Norfolk Boreas Offshore Wind Farm

Consultation Report

Appendix 9.22 Norfolk Boreas Water Resources, Flood Risk, and Ground Conditions outgoing documents

Applicant: Norfolk Boreas Limited
Document Reference: 5.1.9.22
Pursuant to APFP Regulation: 5(2)(q)

Date: June 2019
Revision: Version 1
Author: Copper Consultancy

Photo: Ormonde Offshore Wind Farm

This page is intentionally blank.

Norfolk Boreas Offshore Wind Farm

Environmental Impact Assessment

Ground Conditions and Contamination Method Statement

Document Reference: PB5640-004-001

Author: Royal HaskoningDHV
Applicant: Norfolk Boreas Ltd
Date: January 2018

Date	Issue No.	Remarks / Reason for Issue	Author	Checked	Approved
20/11/2017	D01	Internal draft for review	MW	DBP	DT/AD
14/12/17	D02	Revised following internal review	MW	DBP	DT
05/01/2018	D03	Draft submitted for Vattenfall review	MW	DT	AD
29/01/2018	01F	Issue for consultation	MW	CD	JL

This method statement has been prepared by Royal HaskoningDHV on behalf of Norfolk Boreas Limited in order to build upon the information provided within the Norfolk Boreas Environmental Impact Assessment (EIA) Scoping Report. It has been produced following a full review of the Scoping Opinion provided by the Planning Inspectorate. All content and material within this document is draft for stakeholder consultation purposes, within the Evidence Plan Process.

Many participants of the Norfolk **Boreas** Evidence Plan Process will also have participated in the Norfolk **Vanguard** Evidence Plan Process. . This document is presented as a complete and standalone document however in order to maximise resource and save duplication of effort, the main areas of deviation from what has already been presented through the Norfolk Vanguard Evidence Plan Process and PEIR or in the Norfolk Boreas Scoping Report are presented in orange text throughout this document.

Table of Contents

Figures

Glossary of Acronyms

BGS	British Geological Survey
CIA	Cumulative Impact Assessment
CLR	Contaminated Land Report
CoCP	Code of Construction Practice
CSM	Conceptual Site Model
DCO	Development Consent Order
EA	Environment Agency
EIA	Environmental Impact Assessment
EPP	Evidence Plan Process
ES	Environmental Statement
ETG	Expert Topic Group
GRQA	Generic Quantitative Risk Assessment
HDD	Horizontal Directional Drilling
HDPE	High Density Polyethylene
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
MCZ	Marine Conservation Zone
MMP	Materials Management Plan
MPA	Mineral Planning Authority
PCOC	Potential contaminants of concern
PEI	Preliminary Environmental Information
PIER	Preliminary Environmental Information Report
PPE	Personal Protective Equipment
PPG	Pollution Prevention Guidelines
PRA	Preliminary Risk Assessment
SAC	Special Areas of Conservation
RPE	Respiratory Protective Equipment
SPA	Special Protection Area
SMP	Shoreline Management Plan
SNCI	Site of Nature Conservation Interest
SPZ	Source Protection Zone
SSSI	Site of Special Scientific Interest
SWMP	Site Waste Management Plan
WAC	Waste Acceptance Criteria
WFD	Water Framework Directive
VWPL	Vattenfall Wind Power Ltd VWPL

1 INTRODUCTION

1. The purpose of this method statement is to build upon the information provided within the Norfolk Boreas Environmental Impact Assessment (EIA) Scoping Report, in outlining the proposed approach to be taken and considerations to be made in the assessment of the Ground Conditions and Contamination effects of the proposed development.

2. This method statement and the consultation around it form part of the Norfolk Boreas Evidence Plan Process (EPP). The aim is to gain agreement on this method statement from all members of the ground conditions and contamination Expert Topic Group (ETG) , all agreements will be recorded in the agreement log.

3. This method statement has been produced following a full review of the Scoping Opinion provided by the Planning Inspectorate, responses to the Norfolk Vanguard PEIR and consultation undertaken through Norfolk Vanguard EPP. The EIA Scoping Opinion comments received that relate ground conditions and contamination are summarised in **Table 1.1**.

4. Information provided in this Method Statement is a draft for stakeholder consultation only and is provided in confidence. It is recognised that Norfolk Vanguard ETG meetings are being held in January 2018 and that agreements will be made during those meetings which are not reflected. However due to certain project "Mile Stones" which have been set by the Crown Estate Norfolk Boreas must progress on a programme which requires consultation on the Norfolk Boreas Method Statements prior to the conclusion of the Norfolk Vanguard EPP. Therefore, the material provided in this document represents the best available information at the time of writing.

Table 1.1 Scoping opinion responses relevant to ground conditions and contamination

Consultee	Comment	Response / reference to where this addressed
Secretary of State	The ES should identify and assess potential impacts on the Mineral Safeguarding Areas underlying the onshore scoping area (see the comments of Norfolk County in Appendix 3 of this Opinion).	The Minerals Safeguarding Areas are identified in section 3.1.9 and methodology used for assessment is detailed in section 4.2.2
Secretary of State	The Scoping Report notes there is rapid cliff erosion on the coast of north east Norfolk. The potential impacts of landfall works on coastal processes, including erosion and deposition, should be addressed with appropriate cross reference to other technical reports including landscape and visual impacts. Reference to consideration of the Kelling to Lowestoft Ness Shoreline Management Plan at paragraph 887 of the Scoping Report is welcomed.	The potential impacts of landfall works on coastal processes are discussed in section 5.1.1.
Secretary of State	The Scoping Report has scoped out all operational impacts on ground conditions and contamination at paragraph 907. The only justification for this is that operation and	Impact not included in this Method Statement as it has been scoped out.

Consultee	Comment	Response / reference to where this addressed
	maintenance activities would follow standard procedures. Despite the limited justification provided, the SoS does not consider there would be any significant effects from operation and therefore agrees this can be scoped out.	
Secretary of State	The ES should justify the extent of the study areas used in the assessment in relation to the general 250m and 500m buffer zones around temporary and permanent infrastructure respectively used to define the onshore scoping area as described at paragraph 883 of the Scoping Report.	This was a description of the study area for the Scoping report. The study area for the EIA is defined by the distance over which impacts on ground conditions and contamination from the project may be and by the location of any receptors that might be affected by those potential impacts. This has been established by professional judgement supported by a Preliminary Risk Assessment (PRA) undertaken for Norfolk Vanguard.

1.1 Background

5. A Scoping Report for the Norfolk Boreas EIA was submitted to the Planning Inspectorate on the 9th May 2017. Further background information on the project can be found in the Scoping Report which is available at:

https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010087/EN010087-000015-Scoping%20Report.pdf

6. The Scoping Opinion was received on the 16th June 2017 and can be found at:

https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010087/EN010087-000013-Scoping%20Opinion.pdf

1.2 Norfolk Boreas Programme

7. This section provides an overview of the planned key milestone dates for Norfolk Boreas.

1.2.1 Development Consent Order (DCO) Programme

- EIA Scoping Request submission - 09/05/17
- Preliminary Environmental Information (PEI) submission - Q4 2018
- Environmental Statement (ES) and DCO submission - Q2 2019

1.2.2 Evidence Plan Process Programme

8. The Evidence Plan Terms of Reference (Royal HaskoningDHV, 2017a) provides an overview of the Evidence Plan Process and expected logistics, below is a summary of anticipated meetings:

- Agreement of Terms of Reference - Q3 2017
- Post-scoping Expert Topic Group consultation -Q1 2018
  - Consult on the method statements and Project Design Statement
- Expert Topic Group and Steering Group meetings as required - 2018
  - To be determined by the relevant groups based on issues raised
- PEI Report (PEIR) Expert Topic Group and Steering Group meetings - Q4 2018/ - Q1 2019
  - To discuss the findings of the PEI (before or after submission)
- Pre-submission Expert Topic Group and Steering Group meetings - Q1/Q2 2019
  - To discuss updates to the PEIR prior to submission of the ES

1.2.3 Consultation to Date

9. Norfolk Boreas is the sister project to Norfolk Vanguard (See Section 2 for further details). A programme of consultation has already been undertaken for Norfolk Vanguard which is of relevance to Norfolk Boreas and this is listed below:

- EIA Scoping Request submission - 03/10/16
- Receipt of Scoping Opinion - 11/11/16
- Steering Group meeting -21/03/16
- Steering Group meeting -20/09/16
- Post-scoping Expert Topic Group meetings -25/01/17
  - Agreed method statements and discussed Project Design Statement
- Expert Topic Group meeting to discuss data collection and impact assessment conducted to date - 08/09/17
- EIA Preliminary Environmental Information Report (PEIR) Submission - 27/10/17

2 PROJECT DESCRIPTION

2.1 Context and Scenarios

10. Norfolk Boreas is the sister project to Norfolk Vanguard. Vattenfall Wind Power Ltd (VWPL) is developing the two projects in tandem, and is planning to co-locate the export infrastructure for both projects in order to minimise overall impacts. This co-location strategy applies to the offshore and onshore parts of the export cable route, the cable landfalls, cable relay stations, and onshore substations.

11. The Norfolk Boreas project is approximately 12 months behind Norfolk Vanguard in the Development Consent Order (DCO) process. As such, the Norfolk Vanguard team is leading on site selection for both projects. Although Norfolk Boreas is the subject of a separate DCO application, the project will adopt these strategic site selection decisions.

12. In order to minimise impacts associated with onshore construction works for the two projects, VWPL is aiming to carry out enabling works for both projects under the Norfolk Vanguard DCO. This covers the installation of buried ducts along the onshore cable route, from the landfall to the onshore substation, modifications at the Necton National Grid substation, visual screening works, access road construction, utility connections (water, electricity and phone) and site drainage.

13. However, Norfolk Boreas need to consider the possibility that the Norfolk Vanguard project would not be constructed. In order for Norfolk Boreas to stand up as an independent project, this scenario must be provided for within the Norfolk Boreas DCO. Thus, there are two alternative scenarios to be considered in the context of the EIA and this method statement:

- **Scenario 1:** Norfolk Vanguard consents and constructs transmission infrastructure which would be used by Norfolk Boreas. This includes, cable ducts, access routes to jointing pit locations, extension of the Necton National Grid substation, overhead line modification at the Necton National Grid substation and any site drainage, landscaping and planting schemes around co-located infrastructure. Under Scenario 1 Norfolk Boreas will seek to consent the Horizontal Directional Drilling (HDD) at landfall, the creation of the jointing and transition pits, onshore project substation, cable relay station (if required) and the installation of cables in the ducts through a process of cable pulling'.

- **Scenario 2:** Norfolk Vanguard is not constructed and therefore Norfolk Boreas will seek to consent and construct all required project infrastructure including: HDD at landfall, creation of transition and jointing pits, installation of cable ducts, cable installation, cable relay station (if required), onshore project substation, 400kV interface works (between the onshore project substation and the Necton National Grid substation), extension to the Necton National Grid substation, overhead line modification and any site drainage and landscape and planting schemes. For the sake of clarity, the Norfolk Boreas project would, under Scenario 2, involve the construction and installation of all onshore infrastructure necessary for a viable project.

14. In terms of impacts to ground conditions and contamination caused by the Norfolk Boreas project, there would be greater impacts under Scenario 2 and impacts are likely to be of greater magnitude, due to the greater ground disturbed. However these would be similar in magnitude to the cumulative impacts associated with the Norfolk Vanguard and Norfolk Boreas project combined.

15. **Appendix 1** contains a set of figures showing the onshore infrastructure and **Appendix 2** contains a detailed comparison of what is included in the two different scenarios across all elements of the project. Both these appendices are provided in separate documents.

16. Norfolk Boreas are proposing to adopt a construction strategy whereby there are multiple moving work fronts which complete the majority of all construction works in each area before moving on. This reduces overall construction time as most works are completed in one pass and allows flexibility for areas to be avoided at sensitive times and to minimise impact through scheduling of works.

2.2 Site Selection Update

17. A detailed programme of site selection work has been undertaken by VWPL to refine the locations of the onshore infrastructure for both the Norfolk Vanguard and Norfolk Boreas projects. The Norfolk Vanguard EIA Scoping Report presented search areas for the onshore infrastructure which were identified following constraints mapping to avoid or minimise potential impacts (e.g. noise, visual, landscape, traffic, human health and socio-economic impacts). Further data review has been undertaken to understand the engineering and environmental constraints within the search areas identified. This process has been informed by public drop in exhibitions (October 2016, March and April 2017), along with the Scoping Opinion for Norfolk Vanguard and the feedback from the Expert Topic Groups. Details of the site selection process are provided in Chapter 4 of the Norfolk Vanguard Preliminary Environmental Information Report (Royal HaskoningDHV, 2017b) with a summaries provided below:

2.2.1 Landfall Zone

18. The Norfolk Boreas Scoping report presented three potential landfall locations. Data was reviewed on a broad range of environmental factors, including existing industrialised landscape, the presence of the Cromer Shoal Chalk Beds Marine Conservation Zone (MCZ), coastal erosion and archaeology alongside statutory and non-statutory consultation.

19. After publication of the scoping report, VWPL concluded, taking account of all engineering and environmental factors, as well as public feedback, that the most suitable landfall location would be Happisburgh South. The decision to go to Happisburgh south was presented to the Norfolk Vanguard Evidence Plan Expert Topic groups in June and July 2017 and in the Norfolk Vanguard PEIR (Royal HaskoningDHV 2017b).

20. Happisburgh South also has the benefit of being large enough to accommodate landfall works of both Norfolk Vanguard and Norfolk Boreas, therefore reducing the spatial extent of impacts associated with the two projects.

2.2.2 Cable Relay Station Options

21. The Norfolk Boreas Scoping report presented seven potential cable relay station search zones. A single cable relay station would be required for a High Voltage Alternating Current (HVAC) electrical solution. No cable relay station would be required for a High Voltage Direct Current (HVDC) electrical solution. The decision between HVDC and HVAC solutions is not expected to take place until post consent, therefore for the purposes of the EIA, and under the project envelope approach, assessment would be conducted on the basis of the realistic worst case.

22. Following the scoping opinion further work has been completed and two potential locations are being proposed for the cable relay station (**Appendix 1**). The final siting of the cable relay station on either footprint will have due consideration for of existing watercourses, hedgerows, landscaping, archaeology, ecology, noise, access and other known infrastructure/environmental constraints to minimise impacts, along with feedback from statutory and non-statutory consultation.

23. A Norfolk Boreas cable relay station temporary construction compound area has not yet been identified, however a location will have been determined prior to the Norfolk Boreas PEIR being published in Q4 2018.

2.2.3 Onshore Cable Route

24. A 200m wide cable corridor was presented within the Norfolk Boreas scoping report. This corridor, shared with Norfolk Vanguard, is the shortest realistic route between

landfall and the Necton National Grid substation (thereby minimising disturbance impacts) whilst also aiming to avoid main residential areas and impacts to landscape, nature conservation designations and other key environmental constraints where possible.

25. The proposed route skirts around the main towns of North Walsham, Aylsham, Reepham and Dereham. Since the Norfolk Boreas scoping report was published further work has been completed (see Royal HaskoningDHV, 2017b for detail) to refine the cable corridor and an indicative cable route has been established suitable for infrastructure for both the Norfolk Vanguard and Boreas onshore export cables (**Appendix 1**).

2.2.4 Onshore Project Substation

26. The Norfolk Boreas scoping report presented an onshore project substation zone within which the onshore project substation was to be located. Following further site selection work (presented in Royal HaskoningDHV, 2017b) a preferred onshore project substation location has been identified. Although the onshore project substation location is now well defined there remains the possibility that its exact location may change slightly following consultation on the Norfolk Vanguard PEIR, therefore an onshore project substation search area has been retained (**Appendix 1**).

27. A Norfolk Boreas Onshore project substation temporary construction compound area has not yet been identified, however a location will have been determined prior to the Norfolk Boreas PEIR being published in Q4 2018.

2.2.5 Extension to the Existing Necton National Grid substation

28. The Norfolk Boreas Scoping report presented a National Grid substation extension zone. Since the publication of that report further work has been undertaken to define the footprint of these extension works (**Appendix 1**). Further detail on this process is presented in Chapter 4 of the Norfolk Vanguard PEIR (Royal HaskoningDHV, 2017b).

29. Also presented in the Norfolk Boreas Scoping report was an overhead line modification zone within which the overhead lines leading into the Necton National Grid substation would be realigned (section 2.3.1.5). The area within which this work will be undertaken has been refined and is presented in **Appendix 1**. Further detail on the process behind this refinement is provided in the Norfolk Vanguard PEIR chapter 5 site selection and alternatives.

2.3 Indicative Worst Case Scenarios

30. The following sections set out the current predicted worst case scenarios for Ground Conditions and Contamination. The Norfolk Boreas PEIR and the ES will provide further detail on the Project Description describing the final project design envelope for the DCO application.

31. Each chapter of the PEIR and ES will define the worst case scenario arising from the construction, operation and decommissioning phases of the Norfolk Boreas project for the relevant receptors and impacts. Additionally, each chapter will consider separately the anticipated cumulative impacts of Norfolk Boreas with other relevant projects which could have a cumulative impact on the receptors under consideration.

32. The parameters discussed in this section are based on the best available information for Norfolk Boreas at the time of writing and are subject to change as the project progresses.

2.3.1 Infrastructure Parameters

33. HVAC and HVDC electrical solutions are being considered for Norfolk Boreas. Both electrical solutions would have implications for the required onshore infrastructure. Typically the HVAC solution involves a greater area of land take and additional infrastructure, and as such the HVAC solution is assumed as the worst case in the remainder of this section. Where the worst case assumes the HVDC solution, this is stated in the text.

34. The following key onshore project parameters are considered within this method statement:

- Landfall (Horizontal Directional Drilling (HDD) and associated compounds);
- Cable relay station (required for HVAC only);
- Cable corridor (with associated trenchless crossing technique areas, construction compound mobilisation areas and access);
- Onshore project substation;
- Interface cables connecting the onshore project substation and the Necton National Grid substation; and
- Extension to the existing Necton National Grid Substation, including overhead line modification.

35. Each of these project parameters is described in more detail below.

36. As outlined in section 2.1, not all of the parameters listed above are required for each Scenario. In the description of each parameter set out below, explanation of

which elements of the parameter are required for Scenario 1 or Scenario 2 is included in the text and summarised at the end of the section. For full detail of what is considered in Scenario 1 and what is considered in Scenario 2, please see **Appendix 2**.

37. Under Scenario 1, The Norfolk Vanguard project would be considered within the Cumulative Impact Assessment (CIA), together with the parameters of Norfolk Boreas (as listed in the bullets points above). Other projects which would be considered in the CIA are discussed in section 2.3.2.

2.3.1.1 Landfall

38. The landfall compound zone (**Appendix 1**) denotes the location where up to six Norfolk Boreas offshore export cables would be brought ashore. These would be jointed to the onshore cables in transition pits located within the easternmost "trenchless crossing technique" area shown in **Appendix 1**. Under Scenario 1 Norfolk Boreas would share the landfall area with Norfolk Vanguard at Happisburgh South.

39. Works associated at landfall would be the same under both scenarios. Under Scenario 1, if Norfolk Boreas cable ducts will be installed concurrently with the Norfolk Vanguard ducts, the Norfolk Boreas ducts would be installed only on the landward (western) side of the transition pits. Ducts on the seaward side of the transition pits would be installed using Horizontal Directional Drilling (HDD) which is a trenchless installation technique. The HDD would exit at one of the following two locations (impacts of the HDD exit point will be considered in the offshore assessments including the Marine Geology, Oceanography and Physical Processes and the Benthic and Intertidal Ecology impact assessment):

- On the beach, above the level of mean low water spring (classified as "short HDD").
- At an offshore location, seaward the beach (up to 1000m in drill length) (classified as "long HDD").

40. In the case of a short HDD, temporary beach closures would be required during drilling exit and duct installation to maintain public safety. Beach access would be required for an excavator and 4x4 vehicles.

41. Key parameters of works at landfall:

- Installation of temporary construction compound to accommodate the drilling rig, ducting and associated materials and welfare facilities.
- A total of up to six ducts for the HVAC solution or two ducts for the HVDC solution would be required at the landfall for Norfolk Boreas.

- Temporary footprint of works would be up to 3,000m^2 per compound (up to six compounds).
- For a drill length of 500m, it is anticipated that site establishment, drilling of up to six ducts and demobilisation will take approximately 30 weeks.
- The site would fully reinstated upon completion of the landfall works.

42. Up to six transition pits to connect the offshore and onshore cables at the landfall which would be required, these would be grouped together and staggered as necessary to be accommodated within the permanent cable corridor. The transition pit would comprise of an excavated area of 15m x 10m x 5m at the base, per circuit, with a reinforced concrete floor to allow winching during cable pulling and a stable surface to allow jointing.

43. A temporary compound would be assembled to provide a controlled environment to be maintained during jointing activities. A small generator could be required to provide the necessary electrical power for the enclosure, any powered jointing equipment and any pumps to manage groundwater.

44. Joints would be buried to a depth of 1.2m using stabilised backfill, pre-excavated material or a concrete box. The remainder of the jointing pit would be backfilled with the pre-excavated material and returned to the pre-construction condition, so far as is reasonably possible.

45. Link boxes for each of the transition pits would also be required for an HVAC solution and may be required to a lesser degree for the HVDC solution.

2.3.1.2 Cable Relay Station

46. A cable relay station would be required for a HVAC electrical solution. No cable relay station would be required for a HVDC solution. Therefore the HVAC solution is the worst case scenario for this element of the onshore infrastructure. The cable relay station would be constructed by Norfolk Boreas under both Scenarios 1 and 2 and would be located within one of the sites identified in **Appendix 1**.

47. Key parameters of works at cable relay station are as follows:

- The cable relay station would consist of a three phase reactor per HVAC circuit (a total of six reactors) with associated outdoor GIS (Gas Insulated Switchgear). Each reactor would be installed in concrete bunds to contain oil leakage and prevent damage to the environment. Cables from the landfall and onwards to the onshore substation would be laid in concrete troughs within the cable relay station and terminated at the GIS.

- The maximum height of the reactor and associated GIS equipment would be 8.0m.
- The total cable relay station fenced area would be 73m x 135m, with a perimeter fence height of 2.4m. External to the perimeter fence would be a small control building with associated parking with combined dimensions of 31m x 18m.
- There would be an additional temporary construction area with a maximum temporary footprint of 15,000m^2 during construction of the cable relay station.

48. During construction of the cable relay station the temporary construction compound would be established to support the works. The location of the temporary construction compound has not yet been determined but will be presented within the Norfolk Boreas PEIR being published in Q4 2018. Given construction duration, the compound would likely be tarmacked with some concrete hard standing for heavier plant and equipment. Appropriate access to the B1159 would be provided to permit safe delivery of plant and equipment required for construction (In Scenario 1, this access would be shared with the cable relay station for Norfolk Vanguard; in Scenario 2, the access would have to be constructed as part of Norfolk Boreas.)

49. The compound would accommodate construction management offices, welfare facilities, car parking, workshops and storage areas. Water, sewerage and electricity services would be required at the site and supplied either via mains connection or mobile supplies such as bowsers, septic tanks and generators. Under Scenario 2 this compound would also serve as a Primary Mobilisation Area (PMA) for cable installation works. Under Scenario 1 PMAs are not required.

50. Surface water drainage requirements would be dictated by the final drainage study and would be designed to meet the requirements of the National Planning Policy Framework (NPPF). The SUDS (Sustainable Drainage Systems) philosophy would be employed to limit run-off, where feasible, through the use of infiltration techniques which can be accommodated within the area of development. Foul drainage would be collected through a mains connection to existing local authority sewer system if available or septic tank located within the development boundary. The specific approach would be determined during detailed design with consideration for the availability of mains connection and the number of visiting hours for site attendees during operation.

51. The site would be stripped of soil and soil graded as required by the final design. Under Scenario 2 the stripped material would be reused on site where possible as part of bunding and shielding as allowed for in the final design. Under Scenario 1 there would be less capacity to do this as landscaping schemes developed to mitigate visual impacts of both Norfolk Vanguard and Norfolk Boreas would have

started to mature by the time Norfolk Boreas construction starts. Any excess material would be disposed of at a licenced disposal site. Excavations and laying of foundations, trenches and drainage would commence after grading is complete.

52. At this stage it is not known whether the foundations would either be ground-bearing or piled. The design would be based on the prevailing ground conditions. Upon completion of the foundations, the specialist electrical equipment would then be delivered to site, installed and commissioned. Due to the size and weight of the reactors, specialist delivery methods would be employed and offloaded at site with the use of a mobile gantry crane.

2.3.1.3 Onshore cable corridor

53. The onshore cable corridor will contain the final onshore cable route. Currently an indicative cable route has been identified and is displayed in **Appendix 1**.

2.3.1.3.1 Onshore cable route

54. The onshore cable route would contain the main 220kV HVAC or ±320kV HVDC export cables housed within High Density Polyethylene (HDPE) ducts and 400kV HVAC interface cables connecting the onshore project substation with the Necton National Grid substation. The main export cable onshore corridor connects the landfall to the onshore project substation. A plan of the onshore cable route is shown in **Appendix 1**.

55. The key elements of the onshore cable route for Scenarios 1 and 2 are detailed in **Appendix 2**, and summarised below.

Scenario 1

56. Norfolk Vanguard would install cable ducts and undertake enabling works (e.g. running track, accesses etc.) for Norfolk Boreas along the entire length of the onshore cable corridor. Therefore, all excavations (except Jointing pits and associated temporary construction compounds) and crossings would have already been undertaken. In addition, all ducts would be installed and ground reinstated by Norfolk Vanguard.

Scenario 2

57. Norfolk Boreas would be responsible for installing all onshore cable route infrastructure required for the project, including installing ducts along the entire cable route and reinstating land. Under this scenario the cable route would also require trenches for the cable circuits, a running track to deliver equipment to the installation site from mobilisation areas and storage areas for topsoil and subsoil.

58. For Scenario 2, indicative cable route plans have been developed to illustrate the cable corridor required to install the ducts and cables for the HVAC and HVDC electrical solutions for Norfolk Boreas, see **Plate 2.1** and **Plate 2.2** below.

59. For each corridor, the total temporary strip (total land requirement to install the cables), permanent strip (total ongoing land requirement of the installed cables) and ongoing right of access strip (temporary area required to be reserved for access for future repair or maintenance activities) are illustrated. Dependant on the land agreement approach taken, the ongoing right of access strip could be absorbed within the permanent easement, however, they are identified separately at this time.

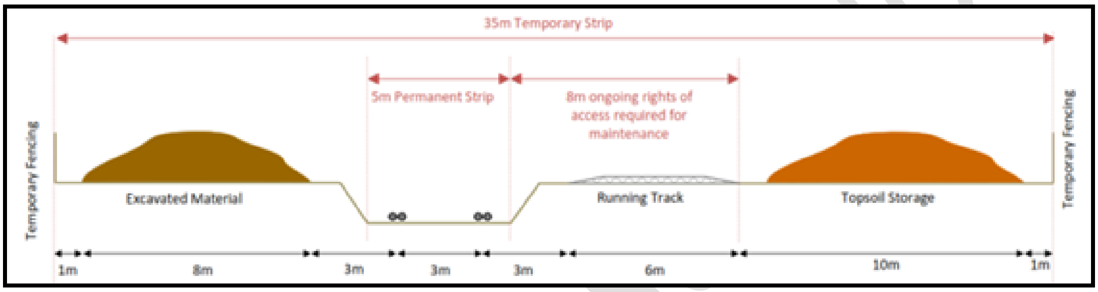

Plate 2.1 Indicative Norfolk Boreas HVDC Onshore Cable Corridor

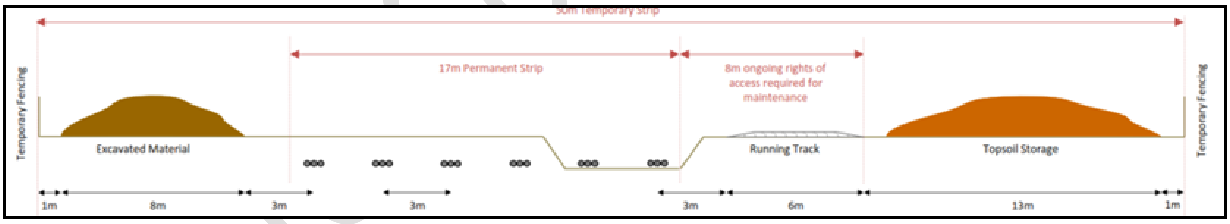

Plate 2.2: Indicative Norfolk Boreas HVAC Onshore Cable Corridor

2.3.1.3.2 Trenching and soil storage

Scenario 1

60. No trenching and soil storage would be required under this scenario for Norfolk Boreas as these works would have been completed under Norfolk Vanguard.

Scenario 2

61. Norfolk Boreas would be responsible for duct installation requiring trenching and storage for topsoil and subsoil. The main duct installation method would be through the use of open cut trenching with HDPE ducts installed, soil backfilled and land reinstated. Cables would then be pulled though the pre-laid ducts at a later stage.

62. Under Scenario 2 the ducts would nominally be installed in a flat formation (each cable core installed alongside each other) to a depth of 1.05m (to top of duct), in a trench of approximate 1m width. This depth allows the cables /ducts (and protective tiles and tape) to be laid below the level of typical field drainage pipes and other underground services to minimise impact and interaction.

63. Where the cable route crosses major transport routes or waterways the standard open cut trenching installation technique might not be suitable. The cable burial depth might increase at these crossing locations or an alternative trenchless method may be used. Further details of crossing methodologies are provided below. Where open cut trenching is employed in these locations and associated locations such as hedgerows, the working width could be reduced to the running track and cable trenching areas only (e.g. 25m for HVAC) with soil storage areas retained immediately before and after the feature crossing.

64. Topsoil would be stripped from the entire width of the onshore cable route for the length of route to be worked on at any one time and stored and capped to minimise wind and water erosion within the onshore cable route as shown in **Plate 2.1** and **Plate 2.2**.

65. The profile of the soil would be carefully maintained during the storage process. The cable trenches would then be excavated, typically utilising tracked excavators. The excavated subsoil would be stored separately from the topsoil, capped and the profile of the soil maintained during the storage process.

66. The trench could require shoring with wooden battens or other edge protection to enhance integrity and mitigate trench collapse risks. This requirement would be dependent on appropriate risk assessments considering the soil and prevailing weather conditions.

67. A pre-construction drainage plan would be developed and implemented to minimise water within the trench and ensure ongoing drainage of surrounding land. Where water enters the trenches during installation, this would be pumped via settling tanks or ponds to remove sediment, before being discharged into local ditches or drains via temporary interceptor drains.

68. A stabilised backfill such as CBS (Cement Bound Sand) would be installed at the base of the trench. A duct for each cable core and a separate duct for a fibre optic bundle would be laid on the CBS base and backfilled with CBS to a covering depth of 100mm. This approach would ensure a consistent homogeneous medium for the dissipation of heat generated by the onshore cables during operation. The CBS backfill would be covered with high voltage cable warning tiles with integrated warning tape and the trench backfilled with subsoil material excavated from the

trench. The stored topsoil would be replaced upon the backfilled subsoil to reinstate the trench to pre-construction condition, so far as reasonably possible.

69. Alternatively, a tracked trenching machine could be used which allows ducting installation to be achieved without excavation. This method will be dependent on soil conditions and other detailed design aspects to be reviewed at the time of construction design.

2.3.1.3.3 Running track

70. A running track would provide safe access for construction vehicles within the onshore cable corridor. The running track could be up to 6m wide with a separation of 2m would be maintained from the edge of the running track and the cable trench for safety and duct storage prior to pulling in the duct sections.

Scenario 1

71. Under Scenario 1 approximately 20% of the Norfolk Vanguard running track would need to be retained or reinstatement (reinstated being the worst case scenario) for the cable pulling phases.

Scenario 2

72. Under Scenario 2 running track would be installed along the entire length of the cable route (approximately 60km) to allow safe access from mobilisation areas to the duct installation sites.

73. Following topsoil stripping, the running track would be formed of protective matting, temporary metal road or permeable gravel aggregate dependant on the ground conditions, vehicle requirements and any necessary protection for underground services. Monitoring of the subsoil would be conducted to minimise long term damage and higher grade protection will be applied if deemed necessary.

74. At drain crossings the running track would be installed over a pre-installed culvert pipe to allow continued access to the cable route. The pipe would be installed in the drain bed so as to avoid upstream impoundment, and would be sized to accommodate reasonable ‘worst-case’ water volumes and flows. These culverts could remain in place for up to two years.

75. At larger road and water course crossings, temporary bridges may be employed to allow continuation of the running track. At railway and main river crossings where a trenchless crossing solution would be used, the running track would not be continuous. These locations would be ‘stop ends’ to the construction work fronts.

76. During the duct installation process, each work team would use the running track to travel from the PMA or appropriate running track access point to the work front. The running track would also be used for transport of plant and materials between the PMA and the work front. The running track would be extended piece-wise as the work front moves outward from the PMA. When duct installation is completed, the running track would be taken up and the topsoil replaced. All recovered stone and other materials would be removed from site via the PMA.

77. The running track would be required to remain cleared for the duration of the trenching and ducting activities to allow access along the cable route. Following construction completion of the duct installation, all or the majority of the running track would be removed and the topsoil reinstated, although rights would be retained to access the running tracks location should repairs of the cables be required during the lifetime of the project. Approximately 20% of the access track would need to be retained or reinstated for subsequent cable pulling phases

2.3.1.3.4 Cable pulling process

78. Under either Scenario the onshore cables would be pulled through the installed ducts later in the construction programme in a staged approach, as offshore generating capacity comes online. This approach allows the major onshore civil engineering works to be completed in advance of cable delivery.

79. Cable pulling would not require the trenches to be reopened, with the cables pulled through the preinstalled ducts between the jointing pits located along the onshore cable route. Access to and from the jointing pits would be required to facilitate the works during this phase of the project.

80. This would be achieved through access to the onshore cable jointing pits directly from the highways network (at crossing locations) or existing local access routes where possible. Under Scenario 2, in some locations, small sections of the running track would be left in place from the duct installation works or required to be reinstated to allow access to more remote jointing bay locations. It is considered that the worst case scenario would require approximately 20% of the running track to be retained or reinstated to facilitate access to jointing pits.

81. The cable pulling and jointing process will take approximately six weeks per 1km of cable length, including installing and removing any temporary hard standing and delivering the cables to the jointing pits. However any one jointing pit may be open for up to 12 weeks to allow its neighbouring jointing pit to be opened and the cables pulled from one pit to the next, dependant on the level of parallel work being conducted.

2.3.1.3.5 Jointing pits

82. Jointing pits would be required along the onshore cable route to allow cable pulling and jointing of two sections of cable. Under both Scenario 1 and 2, the Jointing pits would be installed by Norfolk Boreas for pulling cables through.

83. Under Scenario 1 VWPL are considering the possibility of reusing the same areas as those used to construct jointing pit compounds for Norfolk Vanguard during Norfolk Boreas construction. If at the detailed design phase the decision is made to do this there would be the possibility of leaving materials used to construct the Norfolk Vanguard jointing pit compounds in situ for use in the Norfolk Boreas jointing pit compounds. However, as this is yet to be confirmed the worst case is that this will not be possible and all jointing pit construction compounds would be fully constructed under the Norfolk Boreas consent.

84. The Jointing pits would typically be located at 800m intervals, the maximum cable length which can be delivered, although site specific constraints may result in shorter intervals where necessary. The Jointing pits will be of a similar design and installed in a similar approach to the transition Jointing pits detailed in Section 2.3.1.1

85. Access to and from jointing pits would be required for the cable pull through. These would be retained or reinstated from those used by Norfolk Vanguard in Scenario 1, but would be retained or reinstated from the duct installation phase in Scenario 2. Under either Scenario the land on which the access route has been established would be reinstated.

2.3.1.3.6 Link boxes

86. Link boxes are required for a HVAC connection arrangement to enable the cables to work as efficiently as possible. These would typically be installed in close proximity (within 10m) to jointing pit locations.

87. There are two options being considered for Link Box installation: Either a box with dimensions 1.5m x 1.5m, per circuit, would be buried to ground level within an excavated pit, providing access via a secured access panel or, an above ground link box cabinet with a footprint of 1.0m x 0.5m and a height of 1.0m could be utilised.

2.3.1.3.7 Crossing installation methods

Scenario 1

88. Under this scenario all necessary crossing installation would have been completed by Norfolk Vanguard. No additional works would be required by Norfolk Boreas.

Scenario 2

89. Under this scenario all crossings would be consented and installed by Norfolk Boreas. When crossing some features along the onshore cable route, alternative or amended installation approaches would be required to minimise the impact on the feature or obstacle being crossed as much as reasonably practicable. The following subsections detail the crossing installation methods available with the type proposed at each crossing fully detailed within the PEIR and ES.

90. For hedgerows, roads and watercourses. Under Scenario 1, all crossings would have already been undertaken and land reinstated by Norfolk Vanguard. Under Scenario 2 Norfolk Boreas would consent and install all required crossings.

91. When crossing hedgerows under Scenario 2, the width of the cable route would be reduced to the running track and cable trenches only to minimise the amount of hedgerow removal. Using this technique, the hedgerow removal would be reduced to a maximum of 25m width.

92. Where underground services are identified, manual trench excavation would be employed within 1m (or the stipulated distance requirement of the asset owner if applicable) of these locations to uncover the services in a controlled and safe manner. The works would be conducted within the cable route with no additional land requirements. The running track could require reinforcement in these locations to minimise the risk to services damage. Soil segregation and storage and re-instatement of the trench would be conducted in line with the main cable route installation.

93. Where the onshore cable route crosses roads, tracks and public rights of way, traffic management during the construction phase would be employed to allow these activities to continue safely. Where appropriate, single lane operation of roads would be utilised during installation with signal controls to allow movements to continue. The detailed installation method for each crossing utilising traffic management would be agreed with the relevant highways authority or landowner prior to works beginning. It should be noted that trenchless crossing methods could be required at locations where standard traffic management techniques are not deemed to be suitable. Further work to identify these locations is ongoing and details will be provided within the PEIR and ES project description chapters. The works would be conducted within the cable easement with no additional land requirements. Soil storage and re-instatement of the trench would be conducted in line with the main cable route installation and the road surface would be reinstated to its pre-excavation condition, so far as reasonably possible.

94. Where small scale watercourses such as field drains, which are shallower than 1.5m are to be crossed, temporary damming and diverting of the watercourse could be employed. The suitability of this method would be advised at the detailed design stage following consent from the relevant land owners as part of the agricultural design process; larger water courses may also require consent from internal drainage boards and flood management agencies.

95. The works would be conducted within the cable route with no additional land requirements. The running track may require culverting or temporary bridging in these locations to allow continued cable route access. The running track would be removed once cable installation is complete.

96. Where larger watercourses such as field drains are deeper than 1.5m, culverting might be used. However the Environment Agency deem this technique to be the least desirable river crossing method, therefore the use of culverting would be avoided wherever possible. Where culverting is required, consultation would be carried out would with the Environment Agency, relevant internal drainage boards and flood management agencies at the detailed design phase.

97. Where culverting is employed, a pipe would be installed in the watercourse, suitably sized for necessary water volumes and flows. The pipe would be backfilled or encased in concrete to a depth of 2m. The cable ducts would subsequently laid perpendicular and backfilled to ground level creating a culverted watercourse.

98. Culverting would be carried out within the onshore cable route and would have no additional land requirements. The running track would also be required where culverting is undertaken to allow continued cable route access. Culverting may be required temporarily for a width of 6m to allow the running track to cross watercourses during installation works.

99. Cable bridges could also be used to cross larger water courses. A cable bridge structure would be constructed across the feature at a height specified by the feature and its uses. Ducts would be installed along the bridge for the cables to be pulled within. At the entrance/exit of the cable bridge, the ducts would transition from above ground to below ground. During the transition where the installation depth is less than 1.05m, concrete covers would be laid to protect the cables from damage. The bridge would include protective measures to prevent public access to the cables or the bridge.

100. Trenchless installation methods such as HDD, micro tunnelling or auger boring are likely to be used where open cut trenching is not suitable due to the crossing width or the feature being crossed. Trenchless methods will be employed at the River Wensum and River Bure (Special Area of Conservation – SAC, Site of Special Scientific

Interest – SSSI) and major infrastructure such as Network Rail to minimise the impact to the feature being crossed. The locations of these are shown in **Appendix 1** (termed trenchless crossing techniques).

101. With trenchless methods, the depth at which the ducts are installed depends on the topology and geology at the crossing site. Typically, for a river crossing, HDD ducts would be installed 5 to 15m below the floodplain, and at least 2m below the river bed.

102. Where trenchless drilling activities are to be conducted, a temporary work area would be required to store drilling equipment, welfare facilities, ducting and water for the drilling process. The trenchless drilling compounds would typically be of dimensions 50m x 50m for the reception site and 100m x 50m on the launch site, adjacent to the onshore cable route. A temporary bridge might be included to allow continuation of the running track and allow access to both sides of the crossing. Alternatively, a stop end would be used, requiring the inclusion of a turning area for vehicles within the temporary work area.

2.3.1.3.8 Temporary construction compounds

Scenario 1

103. Under Scenario 1 no primary and secondary mobilisation areas would be required as materials will be delivered directly to jointing pits locations.

Scenario 2

104. Primary and secondary mobilisation areas would be required to store equipment and provide welfare facilities. Indicative locations for these are provided in **Appendix 1**. The primary mobilisation areas would typically be of 100m x 100m dimensions (or 150m x 100m if combined with a trenchless drilling compound) and the secondary mobilisation areas would be approximately 40m x 40m with specific sizing and dimensions for each location based on site constraints and land boundaries.

105. Hardstanding would likely comprise of permeable gravel aggregate to a depth of 0.3m underlain by geotextile or other suitable material would be employed to allow safe storage and movement of vehicles within the area and maintain required drainage. Site lighting and secure fencing around the perimeter of the mobilisation area would be put in place for safety and security purposes. Where possible, the primary mobilisation area would be supplied by existing water, sewerage and electrical services although the use of bowsers, septic tanks and generators can be employed if necessary.

106. The mobilisation areas would remain in place for the duration of the onshore duct installation activities, anticipated to be up to two years. Following installation of the ducts, the mobilisation areas would be removed and the land reinstated. During subsequent cable pull phases (for Scenario 2 and all work in the cable corridor under Scenario 1), materials will be delivered directly to the relevant jointing pit locations.

107. The secondary mobilisation areas would serve construction crews working remotely from the primary mobilisation areas to allow close proximity to storage and welfare facilities during installation.

2.3.1.3.9 Cable route side access

108. Small temporary access routes would be required to facilitate the safe ingress and egress from the public highways to the construction locations termed side accesses.

109. Detailed traffic and transport assessments are ongoing to identify where these side accesses are likely to be required the current proposed locations are displayed in **Appendix 1**. They link each mobilisation area and intersections between the public highway and cable route, where suitable, to facilitate side access to the haul road.

Scenario 1

110. Under Scenario 1 some of the side access to the cable route would be retained or reinstated from the Norfolk Vanguard project. For the purposes of this Method Statement the worst case scenario would be the reinstatement of these accesses.

Scenario 2

111. Under Scenario 2 side accesses to the cable route would need to be constructed and would be left in place for three years to provide for three phases of cable pulling before being removed and land reinstated.

2.3.1.4 Onshore Project Substation

112. The onshore project substation would consist of either an HVAC substation or HVDC substation[1], dependant on the electrical solution utilised. Only one project substation (HVAC or HVDC) would be required for Norfolk Boreas. The proposed onshore project substation location is presented in **Appendix 1**, with dimensions as detailed below.

113. The location of the onshore project substation was determined by an optioneering process which is explained in Chapter 4 site selection and alternatives of the Norfolk Vanguard PEIR (Royal HaskoningDHV, 2017b).

[1] Also referred to as a HVDC converter station. For the purposes of consistency both HVAC and HVDC solutions will be referred to as the onshore project substation.

114. The total land requirement for either the HVAC or HVDC onshore project substation to the perimeter fence would be up to 250m x 300m.

115. During construction of the onshore project substation, a temporary construction compound would be established to support the works. The compound would be formed of hard standing with appropriate access to the A47 to allow the delivery and storage of large and heavy materials and assets, such as power transformers.

116. The location of the temporary construction compound has not yet been determined but will be presented within the Norfolk Boreas PEIR being published in Q4 2018.

117. The compound would be of dimensions 200m x 100m and would accommodate construction management offices, welfare facilities, car parking, workshops and storage areas. Water, sewerage and electricity services would be required at the site and supplied either via mains connection or mobile supplies such as bowsers, septic tanks and generators.

118. Surface water drainage requirements for the onshore project substation would be dictated by the final drainage study and would be designed to meet the requirements of the National Planning Policy Framework (NPPF) with run-off limited, where feasible, through the use of infiltration techniques which can be accommodated within the area of development. Foul drainage would be collected through a mains connection to existing local authority sewer system if available or septic tank located within the development boundary. The specific approach would be determined during detailed design phase with consideration for the availability of mains connection and the number of visiting hours for site attendees during operation.

119. The site would be soil stripped and graded as required by the final design. Stripped material would be reused on site where possible as part of bunding and shielding as allowed for in the final design. Any excess material would be disposed of at a licenced disposal site. Excavations and laying of foundations, trenches and drainage will commence after grading is complete. At this stage it is not known whether the foundations would either be ground-bearing or piled based on the prevailing ground conditions.

120. The enabling works for the onshore project substation would differ between scenarios as outlined below:

Scenario 1

121. Under Scenario 1, a number of enabling works would be undertaken by Norfolk Vanguard. These include:

- Landscaping to reduce visual impacts;
- Access roads; and
- Site drainage infrastructure.

122. In Scenario 1, the access road would be shared with the onshore project substation for Norfolk Vanguard;

Scenario 2

123. Under Scenario 2, all enabling works would be undertaken by Norfolk Boreas and the access would need to be constructed as part of Norfolk Boreas.

2.3.1.5 Necton National Grid Substation Extension

124. The existing Necton National Grid substation would be required to be extended to accommodate the Norfolk Boreas and Norfolk Vanguard connection points. The proposed footprint of this extension is provided in **Appendix 1**. Under Scenario 1 the majority of these works, including modifications to overhead lines, would be undertaken by Norfolk Vanguard for both projects. Under Scenario 2, the extension would be undertaken for Norfolk Boreas only, and therefore part of the Norfolk Boreas DCO application.

Scenario 1

125. Under Scenario 1 all extension enabling works would be completed to facilitate both Norfolk Vanguard and Norfolk Boreas including access roads, earthworks, foundations, buildings and civil works. However only the electrical busbar extensions and other electrical equipment required for Norfolk Vanguard would be constructed under the Norfolk Vanguard consent, with busbar extensions and other electrical equipment required for Norfolk Boreas being installed under Norfolk Boreas consent.

126. In Scenario 1 the Necton National grid substation would have been extended by 470m to provide seven air-insulated switchgear (AIS) bays for Norfolk Vanguard and five further AIS bays for Norfolk Boreas (however this would not include the busbar). All overhead line modification would also have been carried out under the Norfolk Vanguard project.

Scenario 2

127. Under Scenario 2 the Necton National Grid Substation outdoor busbar would be extended in an east and west direction to an estimated total length of approximately 340m with seven AIS bays installed along the busbar extension for Norfolk Boreas.

128. The maximum height of the outdoor busbar and bays at the substation is estimated to be 15m. The total substation area is estimated to be 150m x 370m (inclusive of existing substation operational area). No additional land is anticipated for the overhead line modifications with existing towers being replaced with new towers.

129. Two new overhead line towers would be required in close proximity to the existing corner tower (to the north east of the existing Necton Substation) with a maximum height of 67m. The existing corner tower would be demolished and replaced by two new towers, alternatively, the existing corner tower could be modified and one new terminal tower constructed in close proximity. The design approach taken will be confirmed at detailed design phase.

130. The substation extension and overhead line modification works will be conducted within the areas identified within **Appendix 1** as National Grid Overhead Line Works, National Grid substation extension and National Grid temporary works.

131. During construction of the Necton National Grid Substation, two temporary construction compounds would be established to support the works. Given project duration, the compounds would likely be tarmacked with some concrete hard standing for heavier plant and equipment. Access to the A47 would be provided utilising the existing access road to the site to permit safe delivery of plant and equipment required for construction.

132. The larger compound would be of dimensions 300m x 150m and the smaller compound 200m x 150m. The compounds would accommodate construction management offices, welfare facilities, car parking, workshops and storage areas. Water, sewerage and electricity services will be required at the site and supplied either via mains connection or mobile supplies such as bowsers, septic tanks and generators.

133. The site would be stripped of soil and soil graded as required by the final design. Stripped soil and other material would be reused on site where possible as part of bunding and shielding as allowed for in the final design. Any excess material would be disposed of at a licenced disposal site. Excavations and laying of foundations, trenches and drainage will commence after grading is complete.

134. At this stage it is not known whether the substation foundations would either be ground-bearing or piled based on the prevailing ground conditions.

135. For the overhead line modifications, up to three temporary towers (maximum height 45m) would be constructed in close proximity to the existing towers and the existing circuits transferred over to the temporary towers. The tower foundations could be piled or excavated and cast, dependant on the ground conditions and structural

requirements. It is anticipated that the footprint of the towers would be unchanged from the existing towers; however the orientation and design of the towers may change to allow for the double turn in arrangement. These works would be undertaken within the National Grid temporary works are displayed in **Appendix 1**.

136. The construction programme for the Necton National Grid substation extension and overhead line modification works is 18 months and would be conducted primarily during working hours of 7am to 7pm.

2.3.2 Cumulative Impact Scenarios

2.3.2.1 Norfolk Vanguard

137. Cumulative impacts between Norfolk Boreas and Norfolk Vanguard would only occur in Scenario 1. VWPL are seeking to minimise cumulative impacts between Norfolk Boreas and Norfolk Vanguard through the alignment of onshore cable route and the preference for Norfolk Vanguard to pre-install ducts and undertake other enabling works for Norfolk Boreas. Cumulative impacts between the two sister projects will be assessed within the Norfolk Boreas EIA.

2.3.2.2 Other projects

138. The assessment will consider the potential for significant cumulative impacts to arise as a result of the construction, operation and decommissioning of Norfolk Boreas in the context of other developments that are existing, consented or at application stage.

139. The projects that are proposed to be considered for the CIA due to their temporal or spatial overlap with the potential effects arising from the project are following:

- Hornsea Project Three Offshore Wind Farm.
- Bacton Gas Terminal Extension.
- Bacton Gas Terminal coastal protection.
- Bacton Coastal Protection Scheme.

3 BASELINE ENVIRONMENT

3.1 Desk Based Review

140. A desk based review of ground conditions and contamination receptors was undertaken as part of the Norfolk Boreas scoping report (Royal HaskoningDHV, 2017d). The Environmental Statement (ES) will build upon this information, in conjunction with additional data obtained as part of the Norfolk Vanguard assessment, to thoroughly characterise the baseline environment and identify the receptors that could potentially be impacted by the proposed development.

141. An initial update to the desk based review presented in the scoping report is provided in the subsequent sections.

3.1.1 Available Data

142. **Table 3.1** summarises the data sources which will be used to inform Norfolk Boreas EIA.

Table 3.1 Ground condition and contaminantion data sources

Data	Source	Date
Geology	British Geological Survey (BGS) online viewer: www.mapapps.bgs.ac.uk	11/08/17
Hydrogeology: groundwater vulnerability, groundwater Source Protection Zones (SPZs), abstractions	Information obtained from Envirocheck report Royal HaskoningDHV (2017c) Norfolk Vanguard Offshore Wind Farm Appendix 19.1 Land Quality Phase 1 Preliminary Risk Assessment. Document reference: PB4476-004-0191	11/08/17
Landfills and mining		
Historic Land Use data		
Water Framework Directive (WFD) Classification	Environmental Agency (2016) Catchment Data Explorer: www.environment.data.gov.uk /catchment-planning/	11/08/17
Information on designated sites	Natural England (2013) MAGIC website. (Online) Available from: http://www.magic.gov.uk/ Natural England (undated) Designated Sites View. (Online) Available from: https://designatedsites.naturalengland.org.uk/SiteSearch.aspx	11/08/17
Private water supply	Information obtained from District Councils	11/08/17
Coastal Processes	AECOM (2012) Kelling to Lowestoft Ness Shoreline Management Plan.	11/08/17

143. The data sources listed in **Table 3.1** include data gathered for the Norfolk Vanguard project. The data collected for the Norfolk Vanguard project includes the footprint of the Norfolk Boreas onshore infrastructure. As shown in **Table 3.1**, this data has been collected during 2017. Given the spatial overlap between the onshore infrastructure for these two projects, and the recent gathering of the data, the data sources listed in **Table 3.1** are considered to be valid for use during the Norfolk Boreas project.

3.1.2 Geology

144. The British Geological Survey (BGS) online viewer, shows that the solid geology beneath the study area (as shown in **Figure 1**) compromises White Chalk and Crag Group deposits which dip gently to the south east.

145. The Chalk is a white or grey limestone and is over 460m thick in Norfolk. It principally outcrops as a low, rolling plateau in west Norfolk, along the north Norfolk coast and near Norwich where the Rivers Yare and Wensum have cut down through overlying beds to expose it.

146. The Crag Group deposits are a sequence of sandy, marine deposits which outcrop in the eastern parts of the study area.

147. The solid deposits are overlain predominantly by Glacial Till (as shown in **Figure 2**) dating from the Anglian glaciation, interspersed with sheets of glacial sands and gravels.

148. The cliffs at Happisburgh where the landfall site is located range in height from 6 – 10 metres (m) and are composed of a layer-cake sequence of several Glacial Tills, separated by beds of stratified silt, clay and sand. The marine deposits are overlaid by a series of glacial lithologies deposited during several advances of glacier ice into the region during the Middle Pleistocene. The Happisburgh Till out crops at the base of the cliffs and its base is frequently obscured by modern beach material. The Happisburgh Till Member is a dark grey, highly consolidated till with a matrix composed of a largely massive clayey sand with occasional pebbles of local and far-travelled material.

3.1.3 Coastal processes

149. The landfall site is located within the East of Cromer to Happisburgh area of the Kelling to Lowestoft Ness Shoreline Management Plan (SMP). This is the most active length of coast within the SMP area and is the main provider of sediment for beaches throughout much of the SMP frontage.

150. There are numerous erosion prevention / flood defence assets in the areas of Bacton gas terminal, and the smaller settlements of Bacton, Walcott and Happisburgh. The SMP seeks to maintain present defences for a period with a long-term plan to gradually retreat and relocate, thus enabling a naturally functioning sustainable system to re-establish. The SMP will allow unabated erosion throughout much of this area in the longer term. To manage relocation, occasional measures to temporarily delay (but not halt) this erosion from time to time may be acceptable in some locations where there are larger concentrations of assets.

3.1.4 Designated Geological Sites

151. There is only one designated geological site within the study area. Happisburgh Cliffs Site of Special Scientific Interest (SSSI) is designated specifically for its geological interest (**Figure 3**). The cliffs are an important site for dating the Pleistocene succession in East Anglia, and display a range of marine, freshwater and glacial sediments which span five stages from the pre-Pastonian to the Anglian (Natural England, 1985).

3.1.5 Hydrology and surface drainage

152. The project is located within four main surface water catchments:

- The River Bure and several of its tributaries (most notably King's Beck) would be crossed by the proposed cable route. The 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 flowing through Breydon Water until it entering the sea at Gorleston on Sea. 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, Halvergate Marshes and the Norfolk Broads.
- The River Wensum and several of its tributaries (most notably Wendling Beck and the Blackwater Drain) would be crossed by the onshore cable corridor. The river rises near Whissonsett, from where it flows north towards Fakenham before continuing in a broadly south easterly direction towards Norwich.
- The River Wissey, the headwaters of which would include the proposed grid connection at the Necton National Grid substation. 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.
- The North Walsham and Dilham Canal would be crossed by the proposed onshore cable corridor at North Walsham. The canal commences at Antingham, from where it flows in an easterly direction towards Swafield. The canal is joined by several natural watercourses, including Fox's Beck. The watercourse then continues south - east through North Walsham, to Wayford Bridge, near Dilham, where it joins the tidal River Ant. The River Ant continues to flow in a southerly direction until it joins the River Bure at Horning.

153. A more detailed description of Hydrology and surface drainage can be found in Water Resource and Flood Risk Method Statement (Document Reference PB5640-004-008).

3.1.6 Hydrogeology

154. The Crag and the Chalk aquifers are classified as Principal Aquifers by the Environment Agency (EA). The superficial deposits are classified as Secondary A, B and undifferentiated aquifers (**Figure 4**).

155. The EA 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.

156. The landfall and onshore cable corridor are mostly located on the Broadland Rivers Chalk and Crag groundwater body (GB40501G400300), as defined in the Anglian River Basin Management Plan (EA, 2015). The Water Framework Directive (WFD) status of the groundwater body has been classified by the EA as being of Poor Quantitative Status and Poor Chemical Status. The Poor Quantitative and Chemical Status is attributed to impacts from agriculture.

157. The substation site is located within the Cam and Ely Ouse Chalk (GB40501G400500) and North West Norfolk Chalk (GB40501G400200) groundwater bodies. The landfall is in the North Norfolk Chalk (GB40501G400100) groundwater body.

3.1.7 Groundwater abstractions

158. There are a number of groundwater Source Protection Zones (SPZs) within the onshore project area (**Figure 5**). Currently, the cable corridor crosses three Source Protection Zones 1 (SPZs 1):

- North of North Walsham;
- West of Cawston; and
- South of Hoe.

159. In SPZ 1 located north of North Walsham the use of trenchless technics is proposed when installing the cables. SPZ 1.

3.1.8 Land Quality

160. The majority of the study area is located within an area dominated by agricultural land, where significant contamination is not expected. There is a small risk of encountering buried asbestos or agrochemical waste. Twenty-five historical common clay and shale, sand and gravel pits are present in various locations within the study area that have been infilled, and may contain unknown and potentially contaminated fill material (Royal HaskoningDHV, 2017c).

3.1.9 Minerals Safeguarding Area

161. The study area contains significant sand and gravel resources, associated with the glaciofluvial deposits. The onshore cable corridor crosses a number of Mineral Safeguard Areas (**Figure 6**). These are associated mostly with glacial sand and gravel deposits. A Minerals Safeguarding Area is an area designated by a Mineral Planning Authority which covers known deposits of minerals which are desired to be kept safeguarded from unnecessary sterilisation by non-mineral development.

3.2 Planned Data Collection

162. The results of the initial desk based review presented above will be used as a basis for a more detailed desk based assessment to characterise the baseline for ground conditions and contamination receptors.

163. It is assumed that no further Phase 1 contaminated land surveys are required for the Norfolk Boreas assessment with regards to the ground conditions and contamination, as we consider that the Norfolk Vanguard survey data is valid for the Norfolk Boreas application. Due to the spatial overlapping of the two projects, this information will inform the Norfolk Boreas assessment.

164. Ground investigations are underway as part of the Norfolk Vanguard project. Risk assessments are being undertaken for the trenchless crossing technique (e.g. HDD) locations.

165. Ground investigations are ongoing at key crossing locations listed below:

- Crossing 1 – A47;
- Crossing 2 – Norfolk Railway (East);
- Crossing 2 – Norfolk Railway (West);
- Crossing 3 – River Wensum (East);
- Crossing 3 – River Wensum (West);
- Crossing 4 – River Bure (West);
- Crossing 4 – River Bure(East) / Crossing 5 – A140;
- Crossing 6 – A149 / Crossing – Norfolk Railway; and
- Happisburgh South Landfall.

4 IMPACT ASSESSMENT METHODOLOGY

4.1 Defining Impact Significance

4.1.1 Sensitivity

166. The sensitivity of receptors is assessed according to the criteria set out in **Table 4.1**Table 4.3 below and is based on the capacity of receptors to tolerate change and, whether or not increased risks would be acceptable, within the scope of the prevailing legislation and guidelines. The degree of change that is considered to be acceptable is therefore dependent on the value of a receptor, which is discussed in Section 4.1.2.

Table 4.1 Sensitivity criteria for ground conditions receptors

Sensitivity	Definition
High	Has very limited or no capacity to accommodate physical or chemical changes Increased risk of exposure / pollution would be unacceptable
Medium	Has limited capacity to accommodate physical or chemical changes or influences Increased risk of exposure/ pollution may be acceptable
Low	Has moderate capacity to accommodate physical or chemical changes Increased risk of exposure / pollution likely to be acceptable
Negligible	Is generally tolerant of physical or chemical changes Insensitive to increased risk of exposure / pollution

4.1.2 Value

167. The sensitivity assessment for water and mineral resources takes into account how ‘acceptable’ changes to the availability or quality of a particular resource would be. This is dependent on the value of that resource, which is assessed based on its strategic or geographic importance (**Table 4.2**).

Table 4.2 Value criteria for ground conditions receptors

Value	Definition
High	Is an international or nationally important resource
Medium	Is a regionally important resource
Low	Is a locally important resource
Negligible	Is of no significant resource value

4.1.3 Overall Sensitivity

168. Generic receptor sensitivity examples based on the above criteria are given in **Table 4.3**. It should be noted that receptors may be assessed differently in the EIA due to site-specific considerations.

169. The sensitivity criteria and examples for controlled waters receptors are aligned with those used in the assessment of water resources and flood risk impacts (see separate method statement).

Table 4.3 Generic receptor sensitivity assessment examples

Sensitivity / Value	Examples
High	**Human Heath** • Construction Workers • Site Operatives • General Public (Off-site)
	Controlled Waters • Groundwater SPZ 1 / 2 • Surface Waters with WFD 'High' status objective • Surface water or groundwater supporting internationally designated or nationally important conservation sites (eg. Special Areas of Conservatio (SAC), Special Protection Area (SPA), Ramsar site / SSSI) or fishery resource
Medium	**Controlled Waters** • Principal Aquifer / Secondary A • Groundwater SPZ Total Catchment • Licenced groundwater / surface water abstractions • Surface waters with WFD Status / Potential objective 'Good' • Surface water or groundwater supporting regionally important wildlife sites (Local Nature Reserve (LNR), Site of Nature Conservation Interest (SNCI)) or commercial aquaculture
	Mineral Resources • Mineral Safeguard Area (regionally important resource)
Low	**Controlled Waters** • Secondary B Aquifer / Undifferentiated Aquifer • Surface waters with WFD Status / Potential objective 'Moderate' / 'Poor' • Surface water or groundwater supporting locally important wildlife or amenity site
Very Low	**Controlled Waters** • Water-bearing Unproductive Strata • Surface waters with WFD Status / Potential objective 'Bad'

4.1.4 Magnitude

170. Potential effects may be adverse, beneficial or neutral. The magnitude of an effect is assessed qualitatively, according to the criteria set out in **Table 4.4**. The following definitions apply to time periods used in the magnitude assessment:

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

171. For human health, magnitude reflects the likely increase or decrease in exposure risk for a particular receptor (for example construction workers). For controlled waters, magnitude represents the likely effect that an activity would have on resource usability or value, at the receptor. Magnitude is therefore affected by the distance and connectivity between an impact source and the receptor.

Table 4.4 Effect magnitude definitions and examples

Magnitude Definition	Examples
High Permanent or large scale change affecting usability, risk, value over a wide area, or certain to affect regulatory compliance	**Human Health Risk** • Permanent or major change to existing risk of exposure (Adverse / Beneficial). • Unacceptable risks to one or more receptors over the long-term or permanently (Adverse) • Prosecution under health and safety legislation (Adverse) • Remediation and complete source removal (Beneficial) • Construction workers at risk due to lack of appropriate personal protective equipment (Adverse)
	Controlled Waters • Permanent, long-term or wide scale effects on water quality or availability (Adverse / Beneficial). • Permanent loss or long-term derogation of a water supply source of a water supply source resulting in prosecution (Adverse) • Change in WFD water body status / potential or its ability to achieve WFD status objectives in the future (Adverse / Beneficial) • Permanent habitat creation or complete loss (Adverse / Beneficial) • Measureable habitat change that is sustainable / recoverable over the long-term (Adverse / Beneficial).
Medium Moderate permanent or long-term reversible change affecting usability, value, risk, over the medium-term or local area;	**Human Health Risk** • Medium-term or moderate change to existing risk of exposure (Adverse / Beneficial). • Unacceptable risks to one or more receptors over the medium-term (Adverse) • Serious concerns or opposition from statutory consultees (Adverse)
	Controlled Waters • Medium-term or local scale effects on water quality or availability (Adverse / Beneficial). • Medium-term derogation of a water supply source, possibly resulting in prosecution (Adverse).

Magnitude Definition	Examples
possibly affecting regulatory compliance	• Observable habitat change that is sustainable / recoverable over the medium-term (Adverse / Beneficial). • Temporary change in status / potential of a WFD waterbody or its ability to meet objectives (Adverse / Beneficial).
Low Temporary change affecting usability, risk or value over the short-term or within the site boundary; measureable permanent change with minimal effect usability, risk or value; no effect on regulatory compliance	**Human Health Risk** • Short-term temporary or minor change to existing risk of exposure (Adverse / Beneficial). • Unacceptable risks to one or more receptors over the short-term (Adverse) **Controlled Waters** • Short-term or very localised effects on water quality or availability. (Adverse / Beneficial). • Short-term derogation of a water supply source (Adverse). • Measureable permanent effects on a water supply source that do not impact on its operation (Adverse). • Observable habitat change that is sustainable / recoverable over the short-term (Adverse / Beneficial). • No change in status / potential of a WFD waterbody or its ability to meet objectives (Neutral).
Very Low Minor permanent or temporary change, undiscernible over the medium- to long-term short-term, with no effect on usability, risk or value	**Human Health Risk** • Negligible change to existing risk of exposure • Activity is unlikely to result in unacceptable risks to receptors (Neutral) **Controlled Waters** • Very minor or intermittent impact on local water quality or availability (Adverse / Beneficial). • Usability of a water supply source will be unaffected (Neutral) • Very slight local changes that have no observable impact on dependent receptors (Neutral) • No change in status / potential of a WFD waterbody or its ability to meet objectives (Neutral).

4.1.5 Significance

172. The impact significance assessment combines receptor sensitivity with effect magnitude, as shown in **Table 4.5**Table 4.5. 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. A description of each level of significance is provided in **Table 4.6**.

Table 4.5 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 4.6 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.

173. Effects that result in **Major** or **Moderate** impacts are considered to be ‘significant’ in EIA terms. Significant impacts are those which are likely to influence the outcome of the planning application. Adverse significant impacts may require mitigation that is difficult or expensive to achieve whereas, beneficial significant impacts contribute to the case in favour of the Proposed Development.

174. Embedded mitigation will be referred to and included in the initial assessment of impact. If the impact does not require mitigation (or none is possible) the residual impact will remain the same. If however, mitigation is required there should be an assessment of the post-mitigation residual impact.

4.2 Assessment Methodology

4.2.1 Ground Contamination

175. The assessment of ground contamination impacts will consider human health and controlled waters (surface water and groundwater resources). The assessment will follow the Source-Pathway-Receptor approach, which identifies potential pollutant linkages that may result in unacceptable risks to receptors from ground contamination. For a risk to exist, all three elements (defined below) must be present.

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

176. The EIA baseline comprises a description of the current ground conditions and potential receptors. It should be noted that under Scenario 1 the Norfolk Vanguard infrastructure will be already built. The impact assessment compares the baseline to a Conceptual Site Model (CSM) describing feasible pollutant linkages associated with the construction phase of the proposed development (in accordance with the Norfolk Boreas EIA Scoping Report (Royal HaskoningDHV, 2017d) impacts during the O&M phase have been scoped out).

177. The impact assessment will be based on the findings of a land quality risk assessment, undertaken in general accordance with current UK guidance (and associated documents):

- Environment Agency Groundwater Protection: Principles and Practice, Version 1.1 (Environment Agency, 2013); and
- Environment Agency Model Procedures for the Management of Land Contamination (Contaminated Land Report (CLR) 11) (DFRA and Environment Agency, 2004).

178. The initial step will be to undertake a Preliminary Risk Assessment (PRA) to determine whether or not the onshore works pose potentially unacceptable risks to human health or the environment. The PRA is a desk-based study that proceeds, if required, to intrusive investigation, further risk assessment, options appraisal, remedial design, implementation planning and completion reporting.

179. The PRA will identify potential risks along the cable route. Should potentially unacceptable risks be identified, that cannot be mitigated through the use of appropriate personal protective equipment and adherence to a Construction Code of Practice, targeted soil or groundwater sampling may be undertaken prior to

construction works commencing. The ground investigation data would inform a generic quantitative risk assessment (GQRA) that would either confirm that risks to human health and controlled waters are low; or, inform the design of risk mitigation measures. These could include: further ground investigation to refine the risk assessment; remediation of contaminated ground; or, changes to the proposed construction methodology or scheme design.

4.2.2 Mineral Resources and Waste Sites

180. The approach for assessing impact on mineral resources will be generally in accordance with mineral planning authority (MPA) guidance[2] for assessing the impacts of non-mineral development.

181. The assessment will identify existing and proposed mineral and waste sites, and safeguard areas, from the published Minerals and Waste Development Plan Document. The total safeguarded area affected by the proposed onshore cable route will be calculated using GIS, based on the worst-case scenario for the permanent cable easement.

182. The agreed construction approach will be set out in a materials management plan (MMP) to be followed during construction, which would also deal with excavated waste management.

[2] Guidance Note on the Mineral Safeguarding Process for aggregates – Sand & Gravel and Carstone. Norfolk County Council, November 2014.

5 POTENTIAL IMPACTS

5.1 Potential Impacts during Construction

183. The following section describes the potential impacts anticipated to arise during the construction, operation and maintenance and decommissioning phases of Norfolk Boreas. The impacts described below have been determined based on our knowledge of the project and the nature of the receptors.

184. It should be noted that the potential impact detailed here considers the Worst Case Scenario (development Scenario 2), where the Norfolk Vanguard project does not gain consent and therefore the Norfolk Boreas proposed development will encompass all of the full development elements (e.g. the installation of cable infrastructure and associated infrastructure, development of the substation and landfall sites, etc.).

185. The approach to assessment of each impact will be to divide the assessment into the two separate Scenarios (1 and 2) so that potential impacts arising from each respective scenario can be assessed. Within each scenario, reference will be made to various elements of the project infrastructure and associated works, where relevant.

5.1.1 Impact: Alteration to coast line, including coastal geological designated sites

186. The proposed landfall works have the potential to impact upon coastal processes, and could therefore affect rates of erosion in a dynamic coastal area. These activities therefore have the potential to affect geological designated sites.

5.1.1.1 Approach to Assessment

187. The potential impacts of will be assessed using expert judgement. This assessment will be informed by the results of the desk based assessment outlined section 3.2.

188. As part of the site selection work for landfall locations Royal HaskoningDHV have also conducted a study of coastal erosion rates at three locations along the Norfolk Coast. Specifically the study conducted at the final landfall location, Happisburgh South, will inform the assessment.

189. A study has also been commissioned by VWPL to assess the possible effects on erosion rates of horizontally drilling at landfall to install ducts and cables under the cliffs. The results of the study are expected to be available to inform assessment within the Norfolk Boreas PEIR and subsequent ES.

190. The assessment will assume that any embedded mitigation measures incorporated into the scheme design will be in place.

191. The potential for impacts on coastal processes will also be considered in the Offshore Marine Geology, Oceanography and Physical Processes and Onshore Water Resources and Flood Risk chapters. Impacts on WFD water bodies (including the hydromorphology of the coastal water body) will be considered in the WFD Compliance Assessment. Any linkages to Ground Conditions and Contamination will be cross referenced to this chapter.

5.1.2 Impact: Impacts on controlled waters from contaminant mobilisation caused by earthworks during construction

192. The excavation of the cable trench, earthworks for substation construction and the excavation and stockpiling of soils has the potential to mobilise existing ground contamination (if present), which could result in unacceptable human health risks to for example construction workers and pollution risks to controlled waters (surface water and groundwater). The identified SPZs 1 are particularly sensitive in this regard.

193. It is also anticipated that potentially polluting substances and activities could be introduced during the construction works, for example as a result of concrete pouring, storage of fuels and chemicals, and leaks and spills of fuel and oil from construction plant.

194. During construction, surface layers will be excavated, allowing increased infiltration of rainwater and surface run-off to the subsurface. This could potentially mobilise any residual contamination already present in overlying strata which could potentially migrate into the underlying superficial aquifer.

195. The proposed scheme will result in the construction of infrastructure at various locations where secondary aquifers are present. Depending on the depth of the aquifers and the proposed construction techniques direct impacts could occur where trenching and piling is utilised,

196. Direct impacts to the controlled waters may occur from deep ground workings associated with horizontal drilling operations for the cable installation beneath surface infrastructure and watercourses. There is the potential for drilling mud to leak along the drill path, or from the immediate area of the mud pits or tanks which could cause contamination of groundwater.

197. Physical impacts on groundwater resources (i.e. on groundwater level) will be discussed in the Water Resources and Flood Risk chapter of the ES and cross referenced to this chapter as appropriate. However, it should be noted that these impacts under Scenario 1 will be less as the earthworks under this scenario are limited.

5.1.2.1 Approach to Assessment

198. The potential impacts of the excavation of the cable trench and other earthworks will be assessed using expert judgement. This assessment will be informed by the results of the desk based assessment and results of ground investigations outlined in section 3.2.

199. This section will be divided into Scenarios 1 and 2 so that potential impacts arising from each scenario can be assessed separately. Within each scenario, reference will be made to various elements of the project infrastructure and associated works, where relevant. Due to the lack of trench excavation required under Scenario 1 and the reduced amount of earth works at the Necton National Grid substation, onshore project substation and cable relay stations impacts will occur over a smaller are and be of less magnitude under Scenario 1 compared with Scenario 2.

200. The assessment will assume that any embedded mitigation measures incorporated into the scheme design will be in place. For example, a Code of Construction Practice (CoCP) will be employed during the site works to ensure that all appropriate Pollution Prevention Guidelines (PPG 17) and good practice guidelines are followed. Furthermore, sensitive locations identified along the route will be avoided by the use of trenchless techniques where appropriate and practicable.

201. Where works will be proposed within any SPZ1, a hydrogeological risk assessment will be undertaken at each HDD crossing location in cognisance of the requirements of the Groundwater Protection, Principles and Practice (GP3) guidance published by the EA (EA, 2017).

202. The other potential for impacts on controlled waters will be also considered in the Onshore Water Resources and Flood Risk chapter of the Environmental Statement, and impacts on WFD water bodies (including groundwater) will be considered in the WFD Compliance Assessment. Any linkages to Ground Conditions and Contamination will be cross referenced to this chapter.

5.1.3 Impact: Sterilisation of mineral resources and waste generation

203. The proposed landfall works cross numerous mineral safeguard areas and would prevent future extraction of sand and gravel resources within the cable easement. Excavation of ducts would also generate a significant volume of surplus waste material, not required for backfill. There is potential to reduce resource sterilisation by extracting sand and gravel resources prior to construction and, to reduce waste by re-using suitable material as aggregate during the construction phase.

204. For wastes that are deemed suitable for landfill, the classification as hazardous or non-hazardous would be taken into account when determining the appropriate class

of landfill for disposal. For wastes classified as hazardous, they can only be deposited in a hazardous class of landfill and only if the material passes the hazardous Waste Acceptance Criteria (WAC). If hazardous excavated material fails the hazardous WAC it must be treated to reduce levels of contamination to appropriate limits before it can be landfilled. Dilution is not an acceptable form of treatment.

205. A Site Waste Management Plan (SWMP) will be prepared post consent, which will ensure that any waste arising is closely monitored and that waste prevention, re-use or recycling opportunities are maximised.

5.1.3.1 Approach to Assessment

206. A preliminary assessment of this impact will be undertaken in accordance with the method presented in section 4.2.2. The findings will be discussed with the MPA prior to submission of the EIA to determine their significance and inform the development of mitigation measures, should these be required.

207. Under Scenario 1, Norfolk Vanguard would install cable ducts and undertake supporting works (e.g. running track, accesses, etc.) for Norfolk Boreas along the entire length of the onshore cable corridor. Therefore, all excavations (except jointing pits associated temporary construction compounds, onshore project substation foundations and cable relay station foundations) and waste generation would be minimal and the sterilisation of the mineral resources already occurred,

208. As such, this impact can be discounted from further assessment under Scenario 1.

209. Under Scenario 2, Norfolk Boreas would install all onshore cable route infrastructure required for the project, including installing ducts along the entire cable route and reinstating land. Under this scenario the cable route would require major excavations.

5.1.4 Impact: Impacts to human health, including construction workers and general public during any excavations associated with construction

210. Potential contaminants of concern (PCOC) could be present in the study area and could represent an unacceptable risk to construction workers, and potentially the general public, if exposed during construction activities. Construction activities, particularly earthworks associated with the proposed project could potentially disturb and expose construction workers to localised Made Ground soils and potential soil and/or groundwater contamination associated historical land uses within the study area (this will be further described in the Land Use Method Statement). Construction activities could create pollutant linkages through ingestion, inhalation and direct dermal contact pathways.

5.1.4.1 Approach to Assessment

211. A preliminary assessment of this impact will be undertaken in accordance with the method presented in section 4.2.1.

212. The short term risks to construction workers would be managed through the use of personal protective equipment (PPE) and appropriate working practices. Construction workers will be made aware of the possibility of encountering contaminated soils in made ground through toolbox talks. Safeworking procedures will be implemented, good standards of personal hygiene will be observed and appropriate levels of PPE and respiratory protective equipment (RPE) will be provided and utilised as necessary, thereby minimising the exposure to potentially contaminated soils, ground gas and groundwater.

213. Under Scenario 1, Norfolk Vanguard would install cable ducts and undertake supporting works (e.g. running track, accesses, etc.) for Norfolk Boreas along the entire length of the onshore cable corridor. Therefore, all excavations (except jointing pits associated temporary construction compounds, onshore project substation foundations and cable relay station foundations) and crossings with the potential to cause direct disturbance to ground would have already been undertaken. In addition, the ducts would be installed and ground reinstated by Norfolk Vanguard. The remaining earthworks would be minimal.

214. Under Scenario 2, Norfolk Boreas would install all onshore cable route infrastructure required for the project, including installing ducts along the entire cable route and reinstating land. Under this scenario the cable route would require major excavations.

5.2 Potential Impacts during Operation and Maintenance

215. There are unlikely to be any significant impacts from the operation of the proposed project and they would be the same under Scenario 1 and 2. O&M activities will follow standard procedures therefore minimising any potential impacts. Non-routine maintenance will be subject to robust and effective planning and risk assessment procedures. As discussed previously, impacts during O&M are scoped out of the EIA in accordance with the Norfolk Boreas EIA Scoping Report (Royal HaskoningDHV, 2017d).

5.3 Potential Impacts during Decommissioning

216. No decision has been made regarding the final decommissioning policy for the onshore project substation and cable relay station, as it is recognised that industry best practice, rules and legislation change over time. However, the onshore project substation and cable relay station equipment will likely be removed and reused or

recycled. It is expected the onshore cables will be removed from ducts and recycled, with the transition pits and ducts left in situ.

217. 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 would be provided.

218. At this stage, it is anticipated that the decommissioning impacts will be similar in nature to those of construction (section 5.1).

5.4 Potential Cumulative Impacts

219. Any other project with the potential to result in impacts that may act cumulatively with Norfolk Boreas will be identified during consultation and following a review of available information. These projects will then be included in the CIA and therefore are scoped into the assessment.

220. The assessment would consider the potential for significant cumulative impacts to arise as a result of the construction, operation and decommissioning of Norfolk Boreas in the context of other developments that are existing, consented or at application stage.

221. The projects that are proposed to be considered for the CIA due to their temporal or spatial overlap with the potential effects arising from the project are following:

- Norfolk Boreas Offshore Wind Farm.
- Hornsea Project Three Offshore Wind Farm.
- Bacton Gas Terminal Extension.
- Bacton Gas Terminal coastal protection.
- Bacton Coastal Protection Scheme.

6 REFERENCES

AECOM (2012) Kelling to Lowestoft Ness Shoreline Management Plan. (Online) Available from: http://www.north-norfolk.gov.uk/smp6/files/Kelling_to_Lowestoft_Ness_SMP-final.pdf (Accessed 11/08/17).

British Geological Survey (undated) Geology of Britain viewer. (Online) Available from: http://mapapps.bgs.ac.uk/geologyofbritain/home.html (Accessed 11/08/17).

DEFRA and Environment Agency (2004) Model Procedures for the Management of Land Contamination (Contaminated Land Report (CLR) 11).

Environment Agency (2013) Groundwater Protection: Principles and Practice, Version 1.1.

Environment Agency (undated) Catchment Data Explorer. (Online) Available from: http://environment.data.gov.uk/catchment-planning/ (Accessed 11/08/17).

Landmark Information Group, (2017) Envirocheck Report

Natural England (1985) Happisburgh Cliffs SSSI Citation. (Online) Available from: http://www.sssi.naturalengland.org.uk/citation/citation_photo/1001304.pdf (Accessed 11/08/17).

Natural England (undated) Designated Sites View. (Online) Available from: https://designatedsites.naturalengland.org.uk/SiteSearch.aspx

Royal HaskoningDHV (2016) Norfolk Vanguard Offshore Wind Farm: Environmental Impact Assessment Scoping Report. Document reference PB4476-102-001. October 2016.

Royal HaskoningDHV (2017a) The Evidence Plan Terms of Reference Document reference: PB5640.004.016

Royal HaskoningDHV (2017b) Norfolk Vanguard offshore Wind Farm Preliminary Environmental Information Report. Available at: https://corporate.vattenfall.co.uk/projects/wind-energy-projects/vattenfall-in-norfolk/norfolkvanguard/documents/

Royal HaskoningDHV (2017c) Norfolk Vanguard Offshore Wind Farm Appendix 19.1 Land Quality Phase 1 Preliminary Risk Assessment. Document reference: PB4476-004-0191

Royal HaskoningDHV (2017d) Norfolk Boreas Offshore Wind Farm: Environmental Impact Assessment Scoping Report. Document reference PB5640-102-101. May 2017

Norfolk Boreas Offshore Wind Farm

Environmental Impact Assessment

Onshore Water Resources and Flood Risk Method Statement

Document Reference: PB5640-004-008

Author: Royal HaskoningDHV
Applicant: Vattenfall Wind Power Ltd
Date: January 2018

IEMA
Transforming the world to sustainability
- EIA -

Date	Issue No.	Remarks / Reason for Issue	Author	Checked	Approved
21/11/2017	01D	Internal draft for review	JAD	IAD	AD/DT
15/12/2017	02D	Revised following internal review	JAD	DT	AD
20/12/2017	03D	Draft submitted for Vattenfall review	JAD	DT	AD
29/01/2018	01D	Issue to consultees	JAD	CD	JL

This method statement has been prepared by Royal HaskoningDHV on behalf of Norfolk Boreas Limited in order to build upon the information provided within the Norfolk Boreas Environmental Impact Assessment (EIA) Scoping Report. It has been produced following a full review of the Scoping Opinion provided by the Planning Inspectorate. All content and material within this document is draft for stakeholder consultation purposes, within the Evidence Plan Process.

Many participants of the Norfolk **Boreas** Evidence Plan Process will also have participated in the Norfolk **Vanguard** Evidence Plan Process. This document is presented as a complete standalone document however in order to maximise resource and save duplication of effort, the main areas of deviation from what has already been presented through the Norfolk Vanguard Evidence Plan Process and PEIR or in the Norfolk Boreas Scoping Report are presented in orange text throughout this document.

Table of Contents

Figures

Glossary of Acronyms

AIS	Air Insulated Switchgear
CIA	Cumulative Impact Assessment
DCO	Development Consent order
EA	Environmental Agency
EIA	Environmental Impact Assessment
EPP	Evidence Plan Process
ES	Environmental Statement
ETG	Expert Topic Group
FRA	Flood Risk Assessment
GES	Good Ecological Status
GEP	Good Ecological Potential
GIS	Gas Insulation Switchgear
HDD	Horizontal Directional Drilling
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IDB	Internal Drainage Board
NPPF	National Planning Policy Framework
PEIR	Preliminary Environmental Information Report
PMA	Primary mobilisation areas
RBMP	River Basin Management Plan
SAC	Special Area of Conservation
SSSI	Site of Special Scientific Interest
SNH	Scottish Natural heritage
SPZ	Source Protection Zone
WFD	Water Framework Directive

Royal HaskoningDHV
Enhancing Society Together

VATTENFALL

1 INTRODUCTION

1. The purpose of this method statement is to build upon the information provided within the Norfolk Boreas Environmental Impact Assessment (EIA) Scoping Report, in outlining the proposed approach to be taken and considerations to be made in the assessment of the Onshore Water Resources and Flood Risk effects of the proposed development.

2. This method statement and the consultation around it form part of the Norfolk Boreas Evidence Plan Process (EPP). The aim is to gain agreement on this method statement from all members of the Water Resources and Flood Risk Expert Topic Group (ETG), which will be recorded in the agreement log.

3. This method statement has been produced following a full review of the Scoping Opinion provided by the Planning Inspectorate, responses to the Norfolk Vanguard PEIR (Royal HaskoningDHV, 2017b) and consultation undertaken through the Norfolk Vanguard EPP. The EIA Scoping Opinion comments received that relate to Water Resources and Flood Risk quality are summarised in **Table 1.1**.

4. Information provided in this Method Statement is a draft for stakeholder consultation only and is provided in confidence. It is recognised that Norfolk Vanguard ETG meetings are being held in January 2018 and that agreements will be made during those meetings which are not reflected here. However due to certain project “Mile Stones” which have been set by the Crown Estate Norfolk Boreas must progress on a programme which requires consultation on the Norfolk Boreas Method Statements prior to the conclusion of the Norfolk Vanguard EPP. Therefore, the material provided in this document represents the best available information at the time of writing.

Table 1.1 Scoping opinion responses relevant to Water Resources and Flood Risk

Consultee	Comment	Response / reference to where this addressed
Secretary of State	It is not entirely clear from the Scoping Report whether effects on the River Wensum SAC/SSSI will be covered in the onshore ecology section of the ES or in the section dealing with water resources and flood risk. Given the statutory ecological designations covering the River Wensum the SoS recommends that the ecological effects are reported in the onshore ecology chapter with appropriate cross referencing to the water resources chapter.	Ecological impacts on the River Wensum SAC/SSSI will considered within the onshore ecology chapter of the ES. Hydrological impacts to the SAC/SSSI will be considered in the impact assessment via the consideration of the impacts of construction and operation activities upon receptors, of which statutory designated sites for nature conservation are considered high value/sensitivity.
Environment Agency	Question 1 Table 3.6 of the document confirmed that data has been obtained from our Flood Map for planning in 2012. Further modelling has been completed of the Bure and Yare Rivers since 2012, and the baseline data may therefore need updating as the flood map for planning may have been updated. The most recent data should be obtained from us prior to the writing of the Flood Risk Assessment.	The latest flood risk data has been obtained from the Environment Agency.
Secretary of State	Consideration should be given to the potential impacts on the coastal defence works proposed around Bacton, as noted within NE's response (see Appendix 3 of this Opinion).	The potential impacts on the coastal defence works proposed around Bacton will be considered within the Cumulative Impact Assessment, as detailed in section 5.4.
Secretary of State	The SoS welcomes reference to the preparation of a draft drainage strategy at paragraph 1006 of the Scoping Report and recommends that this be provided with the ES. The location of any swales and/or attenuation basins used to mitigate flood risk should be identified. The assessment should consider potential effects of the Proposed Development on existing field drainage patterns and any potential inter-related effects on the quantity and quality of productive farmland. The SoS welcomes the proposal that all drainage systems would be fully reinstated in consultation with landowners and drainage contractors (paragraph 1081 of the Scoping Report). Advice from Norfolk County Council on a drainage strategy is provided in Appendix 3 of this Opinion.	A CoCP will be developed and monitoring requirements will be identified.
Secretary of State	In relation to 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 and how they will be secured as part of the CoCP or otherwise in the DCO. The Applicant's attention is also drawn to the consultation response from the EA in this regard (Appendix 3 of this Opinion).	Potential risks to both groundwater resources and surface water bodies from leakage of drilling fluid will be considered in the ES, with these impact mechanisms discussed in section 5. Appropriate mitigation will also be detailed in the ES.

Consultee	Comment	Response / reference to where this addressed
Secretary of State	The Applicant is advised to consider the necessary responsibilities in relation to working over or crossing of main rivers including any permits or licences that may be required (for example Flood Risk Activity Permits under the Environmental Permitting regulations). References to any water resources licensing that may be required should be outlined as part of the ES, particularly where the residual effects reported in the ES are wholly or partly reliant on the grant of such licenses.	Vattenfall will be advised of the responsibilities in relation to working over or crossing main rivers, including any permits or licences that may be required, in consultation with the Environment Agency and other appropriate regulatory bodies.
Anglian Water	Reference is made to an onshore cable corridor to be shared with Norfolk Vanguard project and the construction of a cable relay station (if required). At this stage it is unclear whether there is a requirement for potable water and wastewater services. The extent of proposed cable corridor is to be refined further by the applicant. Therefore the extent to which existing water and water recycling assets would be affected will need to be defined with the assistance of Anglian Water.	The requirement for potable water and wastewater services will be detailed in the ES, with consideration of the water assets that could be affected.
Anglian Water	Reference is made to the evidence provided by the Environment Agency in relation to the risk of fluvial and surface water flooding. Anglian Water is responsible for managing the risks of flooding from surface water, foul water or combined water systems. Consideration should be given to all potential sources of flooding including sewer flooding.	Consideration will be given to all potential sources of flooding including sewer flooding in the ES.
Anglian Water	The Environmental Statement should include reference to Anglian Water's existing assets and any potential impacts from the above development. We would expect any requests for alteration or removal of foul sewers or water mains to be conducted in accordance with the Water Industry Act 1991.	The ES will consider any foul sewers or water mains which will be altered or removed, with requests for removal or alteration undertaken by Vattenfall in consultation with Anglian Water.
PHE	When considering a baseline (of existing water quality) and in the assessment and future monitoring of impacts these: • should include assessment of potential impacts on human health and not focus solely on ecological impacts • should identify and consider all routes by which emissions may lead to population exposure (e.g. surface watercourses; recreational waters; sewers; geological routes etc.) • should assess the potential off-site effects of emissions to groundwater (e.g. on aquifers used for drinking water) and surface water (used for drinking water abstraction) in terms of the potential for population exposure • should include consideration of potential impacts on recreational users (e.g. from fishing, canoeing etc) alongside assessment of potential exposure via drinking water	All potential human health impacts will be assessed, with all routes where emissions may lead to population exposure considered, and the potential offsite effects of emissions to groundwater and consideration of potential impacts on recreational users assessed. This will be assessed within the Health Impact Review which will form part of the DCO application (see the Health impact method statement doc ref. PB5640-004-009 for further details

1.1 Background

5. A Scoping Report for the Norfolk Boreas EIA was submitted to the Planning Inspectorate on the 9th May 2017. Further background information on the project can be found in the Scoping Report which is available at:

https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010087/EN010087-000015-Scoping%20Report.pdf

6. The Scoping Opinion was received on the 16th June 2017 and can be found at:

https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010087/EN010087-000013-Scoping%20Opinion.pdf

1.2 Norfolk Boreas Programme

7. This section provides an overview of the planned key milestone dates for Norfolk Boreas.

1.2.1 Development Consent Order (DCO) Programme

- EIA Scoping Request submission - 09/05/17 (complete)
- Preliminary Environmental Information (PEI) submission - Q4 2018
- Environmental Statement (ES) and DCO submission - Q2 2019

1.2.2 Evidence Plan Process Programme

8. The Evidence Plan Terms of Reference (Royal HaskoningDHV, 2017a) provides an overview of the Evidence Plan Process and expected logistics, below is a summary of anticipated consultation:

- Agreement of Terms of Reference - Q3 2017
- Post-scoping Expert Topic Group meetings / correspondence -Q1 2018
    - Discuss method statements and Project Design Statement
- Expert Topic Group and Steering Group meetings as required - 2018
    - To be determined by the relevant groups based on issues raised
- PEI Report (PEIR) Expert Topic Group and Steering Group meetings - Q4 2018/ - Q1 2019
    - To discuss the findings of the PEI (before or after submission)

- Pre-submission Expert Topic Group and Steering Group meetings - Q1/Q2 2019
  - To discuss updates to the PEIR prior to submission of the ES

1.2.3 Consultation to Date

9. Norfolk Boreas is the sister project to Norfolk Vanguard (see section 2 for further details). A programme of consultation has already been undertaken for Norfolk Vanguard which is of relevance to Norfolk Boreas. The complete elements for this are listed below:

- EIA Scoping Request submission - 03/10/16
- Receipt of Scoping Opinion - 11/11/16
- Steering Group meeting 21/03/16
- Steering Group meeting - 20/09/16
- Post-scoping Expert Topic Group meetings
  - Discuss method statements and Project Design Statement - 25/01/17
- Expert Topic Group and Steering Group meetings
  - Watercourse crossing techniques (Internal Drainage Board) -20/04/17
  - Watercourse crossing techniques (Environment Agency) -25/05/17
  - Presentation of initial assessment results -08/09/17
  - Source protection zones -06/11/17

10. Responses to the Norfolk Vanguard PEIR (Royal HaskoningDHV, 2017b) were received in December 2017. This method statement has been updated to incorporate any key comments made that affect the proposed methodology for the Norfolk Boreas EIA.

1.2.4 Survey Programme

11. Details of the proposed data collection exercise are included under section 3.3

2 PROJECT DESCRIPTION

2.1 Context and Scenarios

12. Norfolk Boreas is the sister project to Norfolk Vanguard. Vattenfall Wind Power Ltd (VWPL) is developing the two projects in tandem, and is planning to co-locate the export infrastructure for both projects in order to minimise overall impacts. This co-location strategy applies to the offshore and onshore parts of the export cable route, the cable landfalls, cable relay stations, and onshore substations.

13. The Norfolk Vanguard project is approximately 12 months ahead of Norfolk Boreas in the Development Consent Order (DCO) process. As such, the Norfolk Vanguard team is leading on site selection for both projects. Although Norfolk Boreas is the subject of a separate DCO application, the project will adopt these strategic site selection decisions.

14. In order to minimise impacts associated with onshore construction works for the two projects, VWPL is aiming to carry out enabling works for both projects under the Norfolk Vanguard DCO. This covers the installation of buried ducts along the onshore cable route, from the landfall to the onshore substation, modifications at the Necton National Grid substation, visual screening works access road construction, utility connections (water, electricity and phone) and site drainage.

15. However, Norfolk Boreas needs to consider the possibility that the Norfolk Vanguard project would not be constructed. In order for Norfolk Boreas to stand up as an independent project, this scenario must be provided for within the Norfolk Boreas DCO. Thus, there are two alternative scenarios to be considered in the context of the EIA and this method statement:

- **Scenario 1:** Norfolk Vanguard consents and constructs transmission infrastructure which would be used by Norfolk Boreas. This includes cable ducts, access routes to jointing pit locations, extension of the Necton National Grid substation, overhead line modification at the Necton National Grid substation and any site drainage, landscaping and planting schemes around co-located infrastructure. Under Scenario 1 Norfolk Boreas will seek to consent the Horizontal Directional Drilling (HDD) at landfall, the creation of the jointing and transition pits, onshore project substation, cable relay station (if required) and the installation of cables in the ducts through a process of cable pulling.

- **Scenario 2:** Norfolk Vanguard is not constructed and therefore Norfolk Boreas will seek to consent and construct all required project infrastructure including: HDD at landfall, creation of jointing bays, transition and jointing pits, installation of cable ducts, cable installation, cable relay station (if required), onshore project substation, 400kV interface works (between the onshore project substation and the Necton National Grid substation), extension to the Necton National Grid substation, overhead line modification and any site drainage and landscape and planting schemes. For the sake of clarity, the Norfolk Boreas project would, under Scenario 2, involve the construction and installation of all onshore infrastructure necessary for a viable project.

16. With regards to the scenarios presented above, the key consideration in relation to impacts associated with Water Resources and Flood Risk under the two separate scenarios will arise as a result of the crossings of water bodies. Under Scenario 1, the impacts associated with the crossing of major and sensitive water bodies by the cable corridor are substantially reduced compared to that of Scenario 2 due to the prior consenting and constructing of Norfolk Vanguard.

17. **Appendix 1** contains a set of figures showing the onshore infrastructure and **Appendix 2** contains a detailed comparison of what is included in the two different scenarios across all elements of the project.

18. Norfolk Boreas are proposing to employ a construction strategy whereby there are multiple moving work fronts which complete the majority of all construction works in each area before moving on. This reduces overall construction time as most works are completed in one pass and allows flexibility for areas to be avoided at sensitive times and to minimise impact through scheduling of works.

2.2 Site Selection Update

19. A detailed programme of site selection work has been undertaken by VWPL to refine the locations of the onshore infrastructure for both the Norfolk Vanguard and Norfolk Boreas projects. The Norfolk Vanguard EIA Scoping Report presented search areas for the onshore infrastructure which were identified following constraints mapping to avoid or minimise potential impacts (e.g. noise, visual, landscape, traffic, human health and socio-economic impacts). Further data review has been undertaken to understand the engineering and environmental constraints within the search areas identified. This process has been informed by public drop in exhibitions (October 2016, March and April 2017), along with the Scoping Opinion for Norfolk Vanguard and the feedback from the Expert Topic Groups. Details of the site selection process are provided in Chapter 4 of the Norfolk Vanguard Preliminary Environmental Information Report (Royal HaskoningDHV, 2017b) with summaries provided below:

2.2.1 Landfall Zone

20. The Norfolk Boreas Scoping report presented three potential landfall locations. Data was reviewed on a broad range of environmental factors, including existing industrialised landscape, the presence of the Cromer Shoal Chalk Beds Marine Conservation Zone (MCZ), coastal erosion and archaeology alongside statutory and non-statutory consultation.

21. After publication of the scoping report, VWPL concluded that the most suitable landfall location would be Happisburgh South, taking account of all engineering and environmental factors as well as public feedback. The decision to use the Happisburgh South site was presented to the Norfolk Vanguard Evidence Plan Expert Topic groups in June and July 2017 and in the Norfolk Vanguard PEIR (Royal HaskoningDHV 2017b).

22. The Happisburgh South landfall site also has the benefit of being large enough to accommodate landfall works of both Norfolk Vanguard and Norfolk Boreas, therefore reducing the spatial extent of impacts associated with the two projects.

2.2.2 Cable Relay Station Options

23. The Norfolk Boreas Scoping report presented seven potential cable relay station search zones. A single cable relay station would be required for a High Voltage Alternating Current (HVAC) electrical solution. No cable relay station would be required for a High Voltage Direct Current (HVDC) electrical solution. The decision between HVDC and HVAC solutions is not expected to be taken until post consent, therefore for the purposes of the EIA, and under the project envelope approach, assessment would be conducted on the basis of the realistic worst case.

24. Following the scoping opinion, further work has been completed and two potential locations are being proposed for the cable relay station (**Appendix 1**). The final siting of the cable relay station on either footprint will have due consideration for of existing watercourses, hedgerows, landscaping, archaeology, ecology, noise, access and other known infrastructure/environmental constraints to minimise impacts, along with feedback from statutory and non-statutory consultation.

25. A Norfolk Boreas cable relay station temporary construction compound area has not yet been identified, however a location will have been determined prior to the Norfolk Boreas PEIR being published in Q4 2018.

2.2.3 Onshore Cable Route

26. A 200m wide cable corridor was presented within the Norfolk Boreas scoping report. This corridor, shared with Norfolk Vanguard, is the shortest realistic route between

landfall and the Necton National Grid substation (thereby minimising disturbance impacts) whilst also aiming to avoid main residential areas and impacts to landscape, nature conservation designations and other key environmental constraints where possible.

27. The proposed route skirts around the main towns of North Walsham, Aylsham, Reepham and Dereham. Since the Norfolk Boreas scoping report was published, further work has been completed (see Royal HaskoningDHV, 2017b for details) to refine the cable corridor and an indicative cable route has been established suitable for infrastructure for both the Norfolk Vanguard and Boreas onshore export cables (**Appendix 1**).

2.2.4 Onshore Project Substation

28. The Norfolk Boreas scoping report presented an onshore project substation zone within which the onshore project substation was to be located. Following further site selection work (presented in Royal HaskoningDHV, 2017b), a preferred onshore project substation location has been identified. Although the onshore project substation location is now well defined there remains the possibility that its exact location may change slightly following consultation on the Norfolk Vanguard PEIR, therefore an onshore project substation search area has been retained (**Appendix** 1).

29. A Norfolk Boreas Onshore project substation temporary construction compound area has not yet been identified, however a location will have been determined prior to the Norfolk Boreas PEIR being published in Q4 2018.

2.2.5 Extension to the Existing Necton National Grid substation

30. The Norfolk Boreas Scoping report presented a National Grid substation extension zone. Since the publication of that report further work has been done to define the footprint of these extension works (**Appendix 1**). Further detail on this process is presented in Chapter 4 of the Norfolk Vanguard PEIR (Royal HaskoningDHV, 2017b).

31. Also presented in the Norfolk Boreas Scoping report was an overhead line modification zone within which the overhead lines leading into the Necton National Grid substation would be realigned (section 2.3.1.5). The area within which this work will be undertaken has been refined and is presented in **Appendix 1**. Further detail on the process behind this refinement is provided in the Norfolk Vanguard PEIR chapter 5 site selection and alternatives.

2.3 Indicative Worst Case Scenarios

32. The following sections set out the current predicted worst case scenarios for water resources and flood risk. The Norfolk Boreas PEIR and the ES will provide further

detail on the Project Description describing the final project design envelope for the DCO application.

33. Each chapter of the PEIR and ES will define the worst case scenario arising from the construction, operation and decommissioning phases of the Norfolk Boreas project for the relevant receptors and impacts. Additionally, each chapter will consider separately the anticipated cumulative impacts of Norfolk Boreas with other relevant projects which could have a cumulative impact on the receptors under consideration.

34. The parameters discussed in this section are based on the best available information for Norfolk Boreas at the time of writing and are subject to change as the project progresses.

2.3.1 Infrastructure Parameters

35. HVAC and HVDC electrical solutions are being considered for Norfolk Boreas. Both electrical solutions would have implications for the required onshore infrastructure. Typically the HVAC solution involves a greater area of land take and additional infrastructure, and as such the HVAC solution is generally assumed as the worst case for water resource and flood risk. Where the worst case assumes the HVDC solution, this is stated in the text.

36. The following key onshore project parameters are considered within this method statement. Explanation of which parameters are considered for Scenario 1 and for Scenario 2 is provided in the sections below. Full details of what is considered in Scenario 1 and what is considered in Scenario 2 are provided in **Appendix 2**:

- Landfall (Horizontal Directional Drilling (HDD) and associated compounds);
- Cable relay station (required for HVAC only);
- Cable corridor (with associated trenchless crossing technique areas, construction compounds and mobilisation areas and access);
- Onshore project substation;
- Interface cables connecting the onshore project substation and the Necton National Grid substation; and
- Extension to the existing Necton National Grid Substation, including overhead line modification.

37. Under Scenario 1, The Norfolk Vanguard project would be considered within the Cumulative Impact Assessment (CIA), together with the parameters of Norfolk Boreas (as listed in the bullets points above). Other projects which would be considered in the CIA are discussed in section 0 .

2.3.1.1 Landfall

38. The landfall compound zone (**Appendix 1**) denotes the location where up to six Norfolk Boreas offshore export cables would be brought ashore. These would be jointed to the onshore cables in transition pits located within the eastern most "trenchless crossing technique" area shown in **Appendix 1**. Under Scenario 1 Norfolk Boreas would share the landfall area with Norfolk Vanguard at Happisburgh South.

39. Works associated at landfall would be the same under both scenarios. Under Scenario 1, if Norfolk Boreas cable ducts are installed concurrently with the Norfolk Vanguard ducts, the Norfolk Boreas ducts would be installed only on the landward (western) side of the transition pits. Ducts on the seaward side of the transition pits would be installed using Horizontal Directional Drilling (HDD) which is a trenchless installation technique

40. Key parameters of works at landfall:

- Installation of a temporary construction compound to accommodate the drilling rig, ducting and associated materials and welfare facilities.
- A total of up to six ducts for the HVAC solution or two ducts for the HVDC solution would be required at the landfall for Norfolk Boreas.
- Temporary footprint of works would be up to 3,000m^2 per compound (up to six compounds).
- The site would be fully reinstated upon completion of the landfall works.

41. Each cable circuit would require a separate transition pit to connect the offshore and onshore cables at the landfall which would be grouped together and staggered as necessary to be accommodated within the permanent cable corridor. The transition pit would comprise of an excavated area of 15m x 10m x 5m at the base, per circuit, with a reinforced concrete floor to allow winching during cable pulling and a stable surface to allow jointing.

42. A temporary compound would be assembled to provide a controlled environment to be maintained during jointing activities. A small generator could be required to provide for any pumps to manage groundwater.

2.3.1.2 Cable Relay Station

43. A cable relay station would be required for a HVAC electrical solution. No cable relay station would be required for a HVDC solution. Therefore the HVAC solution is the worst case scenario for this element of the onshore infrastructure. The cable relay station would be constructed by Norfolk Boreas under both Scenarios 1 and 2 and would be located within one of the sites identified in **Appendix 1**.

44. Key parameters of works at cable relay station are as follows:

- The cable relay station would consist of a three phase reactor per HVAC circuit (a total of six reactors) with associated outdoor GIS (Gas Insulated Switchgear). Each reactor would be installed in concrete bunds to contain oil leakage and prevent damage to the environment. Cables from the landfall and onwards to the onshore substation would be laid in concrete troughs within the cable relay station and terminated at the GIS.
- The total cable relay station fenced area would be 73m x 135m, with a perimeter fence height of 2.4m. External to the perimeter fence would be a small control building with associated parking with combined dimensions of 31m x 18m.
- There would be an additional temporary construction area with a maximum temporary footprint of 15,000m^2 during construction of the cable relay station.

45. The location of the temporary construction compound has not yet been determined but will be presented within the Norfolk Boreas PEIR being published in Q4 2018. Given construction duration, the compound would likely be tarmacked with some concrete hard standing for heavier plant and equipment.

46. The compound would accommodate construction management offices, welfare facilities, car parking, workshops and storage areas. Water, sewerage and electricity services would be required at the site and supplied either via mains connection or mobile supplies such as bowsers, septic tanks and generators. Under Scenario 2, this compound would also serve as a Primary Mobilisation Area (PMA) for cable installation works. Under Scenario 1, PMAs are not required.

47. Surface water drainage requirements would be dictated by the final drainage study and would be designed to meet the requirements of the National Planning Policy Framework (NPPF). The SuDS (Sustainable Drainage Systems) philosophy would be employed to limit run-off, where feasible, through the use of infiltration techniques which can be accommodated within the area of development. Foul drainage would be collected through a mains connection to existing local authority sewer system if available or septic tank located within the development boundary. The specific approach would be determined during detailed design with consideration for the availability of mains connection and the number of visiting hours for site attendees during operation.

48. The site would be stripped and graded as required by the final design. Under Scenario 2 the stripped material would be reused on site where possible as part of bunding and shielding as allowed for in the final design. Under Scenario 1 there would be less capacity to do this as landscaping schemes developed to mitigate visual impacts of both Norfolk Vanguard and Norfolk Boreas will have started to

mature by the time Norfolk Boreas construction starts. Any excess material would be disposed of at a licenced disposal site. Excavations and laying of foundations, trenches and drainage would commence after grading is complete.

49. The construction programme for the cable relay station would be 18 months.

2.3.1.3 Onshore cable corridor

50. The onshore cable corridor would contain the final onshore cable route. Currently an indicative cable route has been identified and is displayed in **Appendix 1**.

2.3.1.3.1 Onshore cable route

51. The onshore cable route would contain the main 220kV HVAC or ±320kV HVDC export cables connecting the landfall to the onshore project substation and 400kV HVAC interface cables connecting the onshore project substation with the Necton National Grid substation. The main onshore cable corridor connects the landfall to the onshore project substation. A plan of the onshore cable route is shown in **Appendix 1**.

52. The key elements of the onshore cable route for Scenario 1 and Scenerio 2 are detailed in **Appendix 2**, and summarised below.

Scenario 1

53. Norfolk Vanguard would install cable ducts and undertake enabling (e.g. running track, accesses etc.) for Norfolk Boreas along the entire length of the onshore cable corridor. Therefore, all excavations (except jointing pits and associated temporary construction compounds) and crossings would have already been undertaken. In addition, all ducts will be installed and ground reinstated by Norfolk Vanguard.

Scenario 2

54. Norfolk Boreas would be responsible for installing all onshore cable route infrastructure required for the project, including installing ducts along the entire cable route and reinstating land (cable pulling would then happen at a later date). Under this scenario, the cable route would also require:

- Trenches for the cable circuits;
- A running track to deliver equipment to the installation site from mobilisation areas; and
- Storage areas for topsoil and subsoil.

2.3.1.3.2 Trenching and soil storage

Scenario 1

55. No trenching and soil storage would be required under this scenario for Norfolk Boreas as these works would have been completed under Norfolk Vanguard.

Scenario 2

56. Norfolk Boreas would be responsible for cable installation requiring trenches for cable circuits and storage areas for topsoil and subsoil. The main duct installation method would be through the use of open cut trenching with HDPE ducts installed, soil backfilled and land reinstated. Cables would be pulled though the pre-laid ducts at a later stage.

57. The ducts would be installed in a flat formation (each cable core installed alongside each other) to a depth of 1.05m (to top of duct), in a trench of approximate 1m width. This depth would allow the ducts and the cables within them (and protective tiles and tape) to be laid below the level of typical field drainage pipes and other underground services to minimise impact and interaction.

58. Where the cable route crosses major transport routes or waterways cable burial depth might increase or an alternative trenchless method may be used. Further details of crossing methodologies are provided below. Where open cut trenching is employed in these locations and associated locations such as hedgerows, the working width could be reduced to the running track and cable trenching areas only (e.g. 25m for HVAC) with soil storage areas retained immediately before and after the feature crossing.

59. Topsoil would be stripped from the entire width of the onshore cable route for the length of route to be worked on at any one time and stored and capped to minimise wind and water erosion within the onshore cable route.

60. The profile of the soil would be carefully maintained during the storage process. The cable trenches would then be excavated, typically utilising tracked excavators. The excavated subsoil would be stored separately from the topsoil, capped and the profile of the soil maintained during the storage process. The stored topsoil would be replaced upon the backfilled subsoil to reinstate the trench to pre-construction condition, so far as reasonably possible.

61. A pre-construction drainage plan would be developed and implemented to minimise water within the trench and ensure ongoing drainage of surrounding land. Where water enters the trenches during installation, this would be pumped via settling

tanks or ponds to remove sediment, before being discharged into local ditches or drains via temporary interceptor drains.

62. Alternatively, a tracked trenching machine could be used which allows ducting installation to be achieved without excavation. This method will be dependent on soil conditions and other detailed design aspects to be reviewed at the time of construction design.

2.3.1.3.3 Running track

63. A running track provides safe access for construction vehicles within the onshore cable route. The running track could be up to 6m with a separation of 2m from the edge of the running track and the cable trench for safety and duct storage prior to pulling in the duct sections.

Scenario 1

64. Under Scenario 1 approximately 20% of the Norfolk Vanguard running track would need to be retained or reinstated (reinstatement being the worst case scenario) for the cable pulling phases.

Scenario 2

65. Under Scenario 2 running tracked would be installed along the entire length of the cable route (approximately 60km) to allow safe access from mobilisation areas to the duct installation sites.

66. Following topsoil stripping, the running track would be formed of protective matting, temporary metal road or permeable gravel aggregate dependant on the ground conditions, vehicle requirements and any necessary protection for underground services. Monitoring of the subsoil would be conducted to minimise long term damage and higher grade protection will be applied if deemed necessary.

67. At drain crossings, the running track would be installed over a pre-installed culvert pipe to allow continued access to the cable route. The pipe would be installed in the drain bed to avoid upstream impoundment, and would be sized to accommodate reasonable 'worst-case' water volumes and flows. These culverts could remain in place for up to two years.

68. At larger road and water course crossings, temporary bridges may be employed to allow continuation of the running track. At railway and main river crossings where a trenchless crossing solution would be used, the running track would not be continuous. These locations would be 'stop ends' to the construction work fronts.

69. The running track would be required to remain cleared for the duration of the trenching and ducting activities to allow access along the cable route. Following construction completion of the duct installation, all or the majority of the running track would be removed and the topsoil reinstated, although rights would be retained to access the running tracks location should repairs of the cables be required during the lifetime of the project. Approximately 20% of the access track would need to be retained or reinstated for subsequent cable pulling phases.

2.3.1.3.4 Cable Pulling Process

70. A number of aspects of the cable pull process would be the same irrespective of scenario as follows. The onshore cables would be pulled through the installed ducts later in the construction programme in a staged approach, as offshore generating capacity came online.

71. Cable pulling would not require the trenches to be reopened, with the cables pulled through the preinstalled ducts between the jointing pits located along the onshore cable route.

72. The cable pulling and jointing process will take approximately six weeks per 1km of cable length, including installing and removing any temporary hard standing and delivering the cables to the jointing pits. However, any one jointing pit may be open for up to 12 weeks to allow its neighbouring jointing pit to be opened and the cables pulled from one pit to the next, dependant on the level of parallel work being conducted.

73. Access to and from the jointing pits would be required to facilitate the works during this phase of the project.

74. This would be achieved through access to the onshore cable jointing pits directly from the highways network (at crossing locations) or existing local access routes where possible. Access to jointing pits would differ between scenarios as outlined below:

Scenario 1

75. Under Scenario 1 in some locations, small sections of the running track would be required to be instated to allow access to more remote jointing bay locations (assuming that the entire running track required for the Norfolk Vanguard Project would have been removed). It is considered as a worst case scenario this would require approximately 20% of the running track to be reinstated to facilitate access to jointing pits.

Scenario 2

76. Under this scenario approximately 20% of running track presented would be left in place from the duct installation works, or required to be reinstated to allow access to more remote jointing bay locations.

2.3.1.3.5 Jointing pits

77. Under both Scenario 1 and 2, the jointing pits would be installed by Norfolk Boreas. Jointing pits would be required along the onshore cable route to allow cable pulling and jointing of two sections of cable.

78. The jointing pits would typically be located at 800m intervals, the maximum cable length which can be delivered, although site specific constraints may result in shorter intervals where necessary. The jointing pits will be of a similar design and installed in a similar approach to the transition jointing pits detailed in section 2.3.1.1

79. Construction of jointing pit compounds would differ between scenarios as outlined below.

Scenario 1

80. Under Scenario 1 VWPL are considering the possibility of reusing the same areas as those used to construct jointing pit compounds for Norfolk Vanguard during Norfolk Boreas construction. If at the detailed design phase the decision is made to do this there would be the possibility of leaving materials used to construct the Norfolk Vanguard jointing pit compounds in situ for use in the Norfolk Boreas jointing pit compounds. If the decision is taken not to use the same as areas for jointing pit compounds all associated works would be undertaken by Norfolk Boreas. However, as this is yet to be confirmed the worst case is that this will not be possible and all jointing pits construction compounds would be fully constructed by Norfolk Boreas.

Scenario 2

81. All associated works for jointing pit compounds would be undertaken Norfolk Boreas.

2.3.1.3.6 Link boxes

82. Link boxes would be required under both Scenario 1 and Scenario 2.

83. Link boxes are required for a HVAC connection arrangement to enable the cables to work as efficiently as possible. These would typically be installed in close proximity (within 10m) to jointing pit locations.

84. Link boxes would be placed at every second or third jointing location (~1.0 km – 3.0 km). The number and placement of the link boxes will be determined as part of the detailed design. For the HVDC connection arrangement a smaller number of similar link boxes could be utilised for these aspects.

85. There are two options being considered for Link Box installation: Either a box with dimensions 1.5m x 1.5m, per circuit would be buried to ground level within an excavated pit, providing access via a secured access panel or, an above ground link box cabinet with a footprint of 1.0m x 0.5m and a height of 1.0m could be utilised.

2.3.1.3.7 Crossing installation methods

Scenario 1

86. Under this scenario all necessary crossing installation would have been completed by Norfolk Vanguard. No additional works would be required by Norfolk Boreas.

Scenario 2

87. Under this scenario, crossings would be consented and installed by Norfolk Boreas. When crossing some features along the onshore cable route, alternative or amended installation approaches would be required to minimise the impact on the feature or obstacle being crossed as much as reasonably practicable. The following subsections detail the crossing installation methods available with the type proposed at each crossing fully detailed within the PEIR and ES.

88. Where small scale watercourses such as field drains, which are shallower than 1.5m are to be crossed, temporary damming and diverting of the watercourse could be employed. The suitability of this method would be advised at the detailed design stage following consent from the relevant land owners as part of the agricultural design process; larger water courses may also require consent from internal drainage boards and flood management agencies.

89. The works would be conducted within the cable route with no additional land requirements. The running track may require culverting or temporary bridging in these locations to allow continued cable route access. The running track would be removed once cable installation is complete.

90. Where larger watercourses such as field drains are deeper than 1.5m, culverting might be used. However, the Environment Agency deem this technique to be the least desirable river crossing method, therefore the use of culverting would be avoided wherever possible. Where culverting is required, consultation would be carried out would with the Environment Agency, relevant internal drainage boards and flood management agencies at the detailed design phase.

91. Where culverting is employed, a pipe would be installed in the watercourse, suitably sized for necessary water volumes and flows. The pipe would be backfilled or encased in concrete to a depth of 2m. The cable ducts would subsequently laid perpendicular and backfilled to ground level creating a culverted watercourse.

92. Culverting would be carried out within the onshore cable route and would have no additional land requirements. The running track would also be required where culverting is undertaken to allow continued cable route access. Culverting may be required temporarily for a width of 6m to allow the running track to cross watercourses during installation works.

93. Cable bridges could also be used to cross larger water courses. A cable bridge structure would be constructed across the feature at a height specified by the feature and its uses. Ducts would be installed along the bridge for the cables to be pulled within. At the entrance/exit of the cable bridge, the ducts would transition from above ground to below ground. During the transition where the installation depth is less than 1.05m, concrete covers would be laid to protect the cables from damage. The bridge would include protective measures to prevent public access to the cables or the bridge.

94. Trenchless installation methods such as HDD, micro tunnelling or auger boring are likely to be used where open cut trenching is not suitable due to the crossing width or the feature being crossed. Trenchless crossing techniques will be employed at the River Wensum (Special Area of Conservation – SAC, Site of Special Scientific Interest – SSSI), River Bure, King's Beck, Wendling Beck (downstream), and North Walsham and Dilham Canal. The locations of these are shown in Appendix 1 (termed trenchless crossing techniques).

95. With trenchless methods, the depth at which the ducts are installed depends on the topology and geology at the crossing site. Typically, for a river crossing, HDD ducts would be installed 5 to 15m below the floodplain, and at least 2m below the river bed. The selection of trenchless technique at each site would be dependent upon local geology and associated risks.

96. Where trenchless drilling activities are to be conducted, a temporary work area would be required to store drilling equipment, welfare facilities, ducting and water for the drilling process. The trenchless drilling compounds would typically be of dimensions 50m x 50m for the reception site and 100m x 50m on the launch site, adjacent to the onshore cable route. A temporary bridge might be included to allow continuation of the running track and allow access to both sides of the crossing. Alternatively, a stop end would be used, requiring the inclusion of a turning area for vehicles within the temporary work area.

2.3.1.3.8 Temporary construction compounds

Scenario 1

97. Under Scenario 1 no primary and secondary mobilisation areas would be required as materials will be delivered directly to jointing pits locations.

Scenario 2

98. Primary and secondary mobilisation areas would be required to store equipment and provide welfare facilities. Indicative locations for these are provided in **Appendix 1**. They would be located adjacent to the onshore cable route corridor, accessible from the local highways network suitable for the delivery of cable drums and other heavy and oversized equipment. Each mobilisation area would serve one or two work fronts and would be evenly distributed along the onshore cable route length where possible.

99. The primary mobilisation areas would typically be of 100m x 100m dimensions (or 150m x 100m if combined with a trenchless drilling compound) and the secondary mobilisation areas would be approximately 40m x 40m with specific sizing and dimensions for each location based on site constraints and land boundaries.

100. Hardstanding would likely comprise of permeable gravel aggregate to a depth of 0.3m underlain by geotextile or other suitable material would be employed to allow safe storage and movement of vehicles within the area and maintain required drainage.

101. The mobilisation areas would remain in place for the duration of the onshore duct installation activities, anticipated to be up to two years. Following installation of the ducts, the mobilisation areas would be removed and the land reinstated.

2.3.1.3.9 Cable route side access

102. Small temporary works areas would be required to facilitate the safe ingress and egress from the public highways to the cable route or mobilisation areas through temporary slip roads called side accesses. These are displayed in **Appendix 1** and would be used for the following:

103. Under Scenario 1 these would be retained or reinstated from the Norfolk Vanguard project. For the purposes of this Method Statement the worst case scenario would be the reinstatement of these accesses.

- To gain access to jointing pit locations during cable pulling and jointing phase;
- To gain access to link boxes, and
- To gain access to cables to make repairs during operational phase.

104. The extent of the cable route side access would differ between scenarios as outlined below.

Scenario 1

105. Under Scenario 1 some of the side accesses to the cable route would be retained or reinstated from the Norfolk Vanguard project. For the purposes of this Method Statement the worst case scenario would be the reinstatement of these accesses. Detailed traffic and transport assessments are ongoing to refine which side accesses would need to be reinstated under Scenario 1.

Scenario 2

106. Under Scenario 2 side accesses to the cable route would need to be constructed and would be left in place for three years to provision cable pulling phases before being removed and land reinstated.

107. Detailed traffic and transport assessments are ongoing to refine exactly where these side accesses would be required and which would need to be retained from the duct installation process.

2.3.1.4 Onshore Project Substation

108. The onshore project substation would consist of either an HVAC substation or HVDC substation[1], dependant on the electrical solution utilised. Only one project substation (HVAC or HVDC) would be required for Norfolk Boreas. The total land requirement for both the HVAC and HVDC onshore substation to the perimeter fence is 250m x 300m. The proposed onshore project substation location is presented in **Appendix 1**, with dimensions as detailed below.

109. The location of the onshore project substation was determined by an optioneering process which is explained in Chapter 4 site selection and alternatives of the Norfolk Vanguard PEIR (Royal HaskoniongDHV, 2017b).

110. During construction of the onshore project substation, a temporary construction compound would be established to support the works. The compound would be formed of hard standing with appropriate access to the A47 to allow the delivery and storage of large and heavy materials and assets, such as power transformers.

111. The location of the temporary construction compound has not yet been determined but will be presented within the Norfolk Boreas PEIR to be delivered in Q4 2018. The compound would be of dimensions 200m x 100m and would accommodate

[1] Also referred to as a HVDC converter station. For the purposes of consistency both HVAC and HVDC solutions will be referred to as the onshore project substation.

construction management offices, welfare facilities, car parking, workshops and storage areas. Water, sewerage and electricity services would be required at the site and supplied either via mains connection or mobile supplies such as bowsers, septic tanks and generators.

112. The site would be stripped of soil and soil graded as required by the final design. Stripped material would be reused on site where possible as part of bunding and shielding as allowed for in the final design. Any excess material would be disposed of at a licenced disposal site. Excavations and laying of foundations, trenches and drainage will commence after grading is complete.

113. Surface water drainage requirements for the onshore project substation would be dictated by the final drainage study and would be designed to meet the requirements of the National Planning Policy Framework (NPPF) with run-off limited, where feasible, through the use of infiltration techniques which can be accommodated within the area of development. Foul drainage would be collected through a mains connection to existing local authority sewer system if available or septic tank located within the development boundary. The specific approach would be determined during detailed design phase with consideration for the availability of mains connection and the number of visiting hours for site attendees during operation.

114. At this stage, it is not known whether the foundations would either be ground-bearing or piled based on the prevailing ground conditions.

115. The enabling works for the onshore project substation would differ between scenarios as outlined below:

Scenario 1

116. Under Scenario 1, a number of enabling activities would be undertaken by Norfolk Vanguard. These include:

- Landscaping to reduce visual impacts;
- Access roads; and
- Site drainage infrastructure.

Scenario 2

117. Under Scenario 2, all enabling works would be undertaken by Norfolk Boreas.

2.3.1.5 Necton National Grid Substation Extension

118. The existing Necton National Grid substation is required to be extended to accommodate the Norfolk Boreas and Norfolk Vanguard connection points. The proposed footprint of this extension is provided in **Appendix 1**.

Scenario 1

119. Under Scenario 1 the majority of these works would be undertaken by Norfolk Vanguard for both projects. All extension enabling works would be completed including access roads, earthworks, foundations, buildings and civil works. The Necton National Grid substation would have been extended to provide Air Insulated Switchgear (AIS) bays for Norfolk Vanguard and for Norfolk Boreas. All overhead line modification would also have been carried out under the Norfolk Vanguard project.

120. However the electrical busbar extensions and other electrical equipment required for Norfolk Boreas will be installed by Norfolk Boreas.

Scenario 2

121. Under Scenario 2 all extension works to Necton National Grid Substation and overhead line modifications to accommodate Norfolk Boreas would be undertaken. The outdoor busbar would be extended in an east and west direction to an estimated total length 340m with seven AIS bays installed along the busbar extension for Norfolk Boreas. The total substation area is estimated to be 150m x 370m (inclusive of existing substation operational area).

122. Two new overhead line towers would be required in close proximity to the existing corner tower (to the north east of the existing Necton Substation) with a maximum height of 67m. The existing corner tower would be demolished and replaced by two new towers, alternatively, the existing corner tower could be modified and one new terminal tower constructed in close proximity. The design approach taken will be confirmed at detailed design phase. No additional land is anticipated for the overhead line modifications.

123. During construction of the Necton National Grid Substation, two temporary construction compounds would be established to support the works. Given project duration, the compounds would likely be tarmacked with some concrete hard standing for heavier plant and equipment. Access to the A47 would be provided utilising the existing access road to the site to permit safe delivery of plant and equipment required for construction.

124. The larger compound would be of dimensions 300m x 150m and the smaller compound 200m x 150m. The compounds would accommodate construction

management offices, welfare facilities, car parking, workshops and storage areas. Water, sewerage and electricity services will be required at the site and supplied either via mains connection or mobile supplies such as bowsers, septic tanks and generators.

125. The site would be stripped of soil and soil graded as required by the final design. Stripped soil and other material would be reused on site where possible as part of bunding and shielding as allowed for in the final design. Any excess material would be disposed of at a licenced disposal site. Excavations and laying of foundations, trenches and drainage will commence after grading is complete.

126. The construction programme for the Necton National Grid substation extension and overhead line modification works is 18 months. Further detail on construction programmes is provided below in section 2.3.2.

2.3.2 Construction Programme

127. Currently it is expected that the Norfolk Boreas project would be constructed in one, two or three phases. **Table 2.1** summarises the main construction activities and sequence associated with installation of the Norfolk Boreas project onshore infrastructure under a 'three-phased' approach (as this represents the worst-case scenario in terms of duration of impact). Separate time lines are discussed for both Scenario 1 and 2.

Table 2.1 Construction Programme

<table>
<tr><th>Date</th><th colspan="2">Scenario 1</th><th colspan="2">Scenario 2</th></tr>
<tr><td>2022</td><td colspan="2"></td><td rowspan="2">Pre-construction works
Road modifications
Hedge and tree removal (season dependant)
Ecological preparations (e.g. displacement of water voles, fencing of areas for newts, etc.)
Preconstruction drainage (at cable relay station and substation locations)</td><td></td></tr>
<tr><td>2023</td><td colspan="2"></td><td></td></tr>
<tr><td>2024</td><td>Pre-construction works
(landfall, cable relay station and onshore project substation only)
Ecological preparations (e.g. displacement of water voles, fencing of areas for newts, etc.)
Preconstruction Drainage at cable relay station and substation locations</td><td rowspan="3">Substation and Cable Relay Station Construction
Main works (drainage, foundations and buildings)</td><td rowspan="2">Main duct installation works
Enabling works
Duct installation
Reinstatement works</td><td rowspan="2">Substation and Cable Relay Station Construction
Main works (drainage, foundations and buildings)</td></tr>
<tr><td>2025</td><td></td></tr>
<tr><td>2026</td><td></td><td rowspan="3">Cable installation
Installed in three phases (2026, 2027 & 2028)</td><td rowspan="3">Substation and Cable Relay Station Construction
Plant installation (to tie in with cable pull)</td></tr>
<tr><td>2027</td><td rowspan="3">Cable pulling
Installed in three phases (2027, 2028 & 2029)</td><td rowspan="3">Substation and Cable Relay Station Construction
Plant installation (to tie in with cable pull)</td></tr>
<tr><td>2028</td></tr>
<tr><td>2029</td><td></td><td></td></tr>
</table>

2.3.3 Operation and Maintenance (O&M) Strategy

128. The cable relay station, onshore project substation and overhead line modification area would not be manned, however access would be required periodically for routine maintenance activities, estimated at an average of one visit per week.

129. There would be no anticipated ongoing requirement to maintain the onshore cables following installation. Periodic access to installed link boxes (which may be buried or above ground, see section 2.3.1.3) may be required for inspection, estimated to be annually. These link boxes will be accessible from ground level and will not require excavation works.

130. Access to the cable easement would be required to conduct emergency repairs if necessary.

2.3.4 Decommissioning

131. No decision has been made regarding the final decommissioning policy for the substation and cable relay station, as it is recognised that industry best practice, rules and legislation change over time. However, the substation and cable relay station equipment will likely be removed and reused or recycled. It is expected that the onshore cables will be removed from ducts and recycled, with the jointing pits and ducts left in situ. 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.

3 BASELINE ENVIRONMENT

3.1 Desk Based Review

132. A desk based review of onshore water resources and flood risk receptors was undertaken as part of the Norfolk Boreas scoping report. The Environmental Statement (ES) will build upon this information, in conjunction with additional data obtained as part of the Norfolk Vanguard assessment, to thoroughly characterise the baseline environment and identify the receptors that could potentially be impacted by the proposed development.

133. An initial update to the desk based review presented in the scoping report is provided in the subsequent sections.

3.1.1 Available Data

134. **Table 3.1** summarises the data sources which will be used to information Norfolk Boreas EIA.

Table 3.1 Data sources

Data	Source	Date
Information on the current classification and status objectives of surface and groundwater bodies under the WFD	Environment Agency (2016a) Catchment Data Explorer. (Online) Available from: http://environment.data.gov.uk/catchment-planning/	13/07/17
Additional information on water body status, included in the Anglian River Basin Management Plan	Environment Agency (2015) Anglian River Basin District River Basin Management Plan. (Online) Available from: https://www.gov.uk/government/publications/anglian-river-basin-district-river-basin-management-plan	13/07/17
Information on designated sites	Natural England (2013) MAGIC website. (Online) Available from: http://www.magic.gov.uk/ Natural England (undated) Designated Sites View. (Online) Available from: https://designatedsites.naturalengland.org.uk/SiteSearch.aspx	13/07/17
The Environment Agency's Risk of Flooding from Surface Water tool	Environment Agency (2012a) Risk of Flooding from Surface Water Tool. (Online) Available from: https://flood-warning-information.service.gov.uk/long-term-flood-risk	13/07/17
Environment Agency's Risk of Flooding from Rivers and Sea (Flood Map for Planning) tool	Environment Agency (2012b) Risk of Flooding from Rivers and Sea (Flood Map for Planning) Tool. (Online) Available from: http://maps.environment-agency.gov.uk/wiyby/wiybyController?topic=floodmap&layerGroups=default&lang=_e&ep=map&scale=7&x=531500&y=181500	13/07/17
Geomorphological Survey data	Royal HaskoningDHV (2017c) Norfolk Vanguard Offshore Wind Farm Appendix 20.3 Geomorphological Walkover Survey. Document reference: PB4476-004-0203. (Field survey undertaken 11/04/2017)	13/07/17
Environment Agency Detailed Flood Risk Assessment Map and	Requested from the Environment Agency in association to the Norfolk Vanguard survey area.	Received 15/06/2017

Data	Source	Date
Flood Defence Breach Hazard Map (Product 4 and 8 data)		
'Internal Drainage Board (IDB) data regarding the classification of drains within the North Rivers and Broads IDB regions	Requested from the IDB in association to the Norfolk Vanguard survey area.	Received 28/06/2017

135. The data sources listed in **Table 3.1** include desk and field survey data gathered for the Norfolk Vanguard project. The desk and field survey data collected for the Norfolk Vanguard project includes the footprint of the Norfolk Boreas onshore infrastructure. As shown in **Table 3.1**, this data has been collected during 2017. Given the spatial overlap between the onshore infrastructure for these two projects, and the recent gathering of the data, the data sources listed in **Table 3.1** are considered to be appropriate and fit for purpose for use during the Norfolk Boreas project.

3.1.2 Surface water catchments

136. The project is located within three main surface water catchments (**Figure 1**):

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

137. The River Bure and several of its tributaries, including the King's Beck, would be crossed by the onshore cable corridor. The 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 Breydon Water before entering the sea at Goreleston on Sea . 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, Halvergate Marshes and the Norfolk Broads.

138. The North Walsham and Dilham Canal also forms a tributary of the River Bure, and would be crossed by the proposed onshore cable corridor at North Walsham. The canal commences at Antingham, from where it flows in an easterly direction towards Swafield. The canal is joined by several natural watercourses, including Fox's Beck. The watercourse then continues south-east through North Walsham, to Wayford Bridge, near Dilham, where it joins the tidal River Ant. The River Ant continues to flow in a southerly direction until it joins the River Bure at Horning.

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

140. The Necton National Grid substation is located within the catchment of the headwaters of the River Wissey. 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.

141. Each of these catchments is divided into a number of surface sub-catchments (**Figure 2**), which are analogous to the WFD water body catchments identified by the Environment Agency. Water bodies that could potentially be affected by the proposed development have initially been identified using the Environment Agency's Catchment Data Explorer, as shown in **Table 3.2**.

Table 3.2 Surface sub-catchments potentially affected by the proposed development

Sub-catchment water body name	WFD Water body ID	Current WFD Overall water body status
East Ruston Stream	GB105034055670	Moderate
North Walsham and Dilham Canal (disused)	GB105034055710	Moderate
King's Beck	GB105034055730	Moderate
Scarrow Beck	GB105034055740	Moderate
River Bure	GB105034055690 & GB105034050932	Poor & Moderate
Mermaid Stream	GB105034050900	Moderate
River Wensum	GB105034051111 & GB105034055881	Moderate & Moderate
Blackwater Drain	GB105034051120	Moderate
Blackwater (Wendling Drain)	GB105034051050	Poor
Foulsham Tributary	GB105034055850	Moderate
Little Ryburgh Tributary	GB105034055860	Moderate
Wissey - Upper	GB105033047890	Moderate
Wendling Beck	GB105034051020	Moderate
Nar Upstream of Abbey Farm	GB105033047791	Good

142. There are also a number of Internal Drainage Board (IDB) channels of importance (as shown on **Figure 3**), which in general follow the main river catchments. The IDB catchments and their respective drains include (but are not limited to):

Table 3.3 IDB catchments and respective drains

IDB Catchment	Respective Drains (where applicable)
Hempstead Waxham (Brograve)	
Hundred Stream	BG1301.
North Walsham and Dilham Canal	AG1216; AG1215; and AG1218.
Reepham – Booton	MN 16 – Reepham.
Bylaugh Meadows	MN 25 - Bylaugh Meadows.
Swanton Morley	MN 26 - Pennyspot Farm; MN 12 - Swanton Morley; and MN 24 - Fish Pits.
Dereham Stream	
Gressenhall B	
King's Beck	Boundary Farm Spur (19a); Suffield Beck to Ruggs Hall (19); and Low Level Drain - Colby to Suffield Hall (18).
Blickling	Blickling to Silvergate (28); and Ingworth Bridge to Blickling Lake (27).
Alysham North	Pond Plantation to River Bure; and Mashes Row to Hollys Grove Aylsham (26).
Marsham – Brampton	

143. 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 also shown on **Figure 3**.

3.1.3 Water quality

144. 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.

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

146. In addition, the Wissey – Upper (GB105033047890) water body has elevated levels of phosphate. The Environment Agency (2016a) attributes this to inputs of phosphate fertilisers from agricultural areas via surface run-off draining into the watercourse.

3.1.4 Flood Risk

147. Environment Agency flood zone maps (Environment Agency, 2012a; 2012b) indicate that the majority of the onshore scoping 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 have a higher risk of flooding (up to Flood Zone 3 - high risk of flooding).

148. At landfall, the infrastructure is located within close proximity to an area of Flood Zone 3 deemed to be at high flood risk. This area of high flood risk is likely to be tidally controlled and as such would be deemed to have a 0.5% or greater annual chance of flooding. The area is also shown to not benefit formal any formal flood defences.

149. As identified in **Figure 4**, the development shall intercept a number of watercourses and at these locations the Environment Agency flood zone maps show areas of Flood Zone 2, deemed to be at medium fluvial flood risk (between 0.1% - 1% annual risk of flooding) and areas of Flood Zone 3, deemed to be at high fluvial flood risk (1% or greater).

150. It is important to note that **Figure 4** does not show all watercourses the development shall come in contact with and as such further areas at medium or high risk of fluvial flooding may occur along the development route. Areas designated for substation locations will require further detailed flood risk assessment to ensure all plant is located above any potential flood risk, from fluvial, surface water and other sources.

3.1.5 Groundwater

151. Regionally, the principal groundwater body covering the majority of the proposed onshore scoping area is the Broadland Rivers Chalk & Crag (WFD Waterbody ID GB40501G400300) (**Figure 5**). The chalk bedrock is designated as a Principal Aquifer and a number of groundwater Source Protection Zones (SPZs) are identified within the area, with both inner and outer zones of the SPZs extending across the eastern section of the cable route.

152. There are small sections of the onshore scoping area close to the coast, north of North Walsham that is underlain by the North Norfolk Chalk groundwater body (WFD Waterbody ID GB40501G400100); and to the far west of the onshore scoping area that are underlain by the Cam and Ely Ouse Chalk (WFD Waterbody ID GB40501G400500) and North West Norfolk Chalk (WFD Waterbody ID GB40501G400200) groundwater bodies.

3.1.6 Designated Sites

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

154. 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.

155. The Wensum was also designated as a SAC because it supports Annex 1 watercourses 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*).

156. Further details regarding designated sites can be found within the Onshore Ecology and Ornithology Method Statement (Royal HaskoningDHV, unpublished).

3.2 Survey Data

3.2.1 Desk Based Data Collection

157. The results of the initial desk based review presented above were obtained during the data collection process for the Norfolk Vanguard PEIR. This data will be used as a basis for the Norfolk Boreas detailed desk based assessment to characterise the baseline for water resources and flood risk receptors.

158. GIS analysis will be used to identify potential receptors, based on the potential for hydrological connectivity with the proposed development activities. This will be informed by comparing the site red line boundary (including details of the location of cable route, relay stations, substations and all access routes) to three primary data sets:

- WFD river water body outlines, which represent discrete catchments (or sub-catchments) for surface hydrology. Any activities undertaken within these catchments have the theoretical potential to impact upon water receptors within the catchment area.
- A detailed representation of the surface drainage network, including IDB drains, which will be used to identify individual surface water receptors within each catchment that could potentially be affected by the proposed development.

- WFD groundwater body outlines, which will be used to identify sub-surface water receptors.

159. The results of this GIS analysis will be used to:

- Produce a definitive list of surface water receptors that could be indirectly impacted by the proposed development (e.g. as a result in changes to hydrology and runoff characteristics).
- Produce a definitive list of surface water receptors that will be directly impacted (i.e. crossed) by the proposed transmission route.

160. For each receptor, the potential mechanisms for impact based on the nature of the proposed construction and O&M activities and the degree of hydrological connectivity between them and the receptor will be identified. This will include the potential for changes to surface and groundwater hydrology, geomorphology, water quality and flood risk. This definitive list of receptors will be used as the basis for all subsequent stages of the assessment, including the Environmental Impact Assessment (section 6), Flood Risk Assessment (section 6) and WFD compliance assessment (section 7).

3.2.2 Geomorphology

161. A geomorphological survey of the accessible main river watercourses that would be crossed by the proposed onshore transmission cable was undertaken in April 2017 (Royal HaskoningDHV, 2017c). This survey identified the main geomorphological characteristics, including flow conditions, channel form, floodplain characteristics and any evidence of channel modification, of the following proposed 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.
- Wendling Beck at Bushy Common.

162. **Table** 3.4 below provides an overview of the geomorphological characteristics of each of these water bodies.

Table 3.4 Geomorphological overview of watercourse crossings (Royal HaskoningDHV, 2017c)

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 resectioned. 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 resectioned historical course of the watercourse.
River Bure	The River Bure is a moderately sinuous watercourse that has been historically resectioned 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 resectioned 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 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.

3.3 Planned Data Collection

3.3.1 Desk Based Data Collection

163. It is assumed that the desk based data collection undertaken for the Norfolk Vanguard PEIR will be sufficient in providing data for the Norfolk Boreas PEIR assessment. Relevant sources, such as the Catchment Data Explorer (Environment Agency, 2016a), will be checked to ensure the use of the most up-to-date data in the assessment.

3.3.2 Field Data Collection

164. It is assumed that no further surveys are required for the Norfolk Boreas assessment with regards to the water resources and flood risk assessment, where the Norfolk Vanguard survey data collected is still valid for the Norfolk Boreas application. A walkover survey to characterise the hydrological and geomorphological characteristics of the main surface watercourses that are crossed or connected to the proposed cable route and onshore grid connection associated with the Norfolk Vanguard project has been undertaken (Royal HaskoningDHV, 2017c). Due to the spatial overlapping of the two projects, this information will inform the Norfolk Boreas assessment.

4 IMPACT ASSESSMENT METHODOLOGY

4.1 Overall approach

165. This section sets out the overall approach to the assessment and highlights the main potential impacts on water resources and flood risk receptors. Note that separate, more detailed methodologies are provided for the Flood Risk Assessment and WFD compliance assessment in sections 6 and 7, respectively. Impacts are common between the different assessments, and have not therefore been repeated.

4.2 Defining Impact Significance

166. 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.
- Flood risk: These are the potential impacts of the Proposed Development on site drainage, conveyance and surface water flooding.

167. Whilst there are clear links between the two impact groups, the assessment of receptor sensitivity and the magnitude of effect may differ. Further details are provided in the subsequent sections.

4.2.1 Sensitivity

168. Receptor sensitivity has been defined with reference to the adaptability, tolerance, recoverability and value of individual receptors. **Table 4.1** sets out definitions for the value and sensitivity for surface water receptors.

4.2.2 Value

169. 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 4.2**.

Table 4.1 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 Principal Aquifer with public water supply abstractions by provision of recharge. Site is within a Catchment Source Protection Zone. Supports Secondary A Aquifer with water supply abstractions. Site is within Inner or Outer Source Protection Zones.
		Flood risk More Vulnerable Land Use, as defined by NPPF PPG (DCLG, 2015). Land with between 1 and 100 residential properties or 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 Aquifer with water supply abstractions by provision of recharge. Site is within a Catchment Source Protection Zone.
		Flood risk Less Vulnerable Land Use, as defined by NPPF PPG (DCLG, 2015). Land with 10 or fewer industrial properties (after DMRB, 2009).
Negligible	Receptor is generally tolerant of changes to hydrology,	*Water resources* Controlled waters with hydrology that does not support natural variations, geomorphology that does not

Sensitivity	Definition	Criteria
	geomorphology, water quality or flood risk.	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. Supports Secondary A Aquifer without abstractions, or Secondary B Aquifer. Does not provide recharge to groundwater.
		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).

Table 4.2 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 national or international importance (e.g. SAC, SPA, Ramsar site / SSSI); 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 UK regional or local value (LNR, SNCI, RIGS); and/or • Licensed non-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 of UK regional or local value; and/or • Unlicensed potable abstractions (surface water and groundwater).

Value	Criteria
	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.

Table 4.3 Criteria for appraisal of magnitude of effect for water resources and flood risk receptors

Magnitude	Definition	Criteria
High	Permanent or large scale change affecting usability, risk, value over a wide area, or certain to affect regulatory compliance.	*Water resources* Permanent, long-term or wide scale effects on water quality or availability (adverse / beneficial). Permanent loss or long-term degradation of a water supply source of a water supply source resulting in prosecution (adverse). Change in WFD water body status / potential or its ability to achieve WFD status objectives in the future (adverse / beneficial). Permanent habitat creation or complete loss (adverse / beneficial). Measurable habitat change that is sustainable / recoverable over the long-term (adverse / beneficial).
		Flood risk Permanent or major change to existing flood risk e.g. Creation of flood plain resulting in decrease in flood risk on- and off-site (beneficial). Reduction in on-site flood risk by raising ground level in conjunction with provision of compensation storage (beneficial). Increase in off-site flood risk due to raising ground levels without provision of compensation storage (adverse). Re-location of development outside floodplain or flood zone (beneficial). Failure to meet either sequential or exception test (if applicable) (adverse).
Medium	Moderate permanent or long-term reversible change affecting usability, value, risk, over the medium- term	*Water resources* Medium-term or local scale effects on water quality or availability (adverse / beneficial). Medium-term degradation of a water supply source, possibly resulting in prosecution (adverse). Observable habitat change that is sustainable / recoverable over the medium-term (adverse / beneficial). Temporary change in status / potential of a WFD waterbody or its ability to meet objectives (adverse / beneficial).

Magnitude	Definition	Criteria
	or local area; possibly affecting regulatory compliance.	*Flood risk* Medium-term or moderate change to existing flood risk e.g. Increase in off-site flood risk within the local area due to increased impermeable area (adverse) Possible failure of sequential or exception test (if applicable). Reduction in off-site flood risk within the local area due to the provision managed drainage system (beneficial).
Low	Temporary change affecting usability, risk or value over the short-term or within the site boundary; measurable permanent change with minimal effect usability, risk or value; no effect on regulatory compliance.	*Water resources* Short-term or very localised effects on water quality or availability (adverse / beneficial). Short-term degradation of a water supply source (adverse). Measurable permanent effects on a water supply source that do not impact on its operation (adverse). Observable habitat change that is sustainable / recoverable over the short-term (adverse / beneficial). No change in status / potential of a WFD waterbody or its ability to meet objectives (neutral).
		Flood risk Short-term temporary or minor change to existing flood risk e.g. Increase in on-site or off-site flood risk due to reduced attenuation storage during construction (adverse). Localised increase in on-site or off-site flood risk due to increase in impermeable area (adverse). Passing of sequential and exception test (neutral).
Negligible	Minor permanent or temporary change, undiscernible over the medium- to long-term short-term, with no effect on usability, risk or value.	*Water resources* Very minor or intermittent impact on local water quality or availability (adverse / beneficial). Usability of a water supply source will be unaffected (neutral). Very slight local changes that have no observable impact on dependent receptors (neutral). No change in status / potential of a WFD waterbody or its ability to meet objectives (neutral).
		Flood risk Short-term temporary or very minor change to existing flood risk e.g. Increase in on-site or off-site flood risk due to reduced attenuation storage during construction (adverse). Highly localised increase in on-site or off-site flood risk due to increase in impermeable area (adverse).

4.2.3 Magnitude

170. Receptor magnitude has been defined with consideration to the spatial extent, duration, frequency and severity of the effect. Impact magnitude is defined in **Table 4.3**.

4.2.4 Table 4.3 Significance

171. The potential significance of an impact is a function of the sensitivity of the receptor and the magnitude of the effect. This is derived using an impact significance matrix, as shown in **Table 4.4.** Definitions of each level of significance are provided in **Table 4.5**.

172. 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.

173. Effects that result in **Major** or **Moderate** impacts are usually considered to be 'significant' in EIA terms. Significant impacts are those which are likely to influence the outcome of the planning application. Adverse significant impacts may require mitigation that is difficult or expensive to achieve whereas, beneficial significant impacts contribute to the case in favour of the proposed development.

Table 4.4 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 4.5 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 change	No impact, therefore no change in receptor condition.

5 POTENTIAL IMPACTS

5.1 Potential Impacts during Construction

174. The following section describes the potential impacts anticipated to arise during the construction, operation and maintenance and decommissioning phases of Norfolk Boreas. The impacts described below have been determined based on our knowledge of the project and the nature of the receptors.

175. The approach to assessment of each impact will be to divide the assessment into the two separate Scenarios (1 and 2) so that potential impacts arising from each respective scenario can be assessed. Within each scenario, reference will be made to various elements of the project infrastructure and associated works, where relevant.

176. As detailed in section 2.1, Scenario 1 assumes that Norfolk Vanguard consents and constructs transmission infrastructure which would be used by Norfolk Boreas. Under Scenario 1 Norfolk Boreas will seek to consent only the HDD at landfall, jointing and transition pits, onshore project substation, cable relay station and the installation of cables in the ducts through a process of cable pulling. Scenario 2 on the other hand assumes Norfolk Vanguard is not constructed and therefore Norfolk Boreas will seek to consent and construct all required project infrastructure.

177. With regards to the likely difference in impacts upon Water Resources and Flood Risk receptors associated with the scenarios outlined above, it is assumed that Scenario 1 will have significantly fewer impacts, and of a lower magnitude, as a result of the majority of onshore infrastructure already in place due to the consented and constructed Norfolk Vanguard project. For example, potential impacts such as the direct disturbance of surface water bodies, increased surface water run-off, and increased sediment supply under Scenario 1 would be significantly lowered as a result of the presence of embedded mitigation (such as drainage plans) under the consented and constructed Norfolk Vanguard project.

5.1.1 Impact: Direct disturbance of surface water bodies

178. The installation of the cable infrastructure has the potential to directly disturb the bed and banks of the watercourses it crosses as well as priority habitats for species. Although HDD trenchless crossing techniques would be used for the larger watercourse crossings (specifically the River Wensum, River Bure, King's Beck and the North Walsham and Dilham Canal), open trench techniques would be used for the majority of crossings.

179. Open trench cutting techniques have the potential to directly alter the geomorphology of the watercourse by disrupting flow conveyance and sediment transport (particularly of coarse bed sediments), and cause localised disruption to

the bed and banks within the footprint of the crossings. The likelihood of this occurring is dependent on the method of installation, size of the crossing in relation to the watercourse, and whether any parts of the cable ducting are proud of the natural bed. All cable ducting would need to be installed at sufficient depth beneath the bed of the watercourse to prevent geomorphological impacts (e.g. bed scour and channel instability) and avoid exposure during periods of higher energy flow where the bed could be mobilised. This depth is dependent upon the characteristics of each individual watercourse, but it would be necessary to install cabling below the active bed to prevent impacts.

180. Temporary dams installed while trenching takes place could create indirect impacts such as reduce flow and sediment conveyance, create upstream impoundment, affect patterns of erosion and sedimentation, impede river continuity, and potentially encourage fine sedimentation. They could also act as a barrier to the movement of fish and other aquatic organisms, which is important from a WFD compliance perspective. Furthermore, other temporary structures such as bridges, which may require additional temporary works, also have the potential to affect the geomorphology of the channel.

181. Cable installation would directly disturb the bed and banks, with the potential for the direct loss of habitats and geomorphological instability (e.g. enhanced scour). However, this is likely to be a temporary impact provided that the bed and banks are reinstated to their original level and position.

182. The installation of the cable housing within the active bed layer has the potential to disrupt the natural downstream movement of coarse bed sediments, which could potentially cause increased sedimentation upstream and geomorphological instability downstream and result in non-temporary impacts.

5.1.1.1 Approach to Assessment

Scenario 1

183. Under Scenario 1, Norfolk Vanguard would install cable ducts and undertake supporting works (e.g. running track, accesses, etc.) for Norfolk Boreas along the entire length of the onshore cable corridor. Therefore, all excavations (except jointing pits and associated temporary construction compounds) and crossings with the potential to cause direct disturbance to surface water bodies would have already been undertaken. In addition, the ducts would be installed and ground reinstated by Norfolk Vanguard.

184. As such, this impact can be discounted from further assessment under Scenario 1.

Scenario 2

185. Under Scenario 2, Norfolk Boreas would install all onshore cable route infrastructure required for the project, including installing ducts along the entire cable route and reinstating land. Under this scenario the cable route would also require trenches for the cable circuits, a running track to deliver equipment to the installation site from mobilisation areas and storage areas for topsoil and subsoil.

186. The potential impacts of channel disturbance will be assessed based on the expert judgement of an experienced fluvial geomorphologist. This assessment will be informed by the results of the desk based assessment outlined in section 3.1 and the geomorphological walkover survey outlined in section 3.2.1. The latter is likely to be particularly important in assessing the likely geomorphological responses of each channel to physical disturbance.

187. In addition, reference will be made to guidance on the potential impacts of infrastructure such as culverts and bridges contained within the WFD Expert Assessment guidance (Defra/EA, 2009) and, in particular, Environment Agency (2016b) WFD compliance assessment guidance for works in rivers.

188. The assessment will assume that any primary and tertiary embedded mitigation measures incorporated into the scheme design will be in place.

5.1.2 Impact: Increased surface water runoff and altered subsurface flows

189. The initial site preparation and construction activities associated with the onshore infrastructure (including the landfall, cable relay station, cable route and National Grid Connection substation developments) has the potential to alter surface water flows and drainage patterns, increase surface water runoff, and impact upon priority habitats for species.

190. The development of surface infrastructure has the potential to change surface flows and infiltration rates as a result of changes to land use (i.e. greater proportion of impermeable surfaces) and alter site runoff characteristics.

191. Soil compaction by construction vehicles could potentially reduce infiltration and increase surface runoff, and the dewatering of the cable trench could also increase surface flows. This change in flow pattern could also result in an impact upon surface water receptors.

5.1.2.1 Approach to Assessment

Scenario 1

192. Under Scenario 1, the initial site preparation and construction activities associated with the onshore infrastructure will have already been undertaken, resulting in no new mechanisms with the potential to alter surface water flows and drainage patterns and increase surface water runoff, other than the construction of the onshore project substation and cable relay station (under the HVAC option), and the jointing bay compounds and access tracks. Furthermore, the development of surface infrastructure with the potential to change surface flows and infiltration rates as a result of changes to land use (i.e. greater proportion of impermeable surfaces) and alter site runoff characteristics will be significantly reduced due to a large proportion of infrastructure already being constructed.

193. As such, the assessment under Scenario 1 will focus only on the potential increase of surface water runoff and altered subsurface flows as a result of installing all onshore cable route infrastructure required for the project.

Scenario 2

194. Under Scenario 2, Norfolk Boreas would be responsible for installing all onshore infrastructure required for the project. As such, the assessment under Scenario 2 will require the assessment of the potential increase of surface water runoff and altered subsurface flows as a result of the onshore project substation and cable relay station (under the HVAC option), and the jointing bay compounds and access tracks.

195. The potential impacts of increased surface water runoff, as a result of the construction of onshore project infrastructure associated with Scenario 1 and 2 respectively, would be based on the expert judgement of an experienced fluvial geomorphologist. This assessment would be informed by the results of the desk based assessment outlined in section 3.1 and the geomorphological walkover survey outlined in section 3.2.1.

196. The assessment would assume that any embedded mitigation measures incorporated into the scheme design would be in place.

197. Further details on the proposed approach to assessing changes to flood risk are provided in section 6.

5.1.3 Impact: Increased sediment supply

198. The proposed construction activities (at the landfall, cable relay station, cable route and National Grid Connection substation construction sites) would involve extensive earthworks and create areas of bare ground by removing surface vegetation cover. This is likely to increase the potential for the erosion of soil particulates, resulting in an increase in the supply of fine sediment to surface watercourses through surface runoff and the erosion of exposed soils. This could also have an impact upon priority habitats for species.

199. Increased sediment supply could also result in increased deposition on the bed of the channel. This could smother existing substrates and encourage geomorphological instability, and could potentially cause deterioration in the status of the morphology of the affected channel.

200. In addition, an increase in fine sediment supply could result in localised increases in turbidity and may temporarily increase sediment deposition in the channel downstream. This could potentially smother existing bed habitats and reduce light penetration, adversely affecting biological quality elements (e.g. macrophytes, aquatic invertebrates and fish) and causing deterioration in water body status. Chalk streams such as the River Wensum are likely to be particularly sensitive to such increases in fine sediment supply.

5.1.3.1 Approach to Assessment

Scenario 1

201. Under Scenario 1, the only surface infrastructure to be constructed with the potential to impact upon sediment supply are the onshore project substation, cable relay station (under the HVAC option) and the jointing pit compounds and access tracks. Furthermore, the site preparatory works (e.g. site clearance and earthworks) for Norfolk Boreas would have already have been undertaken under the Norfolk Vanguard project, resulting in the potential impacts of increased sediment supply via this mechanism being significantly reduced.

Scenario 2

202. Under Scenario 2, Norfolk Boreas would be responsible for installing all onshore infrastructure required for the project, and as such, result in significantly more mechanisms of impact associated with increased sediment supply.

203. The potential impacts of increased sediment supply, as a result of the construction of onshore project infrastructure associated with Scenario 1 and 2 respectively, would be assessed based on the expert judgement of an experienced fluvial

geomorphologist. This assessment would be informed by the results of the desk based assessment outlined in section 3.1 and the geomorphological walkover survey outlined in section 3.2.1.

204. The assessment would assume that any committed mitigation measures incorporated into the scheme design would be in place.

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

205. There is the potential for the accidental release of lubricants, fuels, oils and drilling fluid from construction machinery working in and adjacent to surface watercourses, through spillage, leakage and in-wash from vehicle storage areas after rainfall. There is also the potential for accidental release of foul waters and construction materials (including concrete) into the aquatic system during construction.

206. Furthermore, ground disturbance works could potentially introduce contaminants into the shallow secondary aquifers and underlying groundwater bodies, therefore impacting upon groundwater qualitative status. In addition the Chalk bedrock is designated as a Principal Aquifer and a number of groundwater SPZ areas are identified within the area, with both inner and outer zones of the SPZs extending across the eastern section of the onshore cable corridor. The proposed activities could therefore adversely impact upon potable water quality.

207. If a significant leakage or spillage is left unmitigated, there is the potential for adverse impacts upon water quality if these substances enter the river water bodies or percolate into the groundwater body. These water quality impacts also have the potential to adversely affect ecology (particularly macroinvertebrates) if pollutant concentrations are sufficiently high.

5.1.4.1 Approach to Assessment

Scenario 1 and 2

208. Under both scenarios there is the potential for the accidental release of fuels, oils, lubricants, foul waters and construction materials associated with construction activities.

209. The potential impacts of the release of contaminants, as a result of the construction of onshore project infrastructure associated with Scenario 1 and 2 respectively, would be assessed based on the expert judgement of an experienced water quality specialist. This assessment would be informed by the results of the desk based assessment outlined in section 3.1.

210. The assessment will assume that any primary and tertiary embedded mitigation measures incorporated into the scheme design will be in place.

5.1.5 Impact: Changes to flood risk

211. The initial site preparation and construction activities associated with the proposed onshore developments (including the landfall, cable relay station, cable route and National Grid Connection substation developments) has the potential to alter surface drainage patterns, increase surface water runoff and as such increase flood risk.

212. Similarly, the location of site preparation and construction activities may have an effect on flood risk posed by fluvial and tidal sources. Activities located within Flood Zones 2 and / or 3 would be at medium and high risk of flooding from these sources respectively.

5.1.5.1 Approach to Assessment

Scenario 1 and 2

213. Under both scenarios there is the potential for changes to flood risk associated with the potential to alter surface drainage patterns, increase surface water runoff as a result of the construction of onshore project infrastructure.

214. The potential changes to flood risk, as a result of the construction of onshore project infrastructure associated with Scenario 1 and 2 respectively, associated with the development will be assessed based on the expert judgement of an experienced flood risk practitioner. This assessment would be informed by the results of the desk based assessment outlined in section 3.1.

215. The assessment would assume that any primary and tertiary embedded mitigation measures incorporated into the scheme design would be in place.

216. Further details on the proposed approach to assessing changes to flood risk are provided in section 6.

5.2 Potential Impacts during Operation and Maintenance

5.2.1 Impact: Increased surface water runoff and altered groundwater flows

217. The permanent above-ground infrastructure, including the landfall, cable relay station, onshore substation, extension to the existing Necton 400kV National Grid substation and any new, permanent access tracks are likely to result in enduring changes to land use. The change in use from existing greenfield agricultural land use could create an increase in impermeable area. Whilst permeable surface treatments

would be used where possible, the substation and cable relay station are expected to comprise impermeable surfaces, with associated infrastructure such as roads and other associated developments also comprising impermeable surfaces.

218. There is, therefore, likely to be an increase in surface water runoff from impermeable areas which could impact upon the hydrology (e.g. surface water volumes and flow velocities) of the surface water system and result in permanent changes to geomorphology and physical habitat condition. These could impact upon the geomorphology of surface watercourses by increasing erosion rates and encouraging geomorphological adjustment.

219. Furthermore, the presence of the buried cable ducting throughout the cable route has the potential to impact upon subsurface flow routes and change the distribution of groundwater, therefore potentially impacting upon the quantitative status of groundwater bodies and the supply of water to any aquifers present.

5.2.1.1 Approach to Assessment

220. The potential impacts of permanent changes to impermeable areas, as a result of the operation of onshore project infrastructure, would be assessed based on the expert judgement of an experienced flood risk practitioner and hydrogeologist. During operation, both scenarios have the same assumed impact as the project would be identical, albeit that in Scenario 1 the Norfolk Vanguard project would also be present and in Scenario 2 it would not, however under Scenario 1 the Norfolk Vanguard project will be assessed as part of the CIA (see section 0 below).

221. This assessment would be informed by the results of the desk based assessment outlined in section 3.1 and drainage calculations produced as part of the design process.

222. The assessment would assume that any embedded mitigation measures incorporated into the scheme design would be in place.

223. Further details on the proposed approach to assessing changes to flood risk are provided in section 6.

5.2.2 Impact: Supply of fine sediment and other contaminants

224. The permanent operation of the proposed onshore development, including the landfall, cable relay station, onshore substation and operational works and maintenance of the cable route, could result in the supply of fine sediment, fuels, oils and lubricants from the road network and other impermeable surfaces, and also the supply of foul waters originating from the cable relay stations, substation and

NGET Necton substation sites. This could potentially affect the geomorphology and water quality in the surface drainage network.

225. There is potential for an increase in sediment supply to surface waters during operation via mechanisms such as enhanced surface runoff of the sites (see section 5.1.2), which could impact upon the geomorphology and surface water quality of the river water bodies, and consequently impact upon aquatic ecology, as described in section 0.

226. 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 have subsequent impacts upon biological elements.

5.2.2.1 Approach to Assessment

227. The potential impacts of the increased supply of sediment and other contaminants as a result of the operation of onshore project infrastructure, would be assessed based on the expert judgement of an experienced water quality specialist and geomorphologist. During operation, both scenarios have the same assumed impact, with the presents of Norfolk Vanguard under Scenario 1 being assessed as part of the CIA (see section 0 below). This assessment would be informed by the results of the desk based assessment outlined in section 3.1 and the geomorphological walkover survey outlined in section 3.2.1.

228. The assessment would assume that any embedded mitigation measures incorporated into the scheme design would be in place.

5.3 Potential Impacts during Decommissioning

229. No decision has been made regarding the final decommissioning policy for the onshore project substation and cable relay station, as it is recognised that industry best practice, rules and legislation change over time. However, the substation and cable relay station equipment would likely be removed and reused or recycled. It is expected that the onshore cables would be removed from ducts and recycled, with the jointing pits and ducts left in situ. The detail and scope of the decommissioning works would be determined by the relevant legislation and guidance at the time of decommissioning and agreed with the regulator. A decommissioning plan would be provided.

230. At this stage, it is anticipated that the decommissioning impacts would be similar in nature to those of construction (section 5.1).

5.4 Potential Cumulative Impacts

5.4.1.1 Norfolk Vanguard

231. VWPL are seeking to minimise cumulative impacts between Norfolk Boreas and Norfolk Vanguard through the alignment of onshore cable route and the preference for Norfolk Vanguard to pre-install ducts and undertake other enabling works for Norfolk Boreas. Cumulative impacts between the two sister projects would be assessed within the Norfolk Boreas EIA.

5.4.1.2 Other projects

232. The assessment would consider the potential for significant cumulative impacts to arise as a result of the construction, operation and decommissioning of Norfolk Boreas in the context of other developments that are existing, consented or at application stage.

233. Potential projects may include offshore wind farms, coastal defence projects (such as the Bacton sandscaping scheme) road or large infrastructure projects (including the duelling of the A47, Sizewell Nuclear Power Station and the Norwich Northern Distributor Road) which have a potential to act together with the construction, operation or decommissioning phases of Norfolk Boreas in a cumulative way. In particular, VWPL are committed to working with Ørsted (formally DONG Energy) on identifying the potential interactions between the Norfolk Boreas and Norfolk Vanguard onshore cable corridor with the Hornsea Project 3 Offshore Wind Farm onshore cable route, and assessing and mitigating and cumulative effects.

234. Construction and commissioning of the substation for the Dudgeon Offshore Wind Farm is complete and operation is due to commence in 2017. The cumulative impacts during construction are therefore likely to be minimal, however this would be considered further in the CIA.

235. Any other developments with potential to impact upon water resources and flood risk receptors would also be considered should these be identified during the EIA. These are likely to include schemes that involve watercourse crossings, other forms of direct disturbance to the river channel, and ground disturbance that could potentially increase the supply of sediment and other contaminants into the surface drainage system.

6 FLOOD RISK ASSESSMENT METHODOLOGY

6.1 Introduction into Flood Risk Assessments for Planning

236. In England, the requirements of a flood risk assessment for planning purposes are set out by national government, supported by the Environment Agency. Flood risk assessments for planning must adhere to the National Planning Policy Framework (NPPF); however, some Local Planning Authorities will have additional requirements, based on local policy and often associated with particular styles of development.

237. Flood risk assessments for planning are required for all development, regardless of scale for development within Flood Zone 2 or 3, or within a Critical Drainage Area. Developments of 1ha or greater will also require a flood risk assessment regardless of location.

238. Some Local Planning Authorities have additional requirements for when developers require a flood risk assessment; often when surface water flooding has been identified as a concern a flood risk assessment will be required.

239. The information and data required within a flood risk assessment is dependent on location and type of development; for example, a new development of over 1ha in Flood Zone 1 will have different needs to a new development over 1ha in Flood Zone 3.

240. Environment Agency data are required for all flood risk assessments for planning purposed; however the level of detail required again varies depending on the type of development and its location. Further details into this can be found on the government webpage; flood risk assessment for planning applications (https://www.gov.uk/guidance/flood-risk-assessment-for-planning-applications).

6.2 Requirements

241. Flood risk assessments for the Norfolk Boreas project shall incorporate data from a number of sources, including;

- Environment Agency Detailed Flood Risk Assessment Map and Flood Defence Breach Hazard Map (Product 4 and 8 data).
- Relevant Internal Drainage Board flood data.
- Topographic survey data, or remotely sensed LiDAR data.
- Local Council Policy and Local Plan.
- Strategic Flood Risk Assessments.
- Surface Water Management Plans.

242. Given the development is for essential infrastructure the type of flood risk assessment shall be tailored to meet the needs of each individual site. For

development located in close proximity to potentially sensitive receptors a joined up approach will be required to ensure development can be undertaken without increasing flood risk, or negatively affected the ecology of an area. Permanent structures and temporary structures will also need to be managed differently.

6.3 Initial assessment of flood risk assessment requirements

6.3.1 Types of development

243. The types of development associated with the Norfolk Boreas project, depending upon scenario, have been categorised into eight development zones:

- Development zone 1 - Extension to the existing Necton 400kV National Grid substation.
- Development zone 2 - Re-configuration of overhead lines in close proximity to the existing Necton 400kV National Grid substation
- Development zone 3 - Substation search zone.
- Development zone 4 - Cable corridor.
- Development zone 5 - HDD areas, including compounds and HDD sites on both sides of the feature to be drilled under.
- Development zone 6 - Mobilisation areas, in which construction compounds may be sited.
- Development zone 7 - Search zones for Cable Relay Station locations.
- Development zone 8 - Drill corridors from offshore to onshore at landfall.

6.3.2 Flood risk assessment requirements

244. An initial appraisal of the level of flood risk assessment required for each part of the proposed development is presented in **Table 6.1** and **Figure 6**. Note that these assessments will focus on above-ground development, and as such Zone 4 has not been considered.

245. Specific working sites within the development zones identified above have been categorised into three groups, based on the location of the proposals:

- Assessment may not be required: These sites are in Flood Zone 1 and are unlikely to need an FRA.
- Assessment potentially required: These sites are in close proximity to Flood Zones 1 or 2 and an FRA may be required.
- Assessment will be required: These sites are in Flood Zones 2 or 3 and an FRA will be required.

246. However, it should be noted that the area of these sites has not been considered at this stage; any developments greater than 1ha will require assessment.

Furthermore, the Local Planning Authority may require assessment for multiple sites that form part of the same development.

Table 6.1 Initial appraisal of flood risk assessment requirements (see Figure 6)

Development Zone	Flood Zone	Surface Water Flood Risk	Source of Flooding	Initial appraisal of FRA requirements
1	1 with 3 on boundary	Low	Unnamed watercourse	May not be required
2	1 with 3 on boundary	Low – High	Unnamed watercourse	May not be required
3	1 and 3	Low – High	Unnamed watercourse	May not be required
5	1	Low	-	May not be required
	3	Low	Tidal	Will be required
	1, 2, 3	Low – High	Tidal	Will be required
	1	Low	-	May not be required
	1	Low	-	May not be required
	1	Low – High	-	May not be required
	1	Low	-	May not be required
	1 in close proximity to 3	Low	River Bure	Potentially required
	1 in close proximity to 3	Low	River Bure	Potentially required
	1 in close proximity to 3	Low – High	River Wensum	Potentially required
	3	High	River Wensum & Penny Spot Beck	Will be required
	3	High	River Wensum & Penny Spot Beck	Will be required
	1	Low	-	May not be required
	1	Low	-	May not be required
	1 & 3	High	Wendling Beck	Will be required
	1 & 3	High	Wendling Beck & Wendling Carr	Will be required
6	1	Low	-	May not be required
	1 & 3	Low	-	Will be required
	1	Low – High	-	May not be required
	1	Low	-	May not be required
	1 & 3	Low – High	Unnamed watercourse	Will be required
	1 with 3 in proximity	Low	Unnamed watercourse	Potentially required
	1	Low – High	-	May not be required
	1	Low	-	May not be required
	1	Low	-	May not be required
	1	Low – High	-	May not be required
7	1	Low – Medium	-	May not be required
	1	Low	-	May not be required
	1	Low	-	May not be required
	1	Low – High	-	May not be required

Development Zone	Flood Zone	Surface Water Flood Risk	Source of Flooding	Initial appraisal of FRA requirements
	1	Low	-	May not be required
	1 with 3 in proximity	Low – High	Ordinary watercourse	Potentially required
8	1	Low	-	May not be required
	3	Low	Tidal	Will be required
	1, 2, 3	Low – High	Tidal	Will be required

7 WFD COMPLIANCE ASSESSMENT METHODOLOGY

7.1 Overall approach to the WFD compliance assessment

247. The way in which WFD impacts are assessed is quite different to the approach conventionally used within the Environmental Impact Assessment (EIA) process. The standard EIA approach assesses whether an impact is minor, moderate or major, and whether it is beneficial or adverse. This is not compatible with the requirements of the WFD, which requires an assessment of whether a scheme (or element of a scheme) is compliant or non-compliant with the environmental objectives outlined in **Table 7.1.**

Table 7.1 Environmental objectives of the WFD

Objectives (taken from Article 4 of the WFD)	Reference Article
Surface waters	
Member States shall implement the necessary measures to prevent deterioration of the status of all bodies of surface water.	4.1(a)(i)
Member States shall protect, enhance and restore all bodies of surface water, subject to the application of subparagraph (iii) for artificial and heavily modified bodies of water, with the aim of achieving good surface water status by 2015.	4.1(a)(ii)
Heavily Modified and Artificial Water Bodies	
Member States shall protect and enhance all artificial and heavily modified bodies of water, with the aim of achieving good ecological potential and good surface water chemical status by 2015.	4.1(a)(iii)
Progressively reduce pollution from priority substances and cease or phase out emissions, discharges and losses of priority hazardous substances.	4.1(a)(iv)
Groundwater	
Prevent Deterioration in status and prevent or limit input of pollutants to groundwater (Daughter Directive).	4.1(b)(i)

248. Following the recommendations made by the Environment Agency in their internal guidance (Environment Agency, 2016), the approach adopted in this assessment is to determine whether the scheme has:

- Potential to cause deterioration in surface water body status by adversely affecting biological, hydromorphological and/or physico-chemical quality elements.
- Potential to cause deterioration in groundwater body status by adversely affecting quantitative and chemical quality elements.
- Potential to prevent achieving WFD status objectives by impacting upon proposed mitigation measures already identified for water bodies in the area.
- Potential to incorporate mitigation measures included in the appropriate River Basin Management Plan(s).

249. Where the assessment suggests that deterioration in water body status is likely to occur as a result of the scheme, measures to mitigate the likely impacts and therefore avoid deterioration in status are recommended.

250. A four stage process will be used to undertake the WFD compliance assessment. These stages are described in more detail in the subsequent sections:

- Stage 1: Screening assessment.
- Stage 2: Scoping assessment.
- Stage 3: Detailed compliance assessment (if required).
- Stage 4: Summary of mitigation, improvements and monitoring (if required).

251. The WFD compliance assessment will consider both Scenarios of the proposed Norfolk Boreas onshore development during this process. Scenario 1 will have less potential to impact upon the status of WFD water bodies due to the works and mitigation already undertaken and in place on account of the construction of Norfolk Vanguard infrastructure, as detailed in section 5. As such, it is anticipated that the potential impacts associated with Scenario 2 will be more significant.

252. The Norfolk Boreas WFD compliance assessment will aim to utilise baseline data obtained as part of the Norfolk Vanguard WFD compliance assessment where possible and appropriate, for example in identifying receptor sensitivity and value.

7.2 Stage 1: Screening assessment

7.2.1 Identification of WFD water bodies

253. Water bodies that could potentially be affected by the scheme will be identified using the Environment Agency's online WFD mapping system (the Catchment Data Explorer tool), which supports the Anglian River Basin Management Plan (RBMP) (Environment Agency, 2015). Water bodies will be selected for consideration in the compliance assessment based on the following criteria:

- All surface water bodies that could potentially be directly impacted by the scheme (i.e. those within the scheme footprint).
- Any surface water bodies further upstream that have direct connectivity and could potentially be affected by the proposed works.
- Any surface water bodies downstream that have direct connectivity and could potentially be affected by the proposed works.
- Any groundwater bodies that underlie the proposed scheme.

254. To facilitate this identification process and in particular to inform the decision on whether connectivity might lead to impacts, a hydromorphological assessment of the potential impacts of the scheme and potential extent of upstream and

downstream propagation will be made, using the Joint Defra/Environment Agency Flood and Coastal Erosion Risk Management R&D Programme (2009) Expert Assessment Framework as a basis.

7.2.2 Collation of baseline information

255. The following tasks will be undertaken to collate the information required to inform the WFD compliance assessment:

- Collection of water body baseline data, including on the type and status of each quality element and, if appropriate, reasons for failure and mitigation measures identified by the Environment Agency. These data will be collated from the River Basin Management Plan 2 Class Objective Data and any supporting information for each water body available from the Environment Agency.
- Collection of design information for the proposed development, broken down into individual activities so that the compliance of each activity can be considered in the assessment. This will include the identification of the control measures that have been included within the design to minimise the potential impacts of the proposed development.

7.3 Stage 2: Scoping assessment

256. A scoping assessment will be undertaken to determine whether there is the potential for construction impacts under each respective construction Scenario, and any associated activities during the operational phase to cause deterioration in the status or potential of any of the water bodies (as identified during Stage 1), and whether there is the potential to cause a failure to meet GES or GEP targets for these water bodies. For example, the cable pulling activities associated with Scenario 1 will be assessed, whilst Scenario 2 will consider the complete installation of the cable route. The scoping assessment will consider the potential of each activity, under each scenario, to adversely impact on any of the quality elements sufficient to cause deterioration in water body status. This assessment will be based on expert judgement, informed by available data and, in the case of hydromorphological impacts, using the guidance included in the Flood and Coastal Erosion Risk Management R&D Programme Expert Assessment Framework (Defra/EA, 2009). It will be broken down into the potential impact of the various scheme components on each quality element so that any areas of potential impact could be clearly identified, including:

- The potential for the scheme to impact upon proposed WFD mitigation measures and improvements, and therefore prevent GES or GEP being achieved.

- The potential for cumulative impacts as a result of existing pressures, new or recent schemes in the area, and any planned schemes.
- The potential for impacts on critical and sensitive habitats, including designated sites and habitats with particular ecological importance.

257. Water bodies and activities can be screened out of further assessment if it can be satisfactorily demonstrated that there will be no impacts. If impacts are predicted, it will be necessary to undertake a Stage 3 detailed compliance assessment. If no impacts are predicted, the assessment will be complete at the end of Stage 2.

7.4 Stage 3: Detailed compliance assessment

258. The Stage 3 assessment would determine whether the activities and/or scheme components that have been put forward from the Stage 2 scoping assessment will cause deterioration and whether this deterioration will have a significant non-temporary effect on the status of one or more WFD quality elements at water body level. For priority substances, the process requires the assessment to consider whether the activity is likely to cause the quality element to achieve good chemical status.

259. If it is established that an activity and/or scheme component is likely to affect the status at water body level (that is, by causing deterioration in status or by preventing achievement of WFD objectives (including those for Protected Areas) and the implementation of mitigation measures for HMWBs), or that an opportunity may exist to contribute to improving status at a water body level, potential measures to avoid the effect or achieve improvement must be investigated. This stage will consider such measures and, where necessary, evaluate them in terms of cost and proportionality.

260. As outlined above, the end result of Stage 2 would be an agreed list of water bodies, scheme activities and quality elements to be carried forward for further assessment. Stage 3 would then consider the potential for status deterioration associated with each scheme activity (i.e. not the scheme as a whole) on the biological, hydromorphological and physico-chemical and chemical quality elements of each relevant surface water body, and the quantitative and chemical quality elements of each relevant groundwater body.

261. The assessment would establish whether the scheme activities would:

- Cause deterioration within a water body.
- Prevent WFD status objectives (i.e. GES or GEP) being achieved, including prevention of the delivery of mitigation measures identified in the RBMP.

- Prevent status objectives being achieved in any other water bodies, including prevention of the delivery of mitigation measures identified in the RBMP.

262. Following the broad principles of the WFD, the scheme would be considered to be non-compliant if any of the scheme components are likely to cause a non-temporary deterioration in any of the quality elements individually or cumulatively at a water body level.

263. Impacts of the scheme on other European legislation, including the Habitats Directive, Birds Directive, Bathing Waters Directive (2006/7/EC) and Freshwater Fish Directive (2006/44/EC) for example would also be considered in line with Articles 4.8 and 4.9 of the WFD. Where necessary, reference would be made to supporting information contained in the relevant EIA chapters, and in the case of Natura 2000 protected areas, the Shadow HRA (both of which would accompany the project application documents).

264. If, at the end of the Stage 3 assessment process, negative impacts have been identified, measures to mitigate the impacts and, if possible, to improve the state of the water environment would be considered. Where possible, multiple benefits will be sought from each measure (e.g. across different water bodies or improving more than one quality element). Appropriate guidance will be consulted, such as the online "Healthy Catchments" guidance (ERRC, undated). The scope of all measures would be agreed in consultation with the appropriate regulatory authorities.

7.5 Stage 4: Summary of mitigation, improvements and monitoring

265. This stage of the process would provide a summary of the preceding stages and any mitigation and monitoring proposals for each of the activities assessed. This stage would summarise the results of the assessment that is described in the previous sections. This summary would include:

- An overview of the results of the assessment, including whether proposed scheme activities have been screened out, assessed in detail, or mitigated against.
- A description of potential impacts on water body status, including a summary of the activities that cause the impact, and a breakdown of the water bodies and quality elements that they affect.
- A description of the mitigation measures that are required to address any impacts, and prevent deterioration in status or failure to meet WFD objectives set for the relevant water bodies.
- A description of any monitoring that is required, in order to demonstrate that the scheme will not result in impacts on water body status.

- A description of any improvements that can be implemented as part of the proposed development.

8 REFERENCES

Environment Agency (2012a) Risk of Flooding from Surface Water Tool. (Online) Available from: https://flood-warning-information.service.gov.uk/long-term-flood-risk

Environment Agency (2012b) Risk of Flooding from Rivers and Sea (Flood Map for Planning) Tool. (Online) Available from: http://maps.environment-agency.gov.uk/wiyby/wiybyController?topic=floodmap&layerGroups=default&lang=_e&ep=map&scale=7&x=531500&y=181500

Environment Agency (2015) Anglian River Basin District River Basin Management Plan. (Online) Available from: https://www.gov.uk/government/publications/anglian-river-basin-district-river-basin-management-plan

Environment Agency (2016b) Protecting and improving the water environment: Water Framework Directive compliance of physical works in rivers. Position 488_10, Version 2.

Environment Agency (2016ba) Catchment Data Explorer. (Online) Available from: http://environment.data.gov.uk/catchment-planning/

Joint Defra/ Environment Agency Flood and Coastal Erosion Risk Management R&D Programme (2009) WFD Expert Assessment of Flood Management Impacts. R&D Technical Report FD2609/TR.

Natural England (2013) MAGIC website. (Online) Available from: http://www.magic.gov.uk/

Natural England (undated) Designated Sites View. (Online) Available from: https://designatedsites.naturalengland.org.uk/SiteSearch.aspx

Royal HaskoningDHV (2017a) Norfolk Boreas Evidence Plan Process Terms of Reference. Unpublished. Live document. Document reference: PB5640-004-016

Royal HaskoningDHV (2017b) Norfolk Vanguard Offshore Wind Farm Preliminary Environmental Information Report. Available at: https://corporate.vattenfall.co.uk/projects/wind-energy-projects/vattenfall-in-norfolk/norfolkvanguard/documents/preliminary-environmental-information-report/

Royal HaskoningDHV (2017c) Norfolk Vanguard Offshore Wind Farm Preliminary Environmental Information Report. Appendix 20.3 Geomorphological Walkover Survey. Document reference: PB4476-004-0203

Royal HaskoningDHV (Unpublished) Onshore Ecology and Ornithology Method Statement. Document reference: PB5640-004-005