the Mermaid Stream sub-catchments. This will result in an overall impact of **moderate adverse** significance for the East Ruston Stream and River Bure sub-catchments, an overall impact of **minor adverse** significance for the New Cut, King's Beck and the Mermaid Stream sub-catchments and **negligible** significance for the North Walsham and Dilham Canal sub-catchment. It is important to note that this will be a short term impact, limited to the duct installation period (works will be undertaken in 150m sections, and the time from topsoil strip to reinstatement would typically be a maximum of two weeks in each 150m section), and reversible once activities have been completed.

Additional mitigation measures

153. The following mitigation measures will be put in place to prevent the release of sediment into the watercourses within the River Bure catchment:

- A Construction Method Statement (CMS) will be developed for the construction activities and will adhere to construction industry good practice guidance as detailed in the Environment Agency's Pollution Prevention Guidance (PPG) notes (including PPG01, PPG05, PPG08 and PPG21) (now revoked as regulatory guidance in England, but still provides a useful guide for best practice measures), and CIRIA's 'Control of water pollution from construction sites – A guide to good practice' (2001). Specific measures to control sediment supply that will be captured within the CMS include:
    - Subsoil exposure will be minimised and strips of undisturbed vegetation will be retained on the edge of the working area where possible;
    - On-site retention of sediment will be maximised by routing all drainage through the site drainage system;
    - The drainage system will include silt fences at the foot of soil storage areas to intercept sediment runoff at source. Where practicable, runoff will be routed into swales, which incorporate check dams to further intercept sediment and/or attenuation ponds which incorporate sediment forebays. Suitable filters will be used to remove sediment from any water discharged into the surface drainage network;
    - Additional silt fences will be included in parts of the working area that are in close proximity to surface drainage channels; and
    - Soil and sediment will not be allowed to accumulate on roads. Traffic movement would be restricted to minimise the potential for surface disturbance.

- Buffer strips will be retained adjacent to watercourses where possible. Where surface vegetation has been removed, it will be reseeded to prevent future runoff (excluding arable crops).
- A Surface Water and Drainage Plan (SWDP) (DCO requirement 20) will also be developed and implemented to minimise water within the cable trench and ensure ongoing drainage of surrounding land. Where water enters the trenches during installation, this will be pumped via settling tanks, sediment basins or mobile treatment facilities to remove sediment, before being discharged into local ditches or drains via temporary interceptor drains in order to prevent increases in fine sediment supply to the watercourses.

Impacts following mitigation

154. Additional mitigation measures will reduce sediment supply from the working area and are an important and integral part of best practice construction methodology to help ensure that sediment supply is not increased. However, because the assessment has been undertaken on a worst case (sub-catchment) basis the additional mitigation measures are not considered to reduce the magnitude of effect on the River Bure catchment. The most effective mitigation measures are considered to be those embedded in the project already including minimising the area of open ground, storing and reinstating topsoil and using hardstanding in mobilisation areas.

155. Therefore, following application of the additional mitigation measures described above, the high sensitivity and value of the East Ruston Stream sub-catchment, and medium sensitivity and high value of the River Bure sub-catchment, with a low magnitude of effect, would result in an impact of **moderate adverse** significance. The medium sensitivity and high value of the King's Beck and Mermaid Stream sub-catchments, and low sensitivity and high value of the New Cut, with a negligible magnitude of effect, would result in an impact of **minor adverse** significance. The low value and sensitivity of the North Walsham and Dilham Canal sub-catchment, with a negligible magnitude of effect, would result in a **negligible** impact.

156. It is important to note that this assessment is based on a worst case scenario which reflects the cumulative impact of construction activities (e.g. cable trenching and watercourse crossings) within each sub-catchment, rather than the potential impacts on any individual watercourse. When assessed alone, potential impacts on individual watercourses are not considered to give rise to significant effects.

20.7.5.2.3 Receptor ii. River Wensum catchment

Impacts prior to mitigation

157. Construction activities within the onshore project area will disturb a maximum of 2.05km^2 (0.61%) of the River Wensum catchment in total during the 2 year construction programme. This equates to 0.71km^2 (1.09%) in the Blackwater sub-

catchment, 0.47km^2 (0.25%) of the River Wensum sub-catchment (in this instance including Penny Spot Beck), and 0.87km^2 (1.10%) in the Wendling Beck sub-catchment. However, at any one time the working area will be limited within each sub-catchment within the project area (Table 20.17). This equates to 0.24% of the Blackwater sub-catchment, 0.05% of the River Wensum sub-catchment (in this instance including Penny Spot Beck), and 0.22% of the Wendling Beck sub-catchment.

158. The River Wensum sub-catchments have all been assigned a high sensitivity and high value (section 20.7.4). The embedded mitigation measures described in section will control sediment supply from the construction works of the project. The overall magnitude of effect is considered to be negligible for the River Wensum sub-catchment. This will result in an overall impact of **minor adverse** significance for the main River Wensum.

159. As a greater area of the Blackwater and Wendling Beck sub-catchments will be disturbed there is therefore a greater potential for increased sediment to enter these watercourses. The impact is therefore assessed to have a low magnitude in these sub-catchments, resulting in an impact of **moderate adverse** significance. It is important to note that this will be a short term impact, limited to the duct installation period (works will be undertaken in 150m sections, and the time from topsoil strip to reinstatement would typically be a maximum of two weeks within each 150m section), and reversible once activities have been completed.

Additional mitigation measures

160. Additional mitigation measures will be implemented to prevent the release of sediment into the watercourses within the River Wensum catchment, including the retention of buffer strips adjacent to watercourses and the development of a CMS and SWDP (DCO requirement 20). These are described in more detail in section 20.7.5.2.2.

Impacts following mitigation

161. Additional mitigation measures will reduce sediment supply from the working area and are an important and integral part of best practice construction methodology to help ensure that sediment supply is not increased. However, because the assessment has been undertaken on a worst case (sub-catchment) basis the additional mitigation measures are not considered to reduce the magnitude of effect on the River Wensum catchment. The most effective mitigation measures are considered to be those embedded in the project already including minimising the area of open ground, storing and reinstating topsoil and using hardstanding in mobilisation areas.

162. The high sensitivity and value of the Blackwater and Wendling Beck, with a low magnitude of effect, would result in an impact of **moderate adverse** significance.

The high sensitivity and value of the main River Wensum, with a negligible magnitude of effect, would result in an impact of **minor adverse** significance.

163. It is important to note that this assessment is based on a worst case scenario which reflects the cumulative impact of construction activities (e.g. cable trenching and watercourse crossings) within each sub-catchment, rather than the potential impacts on any individual watercourse. When assessed alone, potential impacts on individual watercourses are not considered to give rise to significant effects.

20.7.5.2.4 Receptor iii. River Wissey catchment

Impacts prior to mitigation

164. Construction activities within the onshore project area will disturb a maximum of 0.77km^2 (0.87%) of the River Wissey catchment in total during the 2 year construction programme. However, at any one time the working area will be limited to 0.06km^2 or 0.06% of the catchment (Table 20.17).

165. The Upper Wissey sub-catchment has been assigned a medium sensitivity and medium value (section 20.7.4). The embedded mitigation measures described in section 20.7.1 and additional measures described in section 20.7.5.2 will control sediment supply from the construction works of the project (including the onshore cable route). The overall magnitude of effect is considered to be low for the Upper Wissey sub-catchment. This will result in an overall impact of **minor adverse** significance.

Additional mitigation measures

166. Several additional mitigation measures will be implemented to prevent the release of sediment into the watercourses within the River Wissey catchment, including the retention of buffer strips adjacent to watercourses and the development of a CMS and SWMP. These are described in more detail in section 20.7.5.2.2.

Impacts following mitigation

167. As described in in section 20.7.5.2.2, additional measures will be adhered to as an integral part of construction best practice; however, as the most effective sediment control measures are already embedded into the design, they are not expected to further reduce the magnitude of effect on the River Wissey catchment.

168. The medium sensitivity and value of the upper River Wissey sub-catchment, with a low magnitude of effect, would therefore result in an impact of **minor adverse** significance.

20.7.5.3 Impact 3: Accidental release of fuels, oils, lubricants, foul waters and construction materials

20.7.5.3.1 Description of impacts

169. There is the potential for the accidental release of lubricants, fuels and oils from construction machinery working in and adjacent to surface watercourses, through spillage, leakage and in-wash from vehicle storage areas after rainfall (during the main construction activities, including associated access to sites, and subsequent cable pulling). There is also the potential for accidental release of foul waters (from welfare facilities) and construction materials (including concrete and inert drilling fluids) into the aquatic system during construction.

170. If a significant leakage or spillage occurs, there is the potential for adverse impacts upon water quality if contaminants enter the surface drainage network or percolate into groundwater. These water quality impacts have the potential to adversely affect ecology (particularly fish and macroinvertebrates; see Chapter 22 Onshore Ecology) if pollutant concentrations are sufficiently high.

171. The scale of the potential impact upon a sub-catchment is likely to be proportional to the area of each catchment that would be affected during construction (i.e. the total footprint of construction activities). This is summarised in Table 20.17.

20.7.5.3.2 Receptor i. River Bure catchment

Impacts prior to mitigation

172. The onshore project area will have a total construction-stage footprint of approximately 1.80km^2 (0.79%) in the River Bure catchment; 0.32km^2 (1.26%) in the East Ruston Stream sub-catchment, 0.42km^2 (0.78%) in the North Walsham and Dilham Canal sub-catchment, 0.19km^2 (0.93%) of the New Cut sub-catchment, 0.37km^2 (0.52%) in the King's Beck sub-catchment, 0.39km^2 (1.03%) of the River Bure sub-catchment, and 0.12km^2 (0.57%) in the Mermaid Stream sub-catchment.

173. As discussed in section 20.7.4, the East Ruston Stream has a high sensitivity and high value, and the North Walsham and Dilham Canal has a low sensitivity and low value. The New Cut has a high sensitivity and low value. The main River Bure, King's Beck and the Mermaid Stream sub-catchments have all been assigned a medium sensitivity and high value (section 20.7.4).

174. However, the development will include embedded mitigation measures to prevent the release of foul water from the onshore project substation and mobilisation areas. This measure is described in more detail in section 20.7.1.

175. Based on the proportion of the catchment affected, the overall magnitude of effect is therefore assessed to be medium for the East Ruston Stream and River Bure, and low for the North Walsham and Dilham Canal, New Cut, King's Beck and the

Mermaid Stream sub-catchments. This will result in an overall impact of **major adverse** significance for the East Ruston Stream and River Bure sub-catchments, an overall impact of **moderate adverse** significance for the New Cut, King's Beck and the Mermaid Stream sub-catchments and **minor adverse** significance for the North Walsham and Dilham Canal sub-catchment.

Additional mitigation measures

176. In addition to the embedded mitigation measure to prevent the release of foul waters set out in section 20.7.1, the potential for impacts associated with the accidental release of fuels, oils, lubricants, construction materials and other contaminants will be reduced by a range of additional measures, as set out below:

- A CMS will be produced that adheres to construction industry good practice guidance. This will be informed by the Environment Agency's Pollution Prevention Guidance (PPG) notes (including PPG01, PPG05, PPG08 and PPG21) (now revoked as regulatory guidance in England, but still provides a useful guide for best practice measures), and CIRIA's 'Control of water pollution from construction sites – A guide to good practice' (2001). In addition to the sediment management measures set out in section 20.7.5.2, additional measures to prevent contamination will include the following:
    - Concrete and cement mixing and washing areas will be situated at least 10m away from the nearest watercourse. These will incorporate settlement and recirculation systems to allow water to be re-used. All washing out of equipment will be undertaken in a contained area, and all water will be collected for off-site disposal;
    - All fuels, oils, lubricants and other chemicals will be stored in an impermeable bund with at least 110% of the stored capacity. Damaged containers will be removed from site. All refuelling will take place in a dedicated impermeable area, using a bunded bowser. Biodegradable oils will be used where possible; and
    - Spill kits will be available on site at all times. Sand bags or stop logs will also be available for deployment on the outlets from the site drainage system in case of emergency spillages.
- Suitable biosecurity protocols (such as those outlined by the Non-Native Species Secretariat (NNSS)) would be put in place during the works in order to minimise the risk of contamination and the spread of the invasive non-native species (INNS), including the spread of crayfish plague. This includes the implementation of strict biosecurity protocols such as stringent 'Check, Clean, Dry' working methodology for plant, equipment and construction crews. Further details with regards to mitigation measures implemented to prevent the spread and propagation of INNS are included in Chapter 22 Onshore Ecology.

Impacts following mitigation

177. Following the implementation of these additional mitigation measures, the potential for accidental release of contaminants from construction activities is reduced to an effect of negligible magnitude within all sub-catchments.

178. The high sensitivity and value of the East Ruston Stream sub-catchment, and high value of the River Bure sub-catchment, with a negligible magnitude of effect, would result in an impact of **minor adverse** significance. The medium sensitivity and high value of the King's Beck and Mermaid Stream sub-catchments, and low sensitivity and high value of the New Cut, with a negligible magnitude of effect, would result in an impact of **minor adverse** significance. The low value and sensitivity of the North Walsham and Dilham Canal sub-catchment, with a negligible magnitude of effect, would result in a **negligible** impact.

20.7.5.3.3 Receptor ii. River Wensum catchment

Impacts prior to mitigation

179. The onshore project area will have a construction stage footprint of approximately 2.05km^2 (0.61%) in the River Wensum catchment over the 2 year construction period; 0.71km^2 (1.09%) in the Blackwater sub-catchment, 0.47km^2 (0.25%) of the River Wensum sub-catchment (including Penny Spot Beck), and 0.787m^2 (1.10%) in the Wendling Beck sub-catchment. The sub-catchments have all been assigned a high sensitivity and high value (section 20.7.4).

180. The embedded mitigation measure described in section 20.7.1 will control the accidental release of foul waters, but will not prevent the release of other contaminants from construction activities. The overall magnitude of effect is considered to be low for the River Wensum sub-catchment. This will result in an overall impact of **moderate adverse** significance for the main River Wensum.

181. As a greater area of the Blackwater and Wendling Beck sub-catchments will be subject to construction activities, there is therefore a greater potential for the accidental release of contaminants in these sub-catchments. The impact is therefore assessed to have a medium magnitude of effect in these sub-catchments, with a resulting impact of **major adverse** significance (although this will be a short term impact, limited to the construction period, and reversible once activities have been completed).

Additional mitigation measures

182. In addition to the embedded mitigation measure to prevent the release of foul waters set out in section 20.7.1, the potential for impacts associated with the accidental release of fuels, oils, lubricants, construction materials and other contaminants will be reduced by a range of additional measures. These include the development of a CMS, and are described in more detail in section 20.7.5.3.2.

Impacts following mitigation

183. Following the implementation of these additional mitigation measures, the potential for accidental release of contaminants from construction activities is reduced to an effect of negligible magnitude within all sub-catchments..

184. The high sensitivity and value of the Blackwater and Wendling Beck, and main River Wensum, with a negligible magnitude of effect, would result in an impact of **minor adverse** significance.

20.7.5.3.4 Receptor iii. River Wissey catchment

Impacts prior to mitigation

185. The onshore project area will have a construction stage footprint of approximately 0.77km^2 (0.87%) in the Upper Wissey sub-catchment. This has been assigned a medium sensitivity and medium value (section 20.7.4).

186. The embedded mitigation measure described in section 20.7.1 will control the accidental release of foul waters, but will not prevent the release of other contaminants from construction activities. The overall magnitude of effect is therefore assessed to be low. The low magnitude will result in an overall impact of **minor adverse** significance for the upper River Wissey sub-catchment.

Additional mitigation measures

187. In addition to the embedded mitigation measure to prevent the release of foul waters set out in section 20.7.1, the potential for impacts associated with the accidental release of fuels, oils, lubricants, construction materials and other contaminants will be reduced by a range of additional measures. These include the development of a CMS, and are described in more detail in section 20.7.5.3.2.

Impacts following mitigation

188. Following the implementation of these additional mitigation measures, this effect is expected reduce to a negligible magnitude on the upper River Wissey sub-catchment.

189. The medium sensitivity and value of the Upper Wissey sub-catchment, with a negligible magnitude of effect, would result in an impact of **minor adverse** significance.

20.7.5.3.5 Receptor iv. Groundwater

Impacts prior to mitigation

190. Construction activities which disturb the ground (including excavation, piling and underground trenchless crossings of watercourses and other obstructions such as roads and railways) could potentially introduce contaminants into the underlying groundwater bodies (particularly shallow aquifers). These activities could therefore

adversely affect the quality of the underlying groundwater (including the Principal Aquifer and any secondary aquifers) and could potentially impact upon any licensed and unlicensed abstractions within it.

191. As outlined in section 20.7.4, the groundwater receptors in the study area support abstractions for public water supply and are considered to have a high vulnerability. They therefore have a high sensitivity and high value.

192. The embedded mitigation measure described in section 20.7.1 will control the accidental release of foul waters, but will not prevent the release of other contaminants from construction activities. The overall magnitude of effect is therefore assessed to be medium. The medium magnitude will result in an overall impact of **major adverse** significance on the groundwater receptors.

Additional mitigation measures

193. Additional mitigation measures will be implemented to reduce the potential for impacts upon groundwaters (including SPZ areas) resulting from construction-stage activities. These include the development of a CMS, and are described in more detail in section 20.7.5.3.2.

194. Furthermore, following consultation with the Environment Agency, cable excavations will be designed not to disturb groundwater in any significant manner. Excavations will be shallow (approximately 1.5m) and above the water table of the Principal Aquifer.

195. If works are required in the SPZ1 or SPZ2 areas, the construction working methodology (for example a Construction Method Statement) will stipulate that the best available techniques (BAT) are used for any installations, in accordance with the Energy Network Association Guidance, and in agreement with the Environment Agency. Furthermore, a hydrogeological risk assessment meeting the requirements of Groundwater Protection Principles and Practice (GP3) (Environment Agency, 2017), will be undertaken for any trenchless crossing locations in SPZ1 or 2 areas (specifically the North Walsham and Dilham Canal). If significant risks are identified, alternatives including alternative trenchless drilling techniques (other than HDD) to cross the SPZ area will be considered.

Impacts following mitigation

196. Following the implementation of the additional mitigation measures outlined above, this effect is expected to reduce to a negligible magnitude on the underlying groundwater receptors.

197. The high value and sensitivity and value of the groundwater, with a negligible magnitude of effect, are likely to reduce to an impact of **minor adverse** significance.

20.7.5.4 Impact 4: Increased surface water runoff and flood risk

20.7.5.4.1 Description of impacts

198. The initial site preparation and construction activities associated with the onshore project area (including the landfall, onshore cable route, onshore project substation, National Grid substation extension, and associated access tracks) have the potential to alter surface water flows and drainage patterns by:

- Altering existing flow paths and changing the distribution of surface drainage across development sites and along the cable route;
- Reducing infiltration and increasing surface runoff as a result of soil compaction by construction vehicles;
- De-watering the cable trench and removal of the water through infiltration or discharge into the surface drainage network;
- Increasing the proportion of impermeable surfaces in a catchment and therefore reducing infiltration. The development of surface infrastructure also has the potential to change surface flows and infiltration rates as a result of changes to land use (i.e. by increasing the proportion of impermeable surfaces in a drainage catchment) and alter site runoff characteristics; and
- Temporary changes to surface flows as a result of trenched watercourse crossings (see section 20.7.5.1 for details), particularly if the capacity of any pumps, flumes or diversion channels is exceeded.

199. The construction of the project therefore has the potential to increase surface water runoff, which could adversely affect the hydrology and geomorphology of the surface drainage network (e.g. as a result of increased discharge resulting in bed and bank scour, and the in wash of greater volumes of fine sediment due to increased surface runoff, as discussed in section 20.7.5.2). This could also affect in-channel habitats for species such as brown trout, bullhead and brook lamprey. Specific impacts upon fish species are discussed in Chapter 22 Onshore Ecology.

200. Any changes in surface flows could also increase flood risk in the onshore project area, particularly third party land and property in areas within Flood Zones 2 or 3. The project passes largely through agricultural land, with some residential and agricultural buildings located in proximity to the onshore project area. Third party land and property could therefore be affected along the length of the project route as a result of alterations to surface water flows, run off and drainage patterns.

201. The area of direct impact within the construction footprint and the number of open cut watercourse crossings are used as a proxy for the assessment of potential changes to surface water runoff and flood risk within each sub-catchment. Note that more detailed information regarding potential flood risk impacts are provided in to Appendix 20.1.

202. It is important to note that the changes to surface water runoff and flood risk assessed in detail for each catchment below are expected to relatively localised, and would not be sufficient to cause a major accident or disaster.

20.7.5.4.2 Receptor i. River Bure catchment

Impacts prior to mitigation

203. There are six main sub-catchments in the River Bure catchment that could be impacted by changes to surface water runoff and flood risk:

- The East Ruston Stream. Approximately 0.32km^2 (1.26%) of the sub-catchment could be directly affected by changes in surface water flow patterns, and there will be one open cut watercourse crossing. Based on the value of in-channel habitats it supports, this sub-catchment has a high value and sensitivity;
- The North Walsham and Dilham Canal. The onshore project area within the sub-catchment is approximately 0.42km^2 (0.78%), and there would be one open cut watercourse crossing. This sub-catchment has a low value and sensitivity;
- The New Cut. Approximately 0.19km^2 (0.93%) of the sub-catchment would be directly affected by construction activities, but the watercourse would not be crossed using an open cut technique. This sub-catchment has a low sensitivity and high value;
- The main River Bure. Approximately 0.39km^2 (1.03%) of the sub-catchment would be directly affected by construction activities, and a single watercourse would be crossed with an open cut technique. This sub-catchment has a medium sensitivity and high value;
- King's Beck. Approximately 0.37km^2 (0.52%) of the sub-catchment would be directly affected by construction activities, and four watercourses would be crossed with an open cut technique. This sub-catchment has a medium sensitivity and high value; and
- Mermaid Stream. Approximately 0.12 m^2 (0.57%) of the sub-catchment would be directly affected by construction activities, but the watercourse would not be crossed using an open cut technique. This sub-catchment has a medium sensitivity and high value.

204. The project will include embedded mitigation measures to control surface runoff during the construction phase, including the creation of drainage channels to intercept water from the cable trench and cable corridor. These measures, which are described in more detail in section 20.7.1, will help to control the release of surface waters from onshore development activities and prevent changes to surface runoff and flood risk. With the embedded measures in place, the magnitude of effect is considered to be low.

205. This will result in an overall impact of **moderate adverse** significance for the East Ruston Stream, New Cut, main River Bure, King's Beck and Mermaid Stream sub-

catchments, and **minor adverse** significance for the North Walsham and Dilham Canal sub-catchment.

Additional mitigation measures

206. In addition to the embedded mitigation measures to intercept site drainage that are described in section 20.7.1, the potential for impacts associated with changes to surface water runoff and flood risk will be reduced by a range of additional measures:

- Surface water drainage requirements will be presented in the final SWDP (DCO requirement 20) and will be designed to meet the requirements of the NPPF and NPS EN-5, with runoff limited, where feasible, through the use of infiltration techniques which can be accommodated within the area of development. The drainage strategy will be developed according to the principles of the SuDS discharge hierarchy. Generally, the aim will be to discharge surface water runoff as high up the following hierarchy of drainage options as reasonably practicable: i) into the ground (infiltration); ii) to a surface water body; iii) to a surface water sewer, highway drain or another drainage system; or iv) to a combined sewer;
- A pre-construction drainage plan will be developed as part of the SWDP, (DCO requirement 20) agreed with regulators and implemented to minimise water within the cable trench and other working areas and ensure ongoing drainage of surrounding land. This typically includes interceptor drainage ditches being temporarily installed parallel to the trenches and soil storage areas to provide interception of surface water runoff and the use of pumps to remove water from the trenches during cable installation. Furthermore, the sectionalised duct installation method (excavate, lay and reinstate approximately 150m/week) is designed to minimise water ingress to the trenches. Any pumps, flumes or channels will be designed to have sufficient capacity to convey the required range of flows at each location; and
- Existing land drains along the onshore cable route and at the onshore project substation will be reinstated following construction. A local specialised drainage contractor will undertake surveys to locate drains and create drawings both pre- and post-construction, and ensure appropriate reinstatement. The pre-construction drainage plan will include provisions to minimise water within the working area and ensure ongoing drainage of surrounding land.

Impacts following mitigation

207. Following the implementation of the additional mitigation measures outlined above, the potential for changes to surface water flows and flood risk is reduced and represents a negligible magnitude of effect on each sub-catchment.

208. The high value and sensitivity of the East Ruston Stream sub-catchment, with a negligible magnitude of effect, would result in an impact of **minor adverse** significance.

209. The medium sensitivity and high value of the main River Bure, King's Beck and Mermaid Stream sub-catchments, with a negligible magnitude of effect, would result in an impact of **minor adverse** significance.

210. The low sensitivity and high value of the New Cut, with a negligible magnitude of effect, would result in an impact of **minor adverse** significance.

211. The low value and sensitivity of the North Walsham and Dilham Canal sub-catchment, with a negligible magnitude of effect, would result in a **negligible** impact.

20.7.5.4.3 Receptor ii. River Wensum catchment

Impacts prior to mitigation

212. There are three sub-catchments in the part of the River Wensum catchment that could be impacted by increased surface water runoff and flood risk, all of which have been assigned a high sensitivity and high value (section 20.7.4):

- The main River Wensum (including Penny Spot Beck). Approximately 0.47 km^2 (0.25%) of the sub-catchment would be directly affected by construction activities, and a single tributary of the Penny Spot Beck would be crossed using an open cut technique. This sub-catchment has a high value and sensitivity;
- Blackwater Drain. Approximately 0.71 km^2 (1.09%) of the sub-catchment would be directly affected by construction activities, and there would be sixteen watercourse crossings using an open cut technique. This sub-catchment has a high value and sensitivity; and
- Wendling Beck. Approximately 0.87 km^2 (1.10%) of the sub-catchment would be directly affected by construction activities, and there would be four watercourse crossings using an open cut technique. This sub-catchment has a high value and sensitivity.

213. Taking account of the embedded mitigation measures described in section 20.7.1, the magnitude of effect is considered to be low. This will result in an overall impact of **moderate adverse** significance for the River Wensum, Blackwater Drain and Wendling Beck.

Additional mitigation measures

214. Additional measures will be implemented to control the release of surface waters from construction activities and prevent changes to surface runoff and flood risk. These are described in section 20.7.5.4.2.

Impacts following mitigation

215. The additional measures described in section 20.7.5.4.2 will control the release of surface waters from construction activities and prevent changes to surface runoff and flood risk. The overall magnitude of effect is therefore reduced to negligible for the River Wensum, Blackwater Drain and Wendling Beck sub-catchments. This will result in an overall impact of **minor adverse** significance.

20.7.5.4.4 Receptor iii. River Wissey catchment

Impacts prior to mitigation

216. Approximately 0.77 km^2 (0.87%) of the Upper Wissey sub-catchment would be directly affected by construction activities and a single watercourse would be crossed using an open cut technique. The Upper Wissey sub-catchment has been assigned a medium sensitivity and medium value (section 20.7.4).

217. Taking account of the embedded mitigation measures described in section 20.7.1, the magnitude of effect is considered to be medium. This will result in an overall impact of **moderate adverse** significance for the River Wissey.

Additional mitigation measures

218. Several additional measures will be implemented to control the release of surface waters from construction activities and prevent changes to surface runoff and flood risk. These are described in section 20.7.5.4.2.

Impacts following mitigation

219. The additional measures described in section 20.7.5.4.2 will control the release of surface waters from onshore development activities and prevent changes to surface runoff and flood risk. Given the scale of the development footprint in the sub-catchment, the magnitude of effect will be reduced to low. The medium sensitivity and value of the upper River Wissey sub-catchment, with a low magnitude of effect, would result in an impact of **minor adverse** significance.

20.7.6 Potential Impacts during Operation

20.7.6.1 Impact 1: Increased surface water runoff, altered groundwater flows and changes to flood risk

20.7.6.1.1 Description of impacts

220. The permanent above-ground infrastructure, including the onshore project substation, National Grid substation extension and overhead line modification, joint bays and any new, permanent access tracks will result in permanent changes to land use. In most cases, the change in use from existing greenfield agricultural land use is likely to create a permanent increase in impermeable area. Changes in land use are detailed further within Chapter 21 Land Use and Agriculture. Although permeable surface treatments will be used where possible, joint bays along the onshore cable

route, and the onshore project substation and National Grid substation extension are expected to comprise impermeable surfaces, with associated infrastructure such as roads also comprising impermeable surfaces.

221. An increase in the proportion of impermeable surfaces in a sub-catchment will result in a corresponding decrease in local infiltration and an increase in surface runoff. Furthermore, the presence of the buried cable ducting along the onshore cable route will introduce an impermeable barrier that has the potential to impact upon subsurface flow routes and change the distribution of groundwater by changing subsurface flow patterns and forcing water to move upwards (i.e. towards the surface) or downwards (away from the surface).

222. There is therefore potential for changes in surface water runoff resulting from the increase in impermeable areas and changes to subsurface flows. These could be sufficient to impact upon the hydrology (e.g. by increasing surface water volumes and flow velocities) of the surface water system and result in permanent changes to geomorphology by increasing rates of bed and bank erosion and encouraging geomorphological adjustment. Any geomorphological changes could also impact upon in-channel habitat conditions for aquatic species such as brown trout, bullhead and brook lamprey (specific impacts upon fish species are discussed in Chapter 22 Onshore Ecology). Impacts on geomorphology and in-channel habitats are likely to be particularly marked if drainage from a large area is discharged at a discrete location within the existing surface drainage network.

223. Any changes in the proportion of groundwater contained in surface waters (e.g. due to an increase in surface runoff, or an increase or decrease in groundwater upwelling) could potentially alter water chemistry and impact upon the quality of water-dependant habitats.

224. As well as impacts on geomorphology and in-channel habitats, changes to surface drainage patterns could also increase flood risk to third party land and property, especially if the discharge of any drainage is not sufficiently controlled. Furthermore, watercourse crossing locations have the potential to increase flood risk elsewhere should they not be reinstated to pre-construction channel capacities (i.e. any reductions in channel capacity could increase local flood risk).

225. The scale of the potential impact upon a sub-catchment is likely to be proportional to the area of permanent infrastructure in each catchment during operation. This is summarised in Table 20.18.

Table 20.18 Area of permanent infrastructure in surface water catchments

Catchment	Sub-catchment	Sensitivity	Value	Area of permanent infrastructure	
				km²	%
River Bure	New Cut	Low	High	0.18	0.88
	East Ruston Stream	High	High	0.26	1.04
	North Walsham & Dilham Canal	Low	Low	0.22	0.41
	King's Beck	Medium	High	0.26	0.37
	River Bure	Medium	High	0.28	0.74
	Mermaid Stream	Medium	High	0.08	0.38
			Total	**1.28**	**0.56**
River Wensum	Blackwater	High	High	0.53	0.81
	River Wensum	High	High	0.33	0.17
	Wendling Beck	High	High	0.58	0.73
			Total	**1.44**	**0.43**
River Wissey	River Wissey	Medium	Medium	0.28	0.32
			Total	**0.28**	**0.32**

20.7.6.1.2 Receptor i. River Bure and Wensum catchments

Impacts prior to mitigation

226. There are six main sub-catchments in the River Bure catchment that could be impacted by changes to surface water runoff, groundwater flows and flood risk resulting from the permanent presence of the cable ducting and associated infrastructure:

- The East Ruston Stream. Approximately 0.26km² (1.04%) of the sub-catchment could be directly affected by changes in subsurface flow patterns;
- The North Walsham and Dilham Canal. The onshore project area within the sub-catchment is approximately 0.22km² (0.41%);
- The New Cut. The onshore project area within the sub-catchment is approximately 0.18km² (0.88%);
- The main River Bure. Approximately 0.28km² (0.74%) of the sub-catchment would contain operational infrastructure associated with the cable route;

- King's Beck. Approximately 0.26km^2 (0.37%) of the sub-catchment would contain operational infrastructure associated with the cable route; and
- Mermaid Stream. Approximately 0.08km^2 (0.38%) of the sub-catchment would contain operational infrastructure associated with the cable route.

227. There are three sub-catchments in the part of the River Wensum catchment that could be impacted:

- The main River Wensum (including Penny Spot Beck). Approximately 0.33km^2 (0.17%) of the sub-catchment would contain operational infrastructure associated with the cable route;
- Blackwater Drain. Approximately 0.53km^2 (0.81%) of the sub-catchment would contain operational infrastructure associated with the cable route; and
- Wendling Beck. Approximately 0.58km^2 (0.73%) of the sub-catchment would contain operational infrastructure associated with the cable route.

228. As a result of the limited spatial extent of permanent impermeable development along the cable route, the effect is considered to be of negligible magnitude.

229. The high sensitivity and value of the East Ruston Stream, River Wensum, Blackwater Drain and Wendling Beck sub-catchments, with a negligible magnitude of effect, would result in an impact of **moderate adverse** significance.

230. The low sensitivity and high value of the New Cut sub-catchment, with a negligible magnitude of effect, would result in an impact of **moderate adverse** significance.

231. The medium sensitivity and high value of the River Bure, King's Beck and Mermaid Stream sub-catchments, with a negligible magnitude of effect, would result in an impact of **moderate adverse** significance.

232. The low sensitivity and value of the North Walsham and Dilham Canal sub-catchment, with a negligible magnitude of effect, would result in an impact of **minor adverse** significance.

Additional mitigation measures

233. Surface water drainage requirements for operational onshore project infrastructure will be presented in the final SWDP (DCO requirement 20) and will be designed to meet the requirements of the National Planning Policy Framework (NPPF) and NPS EN-5, with runoff limited, where feasible, through the use of infiltration techniques which can be accommodated within the area of development. The drainage strategy will be developed according to the principles of the SuDS discharge hierarchy. Generally, the aim will be to discharge surface water runoff as high up the following hierarchy of drainage options as reasonably practicable: i) into the ground (infiltration); ii) to a surface water body; iii) to a surface water sewer, highway drain or another drainage system; or iv) to a combined sewer.

Impacts following mitigation

234. The additional measures described above will control drainage from operation activities and prevent changes to surface runoff, groundwater flows and flood risk and further reduce the potential for impacts upon surface watercourses and groundwater. The magnitude of the effect is therefore considered to be negligible.

235. This will result in an impact of **minor adverse** significance in the high value sub-catchments (East Ruston Stream, New Cut, River Bure, King's Beck, River Wensum, Blackwater Drain and Wendling Beck) and an impact of **negligible** significance in the low value sub-catchment (the North Walsham and Dilham Canal).

20.7.6.1.3 Receptor ii. River Wissey catchment

Impacts prior to mitigation

236. Approximately 0.28 km^2 (0.32%) of the Upper Wissey sub-catchment could potentially be impacted by changes to surface water runoff, groundwater flows and flood risk resulting from the permanent presence of the onshore project substation, Necton National Grid Extension, cable ducting and associated infrastructure. This has been assigned a medium sensitivity and medium value (section 20.7.4).

237. As detailed in section 20.7.1, the project will include embedded mitigation measures to reduce the potential for impact. This includes limiting discharge from the onshore project substation to the greenfield runoff rate, creation of a new attenuation pond at the onshore project substation and creation of increased storage volume at the Necton National Grid substation (either by extending the existing attenuation pond or creating a new feature). With these embedded measures in place, the magnitude of effect will be low.

238. Given the medium value and sensitivity of the catchment, this would result in an impact of **minor adverse** significance.

Additional mitigation measures

239. Additional mitigation measures are presented in section 20.7.6.1.2 and include the production of a final SWDP (DCO requirement 20) meeting the requirements of NPPF and using the principles of SuDS discharge hierarchy.

Impacts following mitigation

240. The additional measures described above will control drainage from operation activities and prevent changes to surface runoff, groundwater flows and flood risk and further reduce the potential for impacts upon surface watercourses and groundwater. The magnitude of the effect on the upper Wissey sub-catchment will therefore be reduced to negligible, representing an impact of **negligible** significance.

20.7.6.1.4 Receptor iii. Groundwater bodies

Impacts prior to mitigation

241. There is also potential for the presence of the buried cable ducting throughout the onshore cable route to impact upon the level of recharge and the distribution of groundwater within the aquifers that underlie the onshore project area (including shallow aquifers and deeper Principal Aquifers).

242. The Broadland Rivers Chalk & Crag, Cam and Ely Ouse Chalk, and North Norfolk Chalk groundwater bodies are all designated as Principal Aquifers and contain a number of groundwater SPZ areas (intended to protect potable water abstractions). The Principal Aquifer which underlies the superficial deposits beneath the whole study area is deemed to be of high vulnerability. The shallow aquifers also support unlicensed potable water abstractions as well as sensitive wetland and river habitats. The sensitivity of groundwater receptors is therefore considered to be high.

243. Impacts may arise via the buried cable ducting and permanent above ground infrastructure disrupting natural infiltration patterns of surface water and groundwater flow patterns, therefore impacting upon the quantitative status of groundwater.

244. However, although the buried cable ducting will create an impermeable barrier (1.05m to the top of the duct (typical), with two 260mm diameter (typical) ducts installed per trench, and one small duct for fibre cables), it is expected that subsurface (groundwater) flows will pass above or below the ducting. As a result, although there will be some minor changes in the distribution of flows, there is unlikely to be a significant perturbation / change in overall flow directions and quantities. Furthermore, the size and shallow depth of the impermeable subsurface barrier created by the cable ducting in comparison to the size of the groundwater bodies which underlie the onshore project area comprises 0.001%, 0.003% and 0.0003% of the overall area of the North Norfolk Chalk, Broadland Rivers Chalk & Crag and Cam and Ely Ouse Chalk groundwater bodies respectively. This will result in an effect upon infiltration rates, groundwater flows, sub-surface flow routes and alterations in the distribution of groundwater of low magnitude. The high value and sensitivity of the underlying groundwater aquifers, with a low magnitude of effect, would result in an impact of **moderate adverse** significance.

Additional mitigation measures

245. Additional mitigation measures are presented in section 20.7.6.1.2 and include the production of a final SWDP (DCO requirement 20) meeting the requirements of NPPF and using the principles of SuDS discharge hierarchy.

Impacts following mitigation

246. The additional mitigation measures outlined above will ensure that changes to the balance between surface water runoff and infiltration to groundwater are prevented. This will reduce the magnitude of the effect to negligible. The high value and sensitivity of the underlying groundwater aquifers, with a negligible magnitude of effect, would reduce the impact to **minor adverse** significance.

20.7.6.2 Impact 2: Supply of fine sediment and other contaminants

20.7.6.2.1 Description of impacts

247. The operation of the project, including planned and unplanned maintenance at the onshore project substation, Necton National Grid substation and along the onshore cable route, could result in the supply of fine sediment, fuels, oils and lubricants from the road network and other impermeable surfaces. This could potentially affect the geomorphology and water quality in the surface drainage network.

248. There is potential for an increase in sediment supply to surface waters during operation via mechanisms such as enhanced surface runoff from the permanent above-ground development and associated access tracks (see section 20.7.6.1), which could impact upon the geomorphology and surface water quality of the river water bodies, and consequently impact upon aquatic ecology.

249. Furthermore, there is potential for the supply of contaminants to surface waters during operation through surface runoff or accidental spillage or leakage of fuel oils or lubricants from vehicles during operational activities, which could impact upon surface water quality and that of connected groundwaters. This could have subsequent impacts upon aquatic ecology and the use of water resources for licensed and unlicensed abstractions.

250. As outlined in section 20.7.1, foul drainage at the onshore project substation (including the Necton National Grid substation) will be collected through a mains connection to the existing local authority sewer system if available, or collected in a septic tank and transported off site for disposal at a licensed facility. The specific approach will be determined during detailed design with consideration for the availability of mains connection and the number of visiting hours for site attendees during operation.

20.7.6.2.2 Receptor i. River Bure catchment

Impacts prior to mitigation

251. The onshore project area will have a permanent development footprint of approximately 1.28km^2 (0.56%) in the River Bure catchment; 0.26km^2 (1.04%) in the East Ruston Stream sub-catchment, 0.22km^2 (0.41%) in the North Walsham and Dilham Canal sub-catchment; 0.18km^2 (0.88%) in the New Cut sub-catchment;

0.26km^2 (0.37%) in the King's Beck sub-catchment, 0.28km^2 (0.74%) of the River Bure sub-catchment, and 0.08km^2 (0.38%) in the Mermaid Stream sub-catchment.

252. The East Ruston Stream has a high sensitivity and high value, the North Walsham and Dilham Canal has a low sensitivity and low value, and the New Cut has a low sensitivity and high value (section 20.7.4). The main River Bure, King's Beck and Mermaid Stream sub-catchments have all been assigned a medium sensitivity and high value (section 20.7.4).

253. As a result of the limited spatial extent of permanent development along the cable route, and the fact that there is no requirement to undertake routine maintenance, the impact is considered to be of negligible magnitude.

254. The high value and sensitivity of the East Ruston Stream sub-catchment, with a negligible magnitude of effect, would result in an impact of **minor adverse** significance.

255. The high value and low sensitivity of the New Cut sub-catchment, with a negligible magnitude of effect, would result in an impact of **minor adverse** significance.

256. The low value and sensitivity of the North Walsham and Dilham Canal sub-catchment, with a negligible magnitude of effect, would result in a **negligible** impact.

257. The medium sensitivity and high value of the main River Bure, King's Beck and Mermaid Stream sub-catchments, with a negligible magnitude of effect, would result in an impact of **minor adverse** significance.

Additional mitigation measures

258. Given the negligible significance of the impact, no further mitigation is proposed.

Impacts following mitigation

259. The residual impact will therefore be of **minor adverse** significance for the main East Ruston Stream, New Cut, River Bure, King's Beck and Mermaid Stream sub-catchments, and **negligible** significance for the North Walsham and Dilham Canal sub-catchment.

20.7.6.2.3 Receptor ii. River Wensum catchment

Impacts prior to mitigation

260. The onshore project area will have a permanent development footprint of approximately 1.44km^2 (0.43%) in the River Wensum catchment; 0.53km^2 (0.81%) in the Blackwater sub-catchment, 0.33km^2 (0.17%) of the River Wensum sub-catchment (including Penny Spot Beck), and 0.58km^2 (0.73%) in the Wendling Beck sub-catchment. The sub-catchments have all been assigned a high sensitivity and high value (section 20.7.4).

261. As a result of the limited spatial extent of permanent development along the cable route, and the fact that there is no requirement to undertake routine maintenance, the effect is considered to be of negligible magnitude.

262. The high value and sensitivity of the River Wensum, Blackwater and Wendling Beck sub-catchments, with a negligible magnitude of effect, would result in an impact of **minor adverse** significance.

Additional mitigation measures

263. Given the negligible significance of the impact, no further mitigation has been suggested.

Impacts following mitigation

264. The high sensitivity and value of the River Wensum, Blackwater Drain and Wendling Beck, with a negligible magnitude of effect, would result in a residual impact of **minor adverse** significance.

20.7.6.2.4 Receptor iii. River Wissey catchment

Impacts prior to mitigation

265. The onshore project area will have a permanent development footprint of approximately 0.28km^2 (0.32%) in the Upper Wissey sub-catchment. This has been assigned a medium sensitivity and medium value (section 20.7.4).

266. The embedded mitigation measures described in section 20.7.1 will control the accidental release of foul drainage from the permanent onshore development. The overall magnitude of effect is considered to be low, resulting in an overall impact of **minor adverse** significance.

Additional mitigation measures

267. In addition to the embedded mitigation measures to prevent the release of foul drainage that are described in section 20.7.1, the potential for impacts associated with the supply of fine sediment and other contaminants from the substation sites will be reduced by two additional measures:

- All fuels, oils, lubricants and other chemicals will be stored in an impermeable bund with at least 110% of the stored capacity. Damaged containers will be removed from site. All refuelling will take place in a dedicated impermeable area, using a bunded bowser. Biodegradable oils will be used where possible; and
- Spill kits will be available on site at all times. Sand bags or stop logs will also be available for deployment on the outlets from the site drainage system in case of emergency.

Impacts following mitigation

268. The additional measures described above will reduce the potential for impacts resulting from the accidental release of sediment and other contaminants into the surface drainage network. The effect will therefore be reduced to a negligible magnitude.

269. The medium sensitivity and value of the Upper Wissey sub-catchment, with a negligible magnitude of effect, would result in an impact of **minor adverse** significance.

20.7.6.2.5 Receptor iv. Groundwater bodies

Impacts prior to mitigation

270. During the operational phase, the presence of the permanent below ground infrastructure has the potential to impact upon the quality of surrounding groundwaters via the leaking of contaminated fluids arising from the presence and maintenance of permanent infrastructure.

271. The Broadland Rivers Chalk & Crag, Cam and Ely Ouse Chalk, and North Norfolk Chalk groundwater bodies are all designated as Principal Aquifers and contain a number of groundwater SPZ areas (intended to protect potable water abstractions). The Principal Aquifer which underlies the superficial deposits beneath the whole study area is deemed to be of high vulnerability. The sensitivity of groundwater receptors is therefore considered to be high.

272. The potential for this impact will be significantly reduced by using inert solid plastic insulation within the cables, rather than historic oil insulated cables, therefore removing the potential for fluid leakage from the cables during operation. As such, it is assessed that this represents as effect of negligible magnitude. The high value and sensitivity of the groundwater receptors, with a negligible magnitude of effect, would result in an impact of **minor adverse** significance.

Additional mitigation measures

273. In addition to the embedded mitigation measures to use inert cable insulation and prevent the release of foul drainage that are described in section 20.7.1, the potential for impacts associated with the supply of contaminants from the substation sites will be further reduced by the additional measures described in section 20.7.6.2.4.

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274. It is not expected that these additional mitigation measures will further reduce the magnitude of effect on groundwater receptors, as the most effective measures are considered to be those embedded in the project already. However, the additional

measures are an important and integral part of site operation and will be adhered to for this project to help ensure that contaminants are not released.

275. The high value and sensitivity of the groundwater receptors, with a negligible magnitude of effect, would therefore result in an impact of **minor adverse** significance.

20.7.7 Potential Impacts during Decommissioning

276. This section describes the potential impacts of the decommissioning of the project with regards to impacts on water resources and flood risk. Further details are provided in Chapter 5 Project Description.

277. No decision has been made regarding the final decommissioning policy for the onshore cables, as it is recognised that industry best practice, rules and legislation change over time. It is likely the cables would be pulled through the ducts and removed, with the ducts themselves left in situ.

278. In relation to the onshore project substation, the programme for decommissioning is expected to be similar in duration to the construction phase. The detailed activities and methodology would be determined later within the project lifetime, but are expected to include:

- Dismantling and removal of outside electrical equipment from site located outside of the onshore project substation;
- Removal of cabling from site;
- Dismantling and removal of electrical equipment from within the onshore project;
- Removal of main onshore project substation and minor services equipment;
- Demolition of the support buildings and removal of fencing;
- Landscaping and reinstatement of the site (including land drainage); and
- Removal of areas of hard standing.

279. Whilst details regarding the decommissioning of the onshore project substation are currently unknown, considering the worst case scenario which would be the removal and reinstatement of the current land use at the site, it is anticipated that the impacts would be no worse than those during construction.

280. The decommissioning methodology would need to be finalised nearer to the end of the lifetime of the project so as to be in line with current guidance, policy and legislation at that point. Any such methodology would be agreed with the relevant authorities and statutory consultees. The decommissioning works could be subject to a separate licencing and consenting approach.

20.8 Cumulative Impacts

281. This section describes the CIA for water resources and flood risk, taking into consideration other plans, projects and activities.

282. The assessment of cumulative impact has been undertaken here as a two-stage process. Firstly, all the impacts from previous sections have been assessed for potential to act cumulatively with other projects. This summary assessment is set out in Table 20.19.

Table 20.19 Potential cumulative impacts

Impact		Potential for cumulative impact	Rationale
Construction			
1	Direct disturbance of surface water bodies	Yes	Impacts to water bodies may be exacerbated by other projects
2	Increased surface water runoff and altered subsurface flows	Yes	Impacts to water bodies may be exacerbated by other projects
3	Increased sediment supply	Yes	Impacts to water bodies may be exacerbated by other projects
4	Accidental release of fuels, oils, lubricants, foul waters and construction materials	Yes	Impacts to water bodies may be exacerbated by other projects
Operation			
1	Increased surface water runoff and altered groundwater flows	Yes	Impacts to water bodies may be exacerbated by other projects
2	Supply of fine sediment and other contaminants	Yes	Impacts to water bodies may be exacerbated by other projects
Decommissioning			
The detail and scope of the decommissioning works will be determined by the relevant legislation and guidance at the time of decommissioning and agreed with the regulator. A decommissioning plan will be provided. As such, cumulative impacts during the decommissioning stage are assumed to be no worse than those identified during the construction stage.			

283. The second stage of the CIA is an assessment of whether there is spatial or temporal overlap between the extent of potential effects of the onshore project area and the potential effects of other projects scoped into the CIA upon the same receptors. To identify whether this may occur, the potential nature and extent of effects arising from all projects scoped into the CIA have been identified together with any overlaps

between these and the effects identified above. Where there is an overlap, an assessment of the cumulative magnitude of effect is provided.

284. The projects identified for potential cumulative impacts with Norfolk Vanguard have been discussed during ETG meetings with stakeholders and the full list has been agreed in consultation with local authorities.

285. Table 20.20 summarises those projects which have been scoped into the CIA due to their temporal or spatial overlap with the potential effects arising from the project. The remainder of the section details the nature of the cumulative impacts against all those receptors scoped in for cumulative assessment.

Table 20.20 Summary of projects considered for the CIA in relation to the water resources and flood risk

Project	Status	Development period	[1]Distance from Norfolk Vanguard (km)	Project definition	Project data status	Included in CIA	Rationale
National Infrastructure Planning							
Norfolk Boreas Offshore Wind Farm	Pre-Application	Expected construction date 2026	0 – projects are co-located	Pre-application outline only	High	Yes	Impacts arising from the Norfolk Boreas cable pull and onshore project substation were not considered in the WCS of this project, and are therefore considered in the CIA. Overlapping proposed project boundaries may result in impacts of a direct and / or indirect nature during construction and operation.
Hornsea Project Three Offshore Wind Farm	Pre-Application	Expected construction date 2021	0 – cable intersects project	Full PEIR available: http://hornseaproject3.co.uk/Documents-library/PEIR-Documents	High	Yes	The cable corridor for the Hornsea Project 3 Offshore Wind Farm makes landfall at Weybourne with grid connection at Norwich Main. The Hornsea Project 3 cable corridor crosses the Norfolk Vanguard onshore cable route within the Blackwater Drain water body catchment. The Hornsea Project 3 Offshore Windfarm would also cross watercourses in the River Wensum and the River Bure catchments, both of which will also be crossed by the Norfolk Vanguard project. Overlapping proposed project boundaries may result in impacts of a direct and / or indirect nature during construction and operation.
Dudgeon Offshore Wind Farm	Commissioned	Constructed	0	http://dudgeonoffshorewind.co.uk/	High	No	Construction and commissioning of the onshore project substation for the Dudgeon Offshore Wind Farm is complete

[1] Shortest distance between the considered project and Norfolk Vanguard – unless specified otherwise.

Project	Status	Development period	[1]Distance from Norfolk Vanguard (km)	Project definition	Project data status	Included in CIA	Rationale
							and operation commenced in 2017. The project has therefore been considered as part of the existing baseline.
A47 corridor improvement programme – North Tuddenham to Easton	Pre-application	Expected construction date 2021-23	2.5	https://infrastructure.planninginspectorate.gov.uk/projects/eastern/a47-north-tuddenham-to-easton/	Medium	No	No cumulative effects on onshore water resources and flood risk are anticipated as a result of a lack of hydrological connectivity between the projects.
A47 corridor improvement programme – A47 Blofield to North Burlingham	Pre-application	Expected construction date 2021-22	25	https://infrastructure.planninginspectorate.gov.uk/projects/eastern/a47-blofield-to-north-burlingham/	Medium	No	No cumulative effects on onshore water resources and flood risk are anticipated as a result of a lack of hydrological connectivity between the projects.
A47 corridor improvement programme – A47 / A11 Thickthorn	Pre-application	Expected construction date 2020-21	18	https://infrastructure.planninginspectorate.gov.uk/projects/eastern/a47a11-thickthorn-junction/	Medium	No	No cumulative effects on onshore water resources and flood risk are anticipated as a result of a lack of hydrological connectivity between the projects.
Norwich Western Link	Pre-application	2022	2.8	https://www.norfolk.gov.uk/roads-and-transport/major-projects-and-improvement-plans/norwich/norwich-western-	Medium	No	No cumulative effects on onshore water resources and flood risk are anticipated as a result of a lack of hydrological connectivity between the projects.

Project	Status	Development period	[1]Distance from Norfolk Vanguard (km)	Project definition	Project data status	Included in CIA	Rationale
				link/timeline			
Third River Crossing (Great Yarmouth)	Pre-application	Expected to start in 2020	28	https://www.norfolk.gov.uk/roads-and-transport/major-projects-and-improvement-plans/great-yarmouth/third-river-crossing	Medium	No	No cumulative effects on onshore water resources and flood risk are anticipated as a result of a lack of hydrological connectivity between the projects.
King's Lynn B Power Station amendments	Pre-application	Expected construction 2018 - 2021	28	https://www.kingslynnbccgt.co.uk/	Medium	No	No cumulative effects on onshore water resources and flood risk are anticipated as a result of a lack of hydrological connectivity between the projects.
North Norfolk District Council							
PF/17/1951 Erection of 43 dwellings and new access with associated landscaping, highways and external works, and amendments to substation)	Awaiting decision	Anticipated Q2 2018	0.7	Application available: https://idoxpa.north-norfolk.gov.uk/online-applications/applicationDetails.do?activeTab=summary&keyVal=_NNORF_DCAPR_92323	High	No	No cumulative effects on onshore water resources and flood risk are anticipated as a result of a lack of hydrological connectivity between the projects.
Bacton Gas Terminal Extension	Approved	Approved 20/09/2016. Expires 20/09/2019.	3.0	Approved PDS available https://idoxpa.north-norfolk.gov.uk/on	Medium	No	The Bacton Gas Terminal Extension comprises new infrastructure within the exiting Bacton Gas Terminal, with no additional land take required. The project is located approximately 3km at its closest

Project	Status	Development period	[1]Distance from Norfolk Vanguard (km)	Project definition	Project data status	Included in CIA	Rationale
				line-applications/applicationDetails.do?activeTab=summary&keyVal=_NNORF_DCAPR_88689			point from the boundary of the infrastructure, As such, no cumulative effects on onshore water resources and flood risk are anticipated as a result of a lack of hydrological connectivity between the projects.
Bacton Gas Terminal Coastal Protection	Approved	Approved 18/11/2016. Expires 18/11/2019.	2.5	Approved PDS available	Medium	No	No cumulative effects on onshore water resources and flood risk are anticipated as a result of a lack of hydrological connectivity between the projects.
Bacton and Walcott Coastal Management Scheme	Approved	Expected construction date 2018	1.0	Public information leaflets available: https://www.north-norfolk.gov.uk/media/3371/bacton-to-walcott-public-information-booklet-july-2017.pdf	Medium	No	No cumulative effects on onshore water resources and flood risk are anticipated as a result of a lack of hydrological connectivity between the projects.
Breckland							
21-31 new dwellings in Necton (BLR/2017/0001/PIP)	Awaiting decision	Application received 30/11/2017	1.0	http://planning.breckland.gov.uk/OcellaWeb/showDocuments?reference=BLR/2017/0001/PIP&module=pl	Medium	No	No cumulative effects on onshore water resources and flood risk are anticipated as a result of a lack of hydrological connectivity between the projects.
4-8 new dwellings in	Awaiting	Application	1.0	http://planning.br	Medium	No	No cumulative effects on onshore water

Project	Status	Development period	[1]Distance from Norfolk Vanguard (km)	Project definition	Project data status	Included in CIA	Rationale
Necton (BLR/2017/0002/PIP)	decision	received 30/11/2017		eckland.gov.uk/OcellaWeb/showDocuments?reference=BLR/2017/0002/PIP&module=pl			resources and flood risk are anticipated as a result of a lack of hydrological connectivity between the projects.
70 dwellings (3PL/2016/0298/D) (Phase 2 of 3PL/2012/0576/O)	Approved (21/09/16)	Not known. Application submitted March 2016.	6.4	http://planning.breckland.gov.uk/OcellaWeb/planningDetails?reference=3PL/2016/0298/D&from=planningSearch	Medium	No	No cumulative effects on onshore water resources and flood risk are anticipated as a result of a lack of hydrological connectivity between the projects.
98 dwellings at Swans Nest with access from Brandon Road (3PL/2017/1351/F) (Phase 3 of 3PL/2012/0576/O)	Awaiting decision (due 30/03/2018)	Not known. Application submitted Jan 2016.	6.4	http://planning.breckland.gov.uk/OcellaWeb/planningDetails?reference=3PL/2017/1351/F&from=planningSearch	Medium	No	No cumulative effects on onshore water resources and flood risk are anticipated as a result of a lack of hydrological connectivity between the projects.
175 dwellings with access at land to west of Watton Road, Swaffham (3PL/2016/0068/O) (Swans Nest Phase B)	Awaiting decision (due 13/10/2017)	Not known. Application submitted Jan 2016.	6.4	http://planning.breckland.gov.uk/OcellaWeb/planningDetails?reference=3PL/2016/0068/O	Medium	No	No cumulative effects on onshore water resources and flood risk are anticipated as a result of a lack of hydrological connectivity between the projects.

286. As identified in Table 20.20, Vattenfall Wind Power Ltd, through one of its subsidiaries, is developing the Norfolk Boreas Offshore Wind Farm (herein the 'Norfolk Boreas project'). The offshore project area for Norfolk Boreas is located to the north of Norfolk Vanguard East, and the DCO submission for Norfolk Boreas is expected to follow approximately a year behind the Norfolk Vanguard DCO submission. The development of Norfolk Boreas will use the same onshore cable route as Norfolk Vanguard. Ducts will be installed along the onshore cable route for Norfolk Boreas at the same time as Norfolk Vanguard.

287. The WCS for this assessment set out in section 20.7.2 has therefore assumed that the duct installation for the onshore cable route for the Norfolk Boreas project will be conducted as part of the project construction (as a worst case). Therefore, the elements of Norfolk Boreas not considered in the assessment conducted in section 20.7.2 are the cable pull and construction and operation of the onshore project substation (including the National Grid substation extension, any landscaping or planting, and the onshore 400kV cable route).

288. Impacts that could potentially occur cumulatively are considered to be similar to those impacts considered during construction and operation and outlined in sections 20.7.5 and 20.7.6, although the magnitude could potentially be increased if activities affect the same surface water catchment or groundwater body at the same time.

289. In summary, the following projects will be assessed for potential direct cumulative impacts:

- Norfolk Boreas Offshore Wind Farm; and
- Hornsea Project Three.

20.8.1 Cumulative Impacts during Construction

20.8.1.1 Impact 1: Direct disturbance of surface water bodies

290. Hornsea Project Three will result in the direct disturbance of surface watercourses in the Blackwater Drain, River Wensum and River Bure catchments, all of which will also be impacted by the Norfolk Vanguard project. However, the mitigation measures outlined in sections 20.7.1 and 20.7.5.1 will prevent any significant adverse impacts on these water bodies resulting from the Norfolk Vanguard project. Furthermore, Hornsea Project Three would adopt a similar suite of best practice mitigation measures to minimise disturbance of the river channel, and maintain river flows, sediment transport and the movement of biota during construction. This would limit further impacts on surface waters to a negligible magnitude.

291. The residual impacts on surface waters resulting from direct disturbance during construction of the Norfolk Vanguard project are **moderate adverse** for the River Bure and Blackwater Drain and **minor adverse** for the River Wensum.

292. When the potential for additional trenched watercourse crossings in each of these catchments is taken into account, a **minor** to **moderate adverse** cumulative impact on each catchment is predicted. Note that although the main River Wensum is likely to be subject to trenchless crossings as part of Hornsea Project Three, there is potential for several of its tributaries to be crossed.

20.8.1.2 Impact 2: Increased surface water runoff and altered subsurface flows

293. Due to the geographical overlap between the project, Norfolk Boreas substation and Hornsea Project Three, there is the potential for direct cumulative impacts upon surface water runoff and subsurface flow characteristics during construction. Construction activities for the project and the Norfolk Boreas substation will occur within the upper Wissey catchment. Construction activities for the project and Hornsea Project Three will occur within the River Bure, Blackwater Drain and River Wensum catchments.

294. During the construction stage, impacts on these catchments could occur as a result of site preparation, construction activities and the development of surface infrastructure for the various projects. There is potential for the unmitigated effects to have significant cumulative impacts on surface water runoff and subsurface flows. These would result in a significance of effect ranging between **moderate to major adverse** (depending upon the sensitivity of the receptors; the statutory designations associated with the River Wensum results in a greater impact than for less sensitive watercourses).

295. However, it is assumed that both Norfolk Boreas and Hornsea Project Three would adopt similar best practice mitigation measures which would seek to avoid, reduce or offset the effects of direct impacts upon drainage. These would likely include the design of surface water drainage requirements to meet the requirements of the NPPF, NPS and the implementation of SuDS techniques. Such strategies are considered highly likely to reduce the significance of effect to an acceptable level. As a result of these mitigation measures, the cumulative impact is considered to be negligible.

296. The residual impacts on surface and subsurface flows anticipated following construction of the Norfolk Vanguard project are **minor adverse** for the River Bure, River Wensum and River Wissey, and **moderate adverse** for the Blackwater Drain. The cumulative impact is therefore considered to be **minor** to **moderate adverse**.

20.8.1.3 Impact 3: Increased sediment supply

297. Due to geographical overlap between the project, Norfolk Boreas substation and Hornsea Project Three, there is the potential for direct cumulative impacts upon sediment supply in surface water catchments where activities from all three schemes will take place (Blackwater Drain, River Wensum, River Bure and River Wissey).

298. Construction activities such as extensive earthworks, the creation of areas of bare ground by removing surface vegetation cover and soil storage could all increase sediment supply to surface watercourses. In the absence of mitigation, direct cumulative impact on sediment would be considered to be high, resulting in a significance of effect ranging between moderate to major adverse (depending upon the sensitivity of the receptors).

299. However, it is assumed that both Norfolk Boreas and Hornsea Project Three would adopt similar best practice mitigation measures which would avoid, reduce or offset the effects of direct impacts upon sediment supply. These would likely include the appropriate storage of topsoil in order to minimise wind and water erosion, and the design of drainage requirements to retain sediment and meet the requirements of the NPPF and NPS EN-5. Such strategies are considered highly likely to reduce the significance of effect to an acceptable level. As a result of this mitigation, the cumulative effect is likely to be of negligible magnitude.

300. The residual impacts on sediment supply anticipated following construction of the Norfolk Vanguard project are **minor adverse** for the River Wensum and River Wissey, and **moderate adverse** for the Blackwater Drain and River Bure. The cumulative impact is therefore considered to be **minor** to **moderate adverse**.

20.8.1.4 Impact 4: Accidental release of fuels, oils, lubricants, foul waters and construction materials

301. There is potential for the accidental release of fuels, oils, lubricants, foul waters and construction materials in catchments where project activities overlap. Construction activities for the project and the Norfolk Boreas substation will occur within the upper Wissey catchment. Construction activities for the project and Hornsea Project Three will occur within the River Bure, Blackwater Drain and River Wensum catchments.

302. However, it is assumed that both Norfolk Boreas and Hornsea Project Three would adopt similar best practice mitigation measures which would avoid accidental releases of fuels, oils, lubricants, foul waters and construction materials through measures such as the implementation of appropriate SuDS techniques, drainage strategies and construction working methodologies to industry recognised best

practice standards. As a result of this mitigation, the cumulative effect is considered to be of negligible magnitude.

303. The residual impacts due to the release of contaminants during construction of the Norfolk Vanguard project are **minor adverse** for the River Wensum, River Wissey, Blackwater Drain and River Bure. The cumulative impact is therefore considered to be **minor adverse**.

20.8.2 Cumulative Impacts during Operation

20.8.2.1 Impact 1: Increased surface water runoff and altered groundwater flows

304. The operational phases of the project, Norfolk Boreas and Hornsea Project Three could potentially alter surface runoff and groundwater flows where permanent infrastructure overlaps. The Blackwater Drain, River Wensum and River Bure catchments will contain the cable route for the project and Hornsea Project Three, while the River Wissey catchment will contain the onshore project substations for the project and Norfolk Boreas.

305. it is assumed that each project would adopt best practice mitigation measures which would avoid, reduce or offset the effects of increased surface runoff and altered groundwater flows. These would likely include the design of surface water drainage systems to meet the requirements of the NPPF, NPS EN-5 and the implementation of SuDS techniques at the onshore project substations. Such strategies are considered highly likely to reduce the magnitude of effect to negligible.

306. The residual impacts on surface water and groundwater flows during the operation of the Norfolk Vanguard project are **minor adverse** for the River Wensum, Blackwater Drain and River Bure, and **negligible** for the River Wissey. The cumulative impact is therefore considered to be **negligible** to **minor adverse**.

20.8.2.2 Impact 2: Supply of fine sediment and other contaminants

307. The operational phases of the project, Norfolk Boreas and Hornsea Project Three could potentially supply fine sediment and other contaminants where permanent infrastructure overlaps. The Blackwater Drain, River Wensum and River Bure catchments will contain the cable route for the project and Hornsea Project Three, while the River Wissey catchment will contain the onshore project substations for the project and Norfolk Boreas.

308. it is assumed that each project would adopt similar best practice mitigation measures which would avoid, reduce or offset the effects of increased supply of fine sediment and other contaminants. These would likely include the appropriate storage and capping of topsoil in order to minimise wind and water erosion, implementation of appropriate SuDS techniques, drainage strategies, and

construction working methodologies to industry recognised best practice standards. Such strategies are considered highly likely to reduce the significance of effect to an acceptable level. Although unmitigated impacts have the potential to be significant, the adoption of these measures would mean that any cumulative effects would be of negligible magnitude.

309. The residual impacts resulting from the release of sediment and other contaminants during the operation of the Norfolk Vanguard project are **minor adverse** for the River Wensum, Blackwater Drain, River Bure and River Wissey. The cumulative impact is therefore considered to be **minor adverse**.

20.8.3 Cumulative Impacts during Decommissioning

310. Decommissioning of the Norfolk Boreas and Hornsea Project Three may potentially take place at the same time as the project. The detail and scope of the decommissioning works for the project will be determined by the relevant legislation and guidance at the time of decommissioning and agreed with the regulator. A decommissioning plan will be provided. As such, cumulative impacts during the decommissioning stage are considered to be no worse than those identified during the construction stage.

20.9 Inter-relationships

311. Table 20.21 provides a description of the likely inter-related effects arising from the project on water resources and flood risk receptors.

Table 20.21 Water resources and flood risk inter-relationships

Topic and description	Related Chapter	Where addressed in this Chapter	Rationale
Impacts upon groundwater bodies	Chapter 19 Ground Conditions and Contamination	Sections 0, 0, 20.7.6.1 and 20.7.6.2	Potential impacts on ground conditions could affect the quality and quantity of groundwater and hydrologically-connected surface waters.
Surface water related impacts upon priority species and designated sites	Chapter 22 Onshore Ecology	Section 20.7.5.1, 20.7.5.2, 0, 20.7.6.1 and 20.7.6.2	Potential impacts on the condition of designated surface waters could impact upon the ecological receptors supported by these features.

20.10 Interactions

312. The impacts identified and assessed in this chapter have the potential to interact with each other, which could give rise to synergistic impacts as a result of that interaction. The worst case impacts assessed within the chapter take these interactions into account and for the impact assessments are considered conservative and robust. For clarity, the areas of interaction between impacts are presented in Table 20.22, along with an indication as to whether the interaction may give rise to synergistic impacts.

Table 20.22 Interactions between impacts

Potential interaction between impacts				
Construction				
	1 Direct disturbance of surface water bodies	**2 Increased sediment supply**	**3 Accidental release of fuels, oils, lubricants, foul waters and construction materials**	**4 Increased surface water runoff and flood risk**
1 Direct disturbance of surface water bodies	-	Yes	Yes	Yes
2 Increased sediment supply	Yes	-	Yes	Yes
3 Accidental release of fuels, oils, lubricants, foul waters and construction materials	Yes	Yes	-	No
4 Increased surface water runoff and flood risk	Yes	Yes	No	-
Operation				
	1 Increased surface water runoff, altered groundwater flows and changes to flood risk		**2 Supply of fine sediment and other contaminants**	
1 Increased surface water runoff, altered groundwater flows and changes to flood risk	-		Yes	
2 Supply of fine sediment and other contaminants	Yes		-	
Decommissioning				
It is anticipated that interactions between decommissioning impacts will be similar in nature to those between construction stage impacts.				

20.11 Summary

313. Moderate adverse residual impacts are predicted on the River Bure catchment and River Wensum catchment as a worst case where permanent culverts are used, and due to increased sediment supply when assessed on a worse case sub-catchment basis.

314. All other assessed impacts for water resources and flood risk, with mitigation measures to reduce impacts associated with the project in place, are **negligible** to **minor adverse**. A summary of the findings of the assessment, which relate to water resources and flood risk are presented in Table 20.23.

Table 20.23 Potential impacts identified for water resources and flood risk

Potential Impact	Receptor	Sub-catchment	Value / Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
Construction							
Impact 1: Direct disturbance of surface water bodies	River Bure catchment	North Walsham and Dilham Canal	Low / Low	Low	Minor	20.7.1 20.7.5.1.2	**Negligible**
		East Ruston Stream	High / High	Low	Moderate	20.7.1 20.7.5.1.2	**Minor adverse**
		New Cut	High / Low	No impact	N/A	Not required	**N/A**
		River Bure	High / Medium	Medium	Major	20.7.1 20.7.5.1.2	**Moderate adverse**
		King's Beck	High / Medium	Medium	Major	20.7.1 20.7.5.1.2	**Moderate adverse**
		Mermaid Stream	High / Medium	No impact	N/A	Not required	**N/A**
	River Wensum catchment	River Wensum	High / High	Negligible	Minor	20.7.1 20.7.5.1.2	**Minor adverse**
		Blackwater Drain	High / High	High	Major	20.7.1 20.7.5.1.2	**Moderate adverse**
		Wendling Beck	High / High	Medium	Major	20.7.1 20.7.5.1.2	**Moderate adverse**
		Penny Spot Beck	High / High	Medium	Major	20.7.1 20.7.5.1.2	**Minor adverse**
	River Wissey catchment	Upper River Wissey	Medium / Medium	Medium	Moderate	20.7.1 20.7.5.1.2	**Minor adverse**
Impact 2: Increased	River Bure catchment	North Walsham	Low / Low	Negligible	Negligible	20.7.1	**Negligible**

Potential Impact	Receptor	Sub-catchment	Value / Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
sediment supply		and Dilham Canal				20.7.5.2.2	
		East Ruston Stream	High / High	Low	Moderate	20.7.1 20.7.5.2.2	**Moderate adverse**
		New Cut	High / Low	Negligible	Minor	20.7.1 20.7.5.2.2	**Minor adverse**
		River Bure	High / Medium	Low	Moderate	20.7.1 20.7.5.2.2	**Moderate adverse**
		King's Beck	High / Medium	Negligible	Minor	20.7.1 20.7.5.2.2	**Minor adverse**
		Mermaid Stream	High / Medium	Negligible	Minor	20.7.1 20.7.5.2.2	**Minor adverse**
	River Wensum catchment	River Wensum	High / High	Negligible	Minor	20.7.1 20.7.5.2.2	**Minor adverse**
		Blackwater Drain	High / High	Low	Moderate	20.7.1 20.7.5.2.2	**Moderate adverse**
		Wendling Beck	High / High	Low	Moderate	20.7.1 20.7.5.2.2	**Moderate adverse**
	River Wissey catchment	Upper River Wissey	Medium / Medium	Low	Minor	20.7.1 20.7.5.2.2	**Minor adverse**
Impact 3: Accidental release of fuels, oils, lubricants, foul waters and construction	River Bure catchment	North Walsham and Dilham Canal	Low / Low	Low	Minor	20.7.1 20.7.5.3.2	**Negligible**
		East Ruston Stream	High / High	Medium	Major	20.7.1 20.7.5.3.2	**Minor adverse**

Potential Impact	Receptor	Sub-catchment	Value / Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
materials		New Cut	High / Low	Low	Moderate	20.7.1 20.7.5.3.2	**Minor adverse**
		River Bure	High / Medium	Medium	Major	20.7.1 20.7.5.3.2	**Minor adverse**
		King's Beck	High / Medium	Low	Moderate	20.7.1 20.7.5.3.2	**Minor adverse**
		Mermaid Stream	High / Medium	Low	Moderate	20.7.1 20.7.5.3.2	**Minor adverse**
	River Wensum catchment	River Wensum	High / High	Low	Moderate	20.7.1 20.7.5.3.2	**Minor adverse**
		Blackwater Drain	High / High	Medium	Major	20.7.1 20.7.5.3.2	**Minor adverse**
		Wendling Beck	High / High	Medium	Major	20.7.1 20.7.5.3.2	**Minor adverse**
	River Wissey catchment	Upper River Wissey	Medium / Medium	Low	Minor	20.7.1 20.7.5.3.2	**Minor adverse**
	Groundwater	Principal Aquifer	High / High	Medium	Major	20.7.1 20.7.5.3.2 20.7.5.3.5	**Minor adverse**
Impact 4: Increased surface water runoff and flood risk	River Bure catchment	North Walsham and Dilham Canal	Low / Low	Low	Minor	20.7.1 20.7.5.4.2	**Negligible**
		East Ruston Stream	High / High	Low	Moderate	20.7.1 20.7.5.4.2	**Minor adverse**

Potential Impact	Receptor	Sub-catchment	Value / Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
		New Cut	High / Low	Low	Moderate	20.7.1 20.7.5.4.2	**Minor adverse**
		River Bure	High / Medium	Low	Moderate	20.7.1 20.7.5.4.2	**Minor adverse**
		King's Beck	High / Medium	Low	Moderate	20.7.1 20.7.5.4.2	**Minor adverse**
		Mermaid Stream	High / Medium	Low	Moderate	20.7.1 20.7.5.4.2	**Minor adverse**
	River Wensum catchment	River Wensum	High / High	Low	Moderate	20.7.1 20.7.5.4.2	**Minor adverse**
		Blackwater Drain	High / High	Low	Moderate	20.7.1 20.7.5.4.2	**Minor adverse**
		Wendling Beck	High / High	Low	Moderate	20.7.1 20.7.5.4.2	**Minor adverse**
	River Wissey catchment	Upper River Wissey	Medium / Medium	Medium	Moderate	20.7.1 20.7.5.4.2	**Minor adverse**
Operation							
Impact 1: Increased surface water runoff, altered groundwater flows, and changes to flood risk	River Bure and Wensum catchments	North Walsham and Dilham Canal	Low / Low	Low	Minor	20.7.1 20.7.6.1.2	**Negligible**
		East Ruston Stream	High / High	Low	Moderate	20.7.1 20.7.6.1.2	**Minor adverse**
		New Cut	High / Low	Low	Moderate	20.7.1 20.7.6.1.2	**Minor adverse**

Potential Impact	Receptor	Sub-catchment	Value / Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
		River Bure	High / Medium	Low	Moderate	20.7.1 20.7.6.1.2	**Minor adverse**
		King's Beck	High / Medium	Low	Moderate	20.7.1 20.7.6.1.2	**Minor adverse**
		Mermaid Stream	High / Medium	Low	Moderate	20.7.1 20.7.6.1.2	**Minor adverse**
		River Wensum	High / High	Low	Moderate	20.7.1 20.7.6.1.2	**Minor adverse**
		Blackwater Drain	High / High	Low	Moderate	20.7.1 20.7.6.1.2	**Minor adverse**
		Wendling Beck	High / High	Low	Moderate	20.7.1 20.7.6.1.2	**Minor adverse**
	River Wissey catchment	Upper River Wissey	Medium / Medium	Low	Minor	20.7.1 20.7.6.1.3	**Negligible**
	Groundwater bodies		High / High	Low	Minor	20.7.1 20.7.6.1.4	**Negligible**
Impact 2: Supply of fine sediment and other contaminants	River Bure catchment	North Walsham and Dilham Canal	Low / Low	Negligible	Negligible	20.7.1	**Negligible**
		East Ruston Stream	High / High	Negligible	Minor	20.7.1	**Minor adverse**
		New Cut	High / Low	Negligible	Minor	20.7.1	**Minor adverse**
		River Bure	High / Medium	Negligible	Minor	20.7.1	**Minor adverse**
		King's Beck	High / Medium	Negligible	Minor	20.7.1	**Minor adverse**

Potential Impact	Receptor	Sub-catchment	Value / Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
		Mermaid Stream	High / Medium	Negligible	Minor	20.7.1	**Minor adverse**
	River Wensum catchment	River Wensum	High / High	Negligible	Minor	20.7.1	**Minor adverse**
		Blackwater Drain	High / High	Negligible	Minor	20.7.1	**Minor adverse**
		Wendling Beck	High / High	Negligible	Minor	20.7.1	**Minor adverse**
	River Wissey catchment	Upper River Wissey	Medium / Medium	Low	Minor	20.7.1 20.7.6.2.4	**Minor adverse**
	Groundwater bodies		High / High	Negligible	Minor	20.7.1 20.7.6.2.4	**Minor adverse**
Decommissioning							
Impacts no worse than those during construction							
Cumulative - Construction							
Impact 1: Direct disturbance of surface water bodies	As per construction						**Minor – Moderate adverse**
Impact 2: Increased surface water runoff and flood risk	As per construction						**Minor – Moderate adverse**
Impact 3: Increased sediment supply	As per construction						**Minor – Moderate adverse**
Impact 4: Accidental release of fuels, oils, lubricants, foul waters and	As per construction						**Minor adverse**

Potential Impact	Receptor	Sub-catchment	Value / Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
construction materials							
Cumulative - Operation							
Impact 1: Increased surface water runoff, altered groundwater flows, and changes to flood risk	As per operation						**Negligible – Minor adverse**
Impact 2: Supply of fine sediment and other contaminants	As per operation						**Minor adverse**
Cumulative - Decommissioning							
The detail and scope of the decommissioning works will be determined by the relevant legislation and guidance at the time of decommissioning and agreed with the regulator. A decommissioning plan will be provided. As such, cumulative impacts for the decommissioning phase are assumed to be no worse than for the construction phase.							

20.12 References

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