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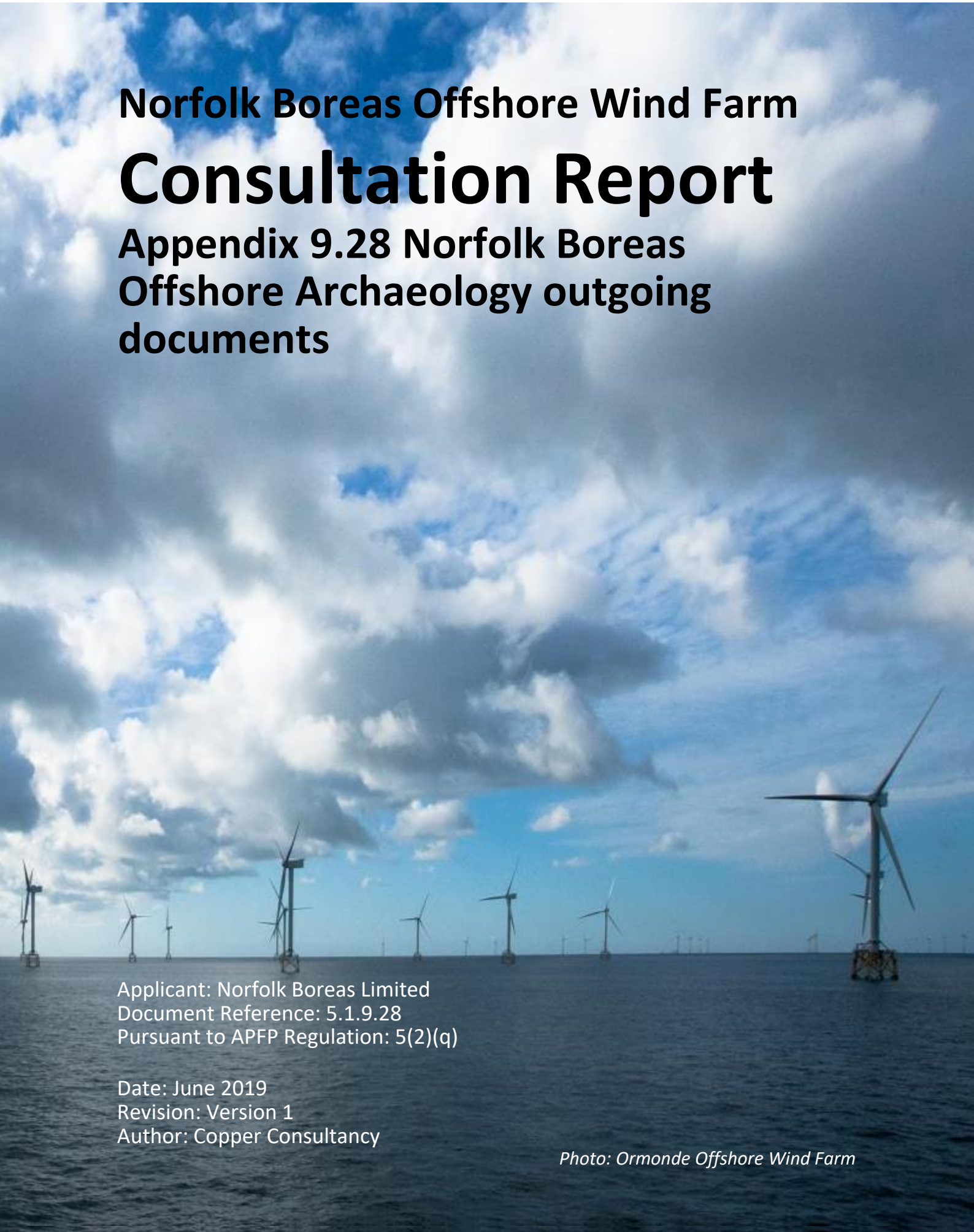
Norfolk Boreas Offshore Wind Farm

Consultation Report

Appendix 9.28 Norfolk Boreas Offshore Archaeology outgoing documents



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Norfolk Boreas Offshore Wind Farm

Environmental Impact Assessment

Offshore Archaeology Method Statement

Document Reference: PB5640-004-011

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

Date	Issue No.	Remarks / Reason for Issue	Author	Checked	Approved
17/11/2017	D01	RHDHV Internal Review	Victoria Cooper (VC)	DT	AD
19/12/2017	D02	Second draft completed	VC	DT	AD
08/02/2018	D03	For Vattenfall Review	VC	DT	AD
16/02/2018	D04	Submitted to ETG for consultation	VC/DT	JL	AD

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.

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1 INTRODUCTION

1. The purpose of this method statement is to outline the proposed approach and the considerations to be made in the assessment of the offshore archaeological effects of the proposed Norfolk Boreas project. The approach is to build upon the information provided within the Norfolk Boreas Environmental Impact Assessment (EIA) Scoping Report and that amassed for the Norfolk Vanguard PEIR. The offshore assessment will encompass the offshore project area as well as the intertidal zone section below Mean High Water Springs (MHWS) at the cable landfall.

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 Offshore Archaeology Expert Topic Group (ETG). Progress will be recorded within an Agreement log during the consultation.

3. This method statement has been produced following a full review of the Scoping Opinion provided by the Planning Inspectorate and associated advice provided within Historic England's letter of 6th June 2016 (Appendix 3 of the Scoping Opinion). The EIA Scoping Opinion comments received that relate to offshore archaeology are summarised in **Table 1.1**.

Table 1.1 Scoping opinion responses relevant to Offshore Archaeology

Consultee	Comment	Response / where addressed
Secretary of State	Paragraphs 751 and 756 of the Scoping Report propose to scope out impacts to the setting of onshore heritage assets from the offshore elements of the Proposed Development during construction and operation. This is because the turbines would be located approximately 72km from the coast and would not be viewed from the shore. The SoS agrees that this can be scoped out; however notes and welcomes that consideration will be given to potential impacts on the setting of onshore heritage assets during installation of offshore export cables close to the coast and activities at the landfall.	The effect of construction activities, nearshore and at the landfall, on the setting of onshore heritage assets is addressed through the onshore archaeology assessment (addressed in Section 5.1.3 of the Onshore Archaeology and Cultural Heritage Method Statement)
Secretary of State	The SoS welcomes the proposed production of a project Written Scheme of Investigation (WSI) and recommends that a draft WSI is provided with the DCO application.	Approach to WSI is set out in Section 5 of this document.
Historic England	We note that to address impacts as might be associated with long HDD in the intertidal and shallow subtidal areas such matters as relevant to the historic environment would need to be considered within the offshore Archaeology and cultural heritage chapter	This offshore Method Statement presents the approach for all assessment of all archaeology below MHWS.
Historic England	Issues as related to an understanding of "setting" as described in paragraphs 750 to 753 are noted and we will offer further comments at the Preliminary Environmental Information Report (PEIR) stage. Similarly matters to do with potential cumulative impacts (section 2.12.2.4) with specific reference to Norfolk Vanguard should also be considered further through the PEIR especially as and when geophysical and geotechnical survey interpretation can support desk-based sources of information. We also note that cumulative impact is addressed in section 4.5 in relation to the Landscape and Visual Impact Assessment (paragraphs 1610 - 1616). We note DONG energy scheme is mentioned as well as other schemes but we also consider that potential cumulative impacts would need to include reference to other offshore wind farms where relevant to this project, specifically other offshore arrays such as the East Anglia series.	All relevant projects, including, but not limited to, Norfolk Vanguard, East Anglia One, East Anglia Three, East Anglia Two and East Anglia One North will be fully considered as part of EIA process. See Section 2.3.9 cumulative Impact Scenarios.
Historic England	The matters identified as mitigation (section 2.12.3) include the identification of AEZs and the preparation of an Archaeological Written Schemes of Investigation (WSI). This should be directly produced in reference to geophysical and geotechnical surveys as planned for summer/autumn 2017 as supplemented by suitable data as might have been acquired previously for the Norfolk Vanguard project. An outline WSI would need be included within the PEIR. We add also that all new programmes for data acquisition must ensure that archaeological objectives are included as part of project planning. We also note the attention given to Historic Seascape Character (paragraph 773) and we look forward to seeing such matters addressed within the PEIR.	Approach to WSI is set out in Section 5.5 of this document. Approach to assessing Historic Seascape Character is included in Sections 5.1.4, 5.2.4, 5.3.4 and 5.4.4.
Historic England	It is stated in paragraph 768-769 that geophysical and geotechnical surveys will be carried out during summer/autumn 2017. The geophysical survey will include Multibeam Echo-sounder, Side Scan Sonar, magnetometer and sub bottom profiler data. These techniques will allow the surface of the seabed as well as the buried sediments and features to be investigated. Details will need to be provided as to the percentage coverage of the development area that the surveys will investigate and the depth of penetration that the sub-bottom profiler technique will achieve	These surveys have now been completed and initial results following archaeological assessment by Wessex Archaeology are summarised in Section 3.

1.1 Background

4. 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

5. 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

6. 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

7. 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
- Note sent to Historic England on survey methodology and extent of survey. -Q4 2017
- Post-scoping Expert Topic Group meetings
  - Discuss method statements and Project Design Statement -Q1 2018
- 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

8. 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 in **Table 1.2**.

1.2.4 Survey Programme

9. Details of the proposed data collection exercise are included in Section 3.

Table 1.2 Consultation undertaken as part of the Norfolk Vanguard Evidence Plan (highlighted on bold is where consultation has been incorporated into this document).

Consultation	Details
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 meeting (01/02/17)	• Discussed potential landfall at Happisburgh and established importance of liaising with key stakeholders including the Ancient Human Occupation of Britain (AHOB) project • Discussed progress of the archaeological assessment of geophysical survey data • Discussed progress of the archaeological assessment of geotechnical survey data and the provision of a deposit model as a method of mitigation • Discussed the concept of 'setting' for offshore assessment and agreed that the extent of change will be described within the assessment although this would not be assessed as an impact (i.e. sensitivity/magnitude) • Agreed approach to archaeological desk-based assessment and impact assessment • Agreed an approach to cumulative impact assessment focusing on 'What matters and why' as a narrative • Agreed an approach to transboundary impact assessment
Note on offshore Survey Scope – (04/04/17)	• Note setting out the details of the survey scope for Norfolk Boreas sent to Historic England to ensure that the acquired data was suitable to meet archaeological objectives in support of the EIA process • Historic England had no specific comment to offer other than to keep them informed regarding progress with this proposed survey programme
Expert Topic Group (coastal, inter-tidal and nearshore) meeting (02/05/17)	• Discussed aims of the AHOB engagement process • Agreed establishment of a coastal, inter-tidal and nearshore steering group • Discussed funding opportunities to support further academic research at Happisburgh • Discussed geotechnical survey opportunities and the need for a survey-specific WSI • Discussed the landfall option refinement • Discussed the potential for archaeological deposits and methodologies for data acquisition • Discussed relevant points of contact
PEIR Expert Topic Group meeting (06/07/17)	• Provided project update and detail of the meeting regarding the AHOB project and Happisburgh landfall, agreed that ongoing engagement should be formalised in the DCO/DML

	• Discussed outcomes of onshore and offshore geoarchaeological assessment and that Historic England would be consulted on what is taken forward for assessment • Provided update on offshore and intertidal baseline as presented in the PEIR and expected outcomes of impact assessment • Agreed commitment to produce a WSI which will be a point in time document, supported by heritage method statements • Agreed that the direct use of UXO survey data for archaeological objectives should be formalised in the DML
Geophysical and Geotechnical Data Assessment (04/04/17)	Update sent to Historic England regarding progress of the offshore geophysical and geotechnical survey and required archaeological assessments
PEIR Consultation Responses	• MMO Response: o Main mitigation of a WSI and AEZs will require consultation with Historic England and captured in the DCO and Deemed Marine Licence. **This commitment is captured within this method statement in Section 5.5 (Written Scheme of Investigation).** • Historic England Response (intertidal)*: o With respect to the landfall at Happisburgh, Historic England drew attention to the internationally significant archaeology found in this area and the potential for deposits/remains associated with the Cromer Forest Bed Formation. If significant features/remains are identified then they would expect to see a suitable mitigation strategy established in the WSI. **This commitment is captured within this method statement in Section 5.5** Written Scheme of Investigation. o Historic England draw attention to the need for careful consideration of scientific dating techniques applied to deposits at the landfall and that these issues need to be addressed to ensure that no opportunities are missed. Comments also specify that the ES should include an Action Plan to address communication and consultation between established experts to peer review the production of a palaeo-environmental deposit model for the area(s) affected by this proposed development. This will be addressed through ongoing consultation with the AHOB and Pathways to Ancient Britain (PAB) research teams with respect to the landfall for both Norfolk Vanguard and Norfolk Boreas **(see paragraph 80).** o With respect to the use of either High Voltage Alternating Current (HVAC) or High Voltage Direct Current (HVDC) cables, Historic England specified that the impacts of both options will need to be discussed. **This is incorporated in the assessment through consideration of the worst case scenario set out in Section 2.3** (Indicative Worst Case Scenario). o With respect to the use of Horizontal Directional Drilling (HDD) at the landfall, Historic England draw attention to the use of bentonite slurry as part of the process and the potential for this to breakout and spread into/coat archaeological deposits, features and materials. Reference is made to the assessment of potential impacts with respect to the use of bentonite slurry in **Section 2.3.5 (Landfall).** o Historic England recommended reference to the Coastal and Intertidal Zone Archaeology Network (CITiZAN) project database of archaeological find spots in order to take advantage of recently collected information. This is included as a

	source to inform the baseline environment **(see Paragraph 77).** • Historic England Response (offshore)*: o With respect to the various options for foundations and cabling, Historic England state that the chosen options would need to be discussed and if necessary a mitigation strategy agreed in the WSI. A**s part of the consenting process, the commitment to the WSI set out in Section 5.5 (Written Scheme of Investigation) will include the full range of foundation and cabling options (assessed as worst case scenario) and also a commitment to refining the mitigation strategy included therein following selection of the final design option.** o Historic England also refer to a need to consider changes to coastal processes with respect to possible options. **This is addressed through reference to indirect impacts associated with the effect of changes to physical processes set out for construction (Section 5.1.3), operation (Section 5.2.3) and decommissioning (Section 5.3.3) and will also be assessed as a cumulative impact (Section 5.4.3).** o With respect to heat lost by HVAC/HVDC cables Historic England suggest that this may have a damaging effect on any waterlogged archaeological remains that may be present. **This has been added for consideration as part of the parameters outlined for the worst case scenario set out in Section 2.3.2 (Offshore Cabling).** o With respect to mitigation options relevant to marine physical processes (i.e. micro-siting of turbines to reduce potential effects) Historic England require that the historic environment should be considered in terms of these options to ensure that remains are not inadvertently damaged. Any requirement for micro-siting would take into account the position of AEZs and anomalies of archaeological interest as part of the embedded mitigation for archaeology **as set out in Section 5.5. (Written Scheme of Investigation).** • Historic England Response (general)*: o Historic England suggest that attention should also be given to highlighting the magnitude of positive effects through actively contributing new data and information about our shared historic environment. Additional explanation as to how positive/beneficial effects will be measured has been added to impacts assessment methodology presented in Section 4. o With regard to planned surveys for the project, Historic England state that a fundamental principle must be that survey commissioning, interpretation and report are programmed, so that the eventual engineering design selected for delivery of this project, should consent be obtained, is fully informed and guided by archaeological advice. **A commitment to obtaining archaeological input into the planning of future surveys will be included in the draft WSI (see Section 5.5).** Please note that consultation responses specific to the assessment for Norfolk Vanguard only are not included here.
Pre-submission Expert Topic Group and Steering Group meetings planned for 08/03/2018	To discuss updates to the PEIR prior to submission of the ES

2 PROJECT DESCRIPTION

2.1 Context and Scenarios

10. Vattenfall (VWPL) is developing Norfolk Boreas and Norfolk Vanguard 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 export cable route and the cable landfalls.

11. The Norfolk Vanguard project is approximately 12 months ahead of Norfolk Boreas in terms of 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. There is a 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 DCO for Norfolk Boreas. Thus, two alternative scenarios are being considered in the context of this Method Statement; Scenario 1 where the offshore elements of Norfolk Vanguard has been fully constructed before any construction of Norfolk Boreas begins, and Scenario 2 where Norfolk Vanguard is not constructed.

13. For both scenarios, Norfolk Boreas would consent and construct all required offshore infrastructure, and so there is no difference in the assessment of offshore archaeology between the scenarios for Norfolk Boreas alone. The only offshore difference is that under Scenario 1, Norfolk Vanguard would be considered within the Cumulative Impact Assessment (CIA), together with the parameters of Norfolk Boreas and under Scenario 2 it would not.

2.2 Site Selection Update

14. 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.

15. 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).

16. 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.

17. Ongoing public and stakeholder consultation as well as initial EIA data collection will be used to inform any further site selection work for the EIA and DCO application, however the offshore site boundaries are now established and are not anticipated to change for the PEIR. Impacts that cannot be avoided through site selection will aim to be reduced through sensitive siting, alternative engineering solutions (mitigation by design) and additional mitigation measures, where possible. Mitigation options would be developed in consultation with stakeholders.

2.3 Indicative Worst Case Scenarios

18. The following sections set out the indicative worst case scenarios for offshore archaeology.

19. 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. The Norfolk Boreas PEIR and the ES will provide further detail on the Project Description describing the final project design envelope (Also known as Rochdale Envelope) for the DCO application.

20. Each chapter of the Environmental Statement (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.

21. The indicative worst case scenario for archaeology below MHWS is based upon the general assumption that the greatest footprint of disturbance represents the greatest potential for direct impacts (e.g. damage / destruction) to surviving archaeological material. This equates to:

- The greatest potential area of contact with the sea floor/intertidal zone;
- The maximum number of locations at which contact may occur; and
- The greatest volume of disturbed seabed sediments and intertidal deposits.

22. Indirect impacts may occur as a result of changes to prevailing marine physical processes caused by the development. In general, buried archaeological material survives better than material exposed to marine processes. The worst case scenario for these indirect impacts equates to those aspects of the development which result in the greatest potential for increased scour and sediment stripping across an area as

a result of changes to physical processes. A method statement for the Marine Physical Processes Assessment (document reference PB5640-004-021) can be provided on request.

23. Indirect impacts to setting may occur if a development affects the surroundings in which a heritage asset is experienced. The historic character of a landscape or seascape may also be affected by development if elements of that development result in a change to that character. The worst case scenario for the disturbance of setting and character will be the maximum intrusive effect (e.g. number and type of new infrastructure elements, height of infrastructure, access restrictions, noise, dust and light disturbance during construction) for the longest duration.

24. The following sections provide key information on the worst case scenarios for offshore archaeology.

2.3.1 Wind Turbine Generator

25. A range of 7MW to 20MW wind turbines is included in the Norfolk Boreas project design envelope in order to future proof the EIA and DCO to accommodate foreseeable advances in technology.

26. The foundations of 15MW to 20MW turbines are estimated to have the same physical parameters. As a result, if the worst case scenario is associated with the largest wind turbines, 120 x 15MW would be the worst case scenario, rather than 90 x 20MW, due the greater number of devices making up the maximum site capacity of 1,800MW. The maximum number of wind turbines would be 257 x 7MW.

27. A range of foundation options; monopile, jackets on pin piles (on three or four legs), jackets on suction caissons (on three or four legs), gravity base structures (GBS) and floating foundations with tension leg mooring system are included in the current project design Envelope. Ongoing review by the VWPL design team has identified that this is necessary in order to future proof the EIA and DCO to include the types of foundations that are likely to be available at the time of Norfolk Boreas construction.

28. GBS foundations are currently considered to provide the worst case scenario for offshore archaeology as they require the greatest amount of seabed preparation and have the greatest combined footprint for foundation and associated scour protection.

29. Indicative parameters indicate that the maximum diameter for GBS foundations is 40m for 7MW foundations and 50m for 15-20MW foundations. Scour protection is estimated to be approximately 5 times the diameter of the foundation. GBS foundations also have a required preparation area of 50m diameter for the 7MW turbines and 60m for the 15-20MW turbines. Seabed preparation would comprise

dredging works (likely to be carried out using a trailer suction hopper dredger) and the installation of a bedding and levelling layer. The worst case scenario envisaged is an excavation to level an area of sand waves up to 5 m in depth.

30. Based on the indicative parameters provided for GBS foundations, the greater number of 257 x 7MW wind turbines is considered to represent the worst case scenario footprint rather than 120 x 15MW wind turbines. This provides the scenario with the maximum potential for interaction with potential archaeological material.

31. In practice, fewer GBS foundations may be used (due to larger capacity wind turbines installed and / or alternative foundation types used), and the effect would be less than the considered worst case. Where GBS foundations are used, they would likely be installed where none or little ground preparation is required and micro-siting will be used to minimise any dredging requirements.

32. It is anticipated that the layout of wind turbines would be regular in plan (i.e. turbines will be set out in rows) although the location of the wind turbines would be finalised pre-construction based on ground investigation and constraints identified in the EIA. This will include the location of heritage assets identified in the offshore archaeology assessments as informed by geophysical and geotechnical survey data, the programme for which will be informed by a draft Outline WSI, which will be produced as part of the application process.

2.3.2 Offshore Cabling

33. Two electrical solutions are being considered for Norfolk Boreas, a HVAC scheme and HVDC scheme. The decision on which solution will be used would be taken post consent and will depend on availability, technical considerations and cost. Both electrical solutions will have implications on the required offshore infrastructure which are detailed in the following sections.

34. The preferred installation technique and depth of burial for the offshore electrical infrastructure will be decided pre-construction based on ground investigation. Possible installation techniques include:

- Ploughing;
- Jetting;
- Dredging;
- Mass flow excavation[1]; and
- Trenching.

[1] An example of a mass flow excavator is available at http://www.rotech.co.uk/subsea/

35. Although Norfolk Boreas will use the same offshore cable corridor and landfall as Norfolk Vanguard, the cabling required for Norfolk Boreas will be consented and constructed separately within the defined boundaries. Therefore, in terms of potential impacts to offshore archaeology indicative offshore cabling parameters for Norfolk Boreas are as follows:

- Number of cables:
    - Up to six subsea HVAC export cables or four subsea HVDC export cables;
    - Up to three subsea interconnector cables in up to two trenches linking the offshore substation platforms; and
    - Array cabling - subject to the number of wind turbines and layout.
- Heat lost per meter:
    - At full load, total heat loss per meter for a large HVAC 3-core cable is roughly 150 W/m; and
    - At full load, total heat loss per meter for a pair of large HVDC cables is roughly 100 W/m.
- Export cable length per cable (from substation to landfall):
    - 140km for both HVAC and HVDC electrical solutions.
- Maximum export cable length:
    - 840km based on six HVAC cables.
- Interconnector cable length up to 50km per cable for both HVAC and HVDC electrical solutions (maximum of 3 cables under the HVDC solution).
- Array cable length up to 750km.
- Footprints during installation:
    - Export cable – trench width 10m for installation with a 20m dredging corridor for the HVDC electrical solution, and a 30m dredging corridor for the HVAC electrical solution;
    - Interconnector cable – trench width 10m for installation with a 20m pre-sweeping (dredging) corridor; and
    - Array cable jetting or ploughing – trench width 1m with a 20m pre-sweeping (dredging) corridor.

- Number of trenches:
    - 1 trench per export cable system (260km total trench length for HVDC option and 780km for HVAC option);
    - 2 trenches per interconnector system for HVDC option (100km total trench length); and
    - 1 trench per interconnector cable system for HVAC option (50km max trench length) per cable (for up to 3 cables).
- Burial depth:
    - Maximum burial depth would be 3m for the majority of the route. In soft sediments, burial up to 5m may be necessary.

36. In some cases, cable burial would not be possible and surface laying with cable protection would be required. In addition to this it is estimated that 50m of array cable would be surface laid on approach to the each wind turbines as well as 50m of export cable and interconnector cables on approach to the substation platforms. Trenching (and pre-sweeping) is considered the worst case for offshore archaeology although the following parameters for cable protection should be considered:

- Array cables:
    - Cable protection for unburied cables would be 5m wide;
    - Cable protection for crossings would be 10m wide;
    - Each wind turbine would have up to 100m of unburied array cable with an area of 128,600m²; and
    - The area required for up to 10 crossings would be 128,500m².
- Interconnector cables:
    - Maximum length of interconnector cables that will be protected is 15km; and
    - The 15km of cable would be protected with 5m wide cable protection.
- Export cables:
    - Total of seven crossings (five cable crossings and two pipeline crossings) are required for each cable (up to six cables) resulting in a total footprint of 42,000m² (based on an area per crossing of 1000m² and up to six cables);

- Cable protection could be required at each of the landfall HDD exit points (for the long HDD option). This would entail one mattress (6m length x 3m width x 0.3m height) plus rock dumping (5m length x 5m width x 0.5m height) at each exit point (up to six cables); and
- Further cable protection may be required during the operation and maintenance phase, should cables become unburied.

2.3.3 Ancillary Infrastructure

2.3.3.1 Offshore substation/convertor station platforms

37. Up to three 600MW substation platforms (HVAC) or two 900MW convertor platforms (HVDC) would be required. Foundation options include:

- Piled monopile (10m diameter per substation)
- Suction caisson monopile (20m diameter caisson per substation);
- Piled tripod (3m diameter pile per substation);
- Suction caisson tripod (3 x 3m diameter caissons per substation);
- Piled quadropod (4 x 3m diameter pile per foundation); and
- Suction caisson quadropod (4 x 3m diameter caisson).

2.3.3.2 Accommodation platforms

38. A single accommodation platform may be required. Foundation options are as described in Section 2.3.3.1.

2.3.3.3 Met Masts

39. Up to two operational meteorological masts (met masts) may be installed within Norfolk Boreas. Foundation options include:

- Jacket with pin piles;
- Jacket with suction caissons;
- GBS;
- Suction caisson monopile; and
- Piled Monopile.

40. In addition two LiDAR buoys and two wave buoys may be required.

2.3.4 Construction Vessels

41. Further to the infrastructure parameters outlined in Sections 2.3.1 to 2.3.3, vessel anchors and jack ups required for construction also have the potential to impact physical processes on the seabed. The maximum number of anchors or jack-ups representing the worst case scenario will be defined in the ES but the worst case scenario is likely to be that jack-up barges with four legs per barge (176.71m^2 per leg, 706.86m^2 combined leg area) would be used for wind turbine installation contributing a total footprint area of 363,316m^2 (based on two jacking operations per wind turbine for 257 x 7MW turbine sites).

42. It is anticipated that several types of construction vessel could work in parallel during the construction of Norfolk Boreas. For wind turbine installation, the most likely installation vessel would be a jack-up vessel, although DP vessels are also under consideration.

2.3.5 Landfall

43. The landfall is the location where the export cables are brought ashore and jointed to the onshore cables within transition pits. Norfolk Boreas would share a landfall with Norfolk Vanguard at Happisburgh South.

44. The export cables would be required to be installed in ducts under the existing sea defences and to be jointed to the onshore cables at the transition pits located on the landward side of the landfall site. Ducts would be installed using HDD which is a trenchless installation technique. The HDD would exit at one of the following two locations:

- On the beach, above the level of Mean Low Water Springs (MLWS) (classified as short HDD); or
- At an offshore location, seaward the beach (up to 1,000m in drill length) (classified as long HDD).

45. In the case of a short HDD, temporary beach closures may be required during drilling exit and duct installation to maintain public safety. Beach access would be required for an excavator and 4x4 vehicles. The archaeological assessment of possible impacts would need to consider the entire associated working area necessary to deliver the proposed project (e.g. operation of plant on the foreshore) as part of the ES. The assessment will also consider the potential for the breakout of bentonite slurry used in the HDD process and the potential impacts upon any identified significant and *in situ* archaeological remains, including physical damage, changes to the burial environment and the potential for impacts upon site preservation.

46. A total of 6 ducts for the HVAC option or 2 ducts for the HVDC option would be required at the landfall for Norfolk Boreas (in addition to the six required for Norfolk Vanguard see Section 2.3.9 below). Therefore the HVAC option represents the worst case scenario for intertidal archaeology.

47. The ducts are typically floated into position at the offshore/intertidal exit point via barges, the ducts are then flooded with water and pulled into the reamed drill hole from the entry pit. Once the duct has been installed, the offshore cables can be installed when convenient by positioning the cables at the offshore exit point and pulling through the ducts to the transition joint pit.

2.3.6 Construction Programme

2.3.6.1 Phasing

48. It is envisaged that Norfolk Boreas would either be built in one single phase, two phases of 900MW or three phases of 600MW. The location of each phase across the Norfolk Boreas site would be determined based on constraint identification throughout the EIA process as well as post consent site investigations. The EIA will therefore assess up to the capacity of 1,800MW.

49. Norfolk Boreas construction is likely to be staggered and may have temporal overlap between phases. The objective is to ensure each phase is complete and generating electricity in as short a time as possible. Under Scenario 1, an indicative three phase programme would be:

- Phase 1 - Construction and commissioning 2028;
- Phase 2 - Construction and commissioning 2029; and
- Phase 3 - Construction 2029 and commissioning 2030.

50. Under Scenario 2, an indicative three phase programme would be

- Phase 1 - Construction and commissioning 2027;
- Phase 2 - Construction and commissioning 2028; and
- Phase 3 - Construction and commissioning 2029.

2.3.6.2 Foundations

51. The construction programme with the longest duration has the greatest potential to disturb the setting of heritage assets. It is expected that installation of all foundations would take up to 12 months over a two year period, with up to 4 foundation installation vessels used to install foundations simultaneously.

2.3.6.3 Offshore cable laying

52. Under a single phased approach cable laying could take up to 14 months period. Under two- or three-phase approaches the principal difference compared to the single phase assessment is that installation of the cables would occur over two or three distinct phases, each lasting up to nine months or five months, respectively.

2.3.6.4 Landfall

53. For an indicative HDD length of 500m, it is anticipated that site establishment, drilling of six ducts and demobilisation would take approximately 30 weeks when considering 12 hour (7am-7pm), seven-day shifts. A 24-hour operation could be employed for drilling activities, subject to planning and environmental restrictions, and could reduce the installation to approximately 20 weeks. Cable pulling would be undertaken subsequent to the duct installation.

2.3.7 Operation and Maintenance (O&M) Strategy

54. Once commissioned, the wind farm would have an indicative design life of 25 years. All offshore infrastructure including wind turbines, foundations, cables and offshore substation platforms would be monitored and maintained during this period in order to maximise efficiency.

55. As for construction, vessel anchors and jack-ups required for these maintenance activities also have the potential to affect marine physical processes with the maximum number of anchors/jack-ups representing the worst case.

2.3.8 Decommissioning

56. Decommissioning would most likely involve the accessible installed components comprising:

- All of the wind turbine components;
- Part of the foundations (those above seabed level); and
- The sections of the array cables close to the offshore structures, as well as sections of the export cables.

57. The process for removal of foundations is generally the reverse of the installation process. Possible impacts associated with the decommissioning stage(s) will be further considered as part of the EIA.

58. It is anticipated that a full EIA will be carried out ahead of any decommissioning works to be undertaken.

2.3.9 Cumulative Impact Scenarios

59. In addition to Norfolk Boreas, Vattenfall is also developing the Norfolk Vanguard offshore wind farm with the EIA approximately a year ahead of the Norfolk Boreas EIA. The development of Norfolk Boreas will use the same offshore cable corridor as Norfolk Vanguard with the addition of a spur to the Norfolk Boreas site.

60. For both projects, a total of 12 offshore cables and 12 ducts at the landfall would be required (six for each project under the worst case HVAC electrical solution). The full implications of Norfolk Vanguard and Norfolk Boreas cumulative impact scenarios, as well as cumulative impacts with respect to other existing and planned projects (including, but not limited to, East Anglia One, East Anglia Three, East Anglia One North and East Anglia Two), will be fully considered as part of EIA process.

61. Other offshore project types, where applicable, will also be considered in the CIA.

62. Direct cumulative impacts to known heritage assets are unlikely to occur due to the avoidance of known archaeological sites and features identified through EIA for each of the constructed and planned projects as part of the consenting process. With regard to potential archaeological sites, although the effect of unavoidable impacts will be mitigated by agreed measures, the cumulative impact of multiple unavoidable impacts from multiple projects will be considered as part of the ES.

63. Under Scenario 2 (where Norfolk Vanguard is not constructed) the cumulative impact of multiple unavoidable impacts will potentially be less than under Scenario 1. The worst case, therefore, would be Scenario 1 as this would result in a greater number of interactions with the seabed at a greater number of locations and, therefore, greater potential for multiple unavoidable impacts to occur.

64. The assessment will also consider the beneficial cumulative impact associated with the accumulation of archaeologically interpreted geophysical and geotechnical data and the information provided by chance discoveries. In this respect, Scenario 2 would represent the worst case as this presents fewer opportunities to accumulate further information on the marine historic environment.

65. Across the region, cumulative effects to the setting of heritage assets and historic seascape character will occur, although effects associated with construction will be temporary and transitory, while decommissioning will result in further change to the character, reminiscent of the pre-wind farm character.

66. Under Scenario 2, the cumulative effect of change to the setting and historic character of the region would be less than if Norfolk Vanguard had been built. Therefore, Scenario 1 represents the worst case scenario.

2.3.10 Transboundary Impact Scenarios

67. Transboundary impacts may occur where a planned activity results in an effect within a transboundary context (i.e. across state borders). For offshore archaeology this could comprise:

- Wrecks or aircraft of non-British, European nationality subject to impact from development which may fall within the jurisdiction of another country;
- Indirect impacts to heritage assets in neighbouring sea areas if cumulative effects of changes to physical processes extend across borders;
- Potential for developments, individually and cumulatively, to impact palaeolandscapes and historic seascapes which may extend across borders; and
- Sensitivities in conjunction with local community groups and interests.

68. As all known wrecks and aircraft would be avoided through the application of Archaeological Exclusion Zones (AEZs), the worst case for unexpected discoveries of wrecks or aircraft of non-British nationality would be Scenario 1 as this would result in greater potential for unavoidable impacts to occur. Similarly, the worst case for impacts to palaeolandscapes and historic seascapes and with regard to local would also be Scenario 1.

69. Transboundary impacts with regard to marine physical processes will be assessed through consideration of the extent of influence of changes or effects and their potential to impact upon marine physical processes receptor groups that are located within other European Union (EU) member states.

70. There is also potential for beneficial transboundary impacts associated with the acquisition of survey data and the information gained from unexpected discoveries which will contribute to an international understanding of palaeolandscapes and maritime and aviation archaeology which transgress North Sea territorial boundaries. In this respect, Scenario 2 would represent the worst case as this presents fewer opportunities to accumulate further information on the marine historic environment.

3 BASELINE ENVIRONMENT

71. The Norfolk Boreas offshore archaeology PEIR will address the subtidal area and the intertidal area below MHWS. The assessment of onshore archaeology will address terrestrial areas above MHWS. However, data gathering and assessment will be integrated and cross referenced between the onshore and offshore archaeological assessments, as this will be essential for understanding the full extent of the known and potential archaeological resource in the coastal region.

72. The offshore archaeology Desk Based Assessment (DBA) will take account of:

- Seabed prehistory (i.e. palaeoenvironmental deposits and archaeological remains corresponding to the activities of prehistoric populations that may have inhabited what is now the seabed when sea levels were lower);
- Maritime archaeology (i.e. the remains of boats and ships and archaeological material associated with prehistoric and historic maritime activities);
- Aviation archaeology (i.e. the remains of crashed aircraft and archaeological material associated with historic aviation activities);
- Historic seascape character (i.e. the attributes that contribute to the formation of the historic character of the seascape); and
- Archaeology (including palaeoenvironmental deposits) specific to the intertidal zone below MHWS and above MLWS.

73. Information to support the scoping study for Norfolk Boreas was primarily taken from the Zonal Environmental Appraisal (ZEA) for the former East Anglia Zone (EAOW, 2012). The baseline data was supplemented by records of wrecks and obstructions held by the United Kingdom Hydrographic Office (UKHO) obtained through OceanWise. Further data sources which will inform the PEIR and ES are outlined below.

74. The primary source of information for the assessment of offshore archaeology within the export cable route and at the landfall will be the DBA prepared by Wessex Archaeology (2017a) in order to inform the Norfolk Vanguard PEIR. The DBA incorporated the results of the archaeological assessment of geophysical data (sub-bottom profiler, sidescan sonar, multibeam echosounder and magnetometer) acquired from the provisional offshore cable corridor during the Norfolk Vanguard offshore survey campaign in autumn 2016 and subject to analysis by Wessex Archaeology. The DBA also included data on charted wrecks and obstructions from the UKHO and from sources which extend to the 12nm limit of UK territorial waters only including:

- The National Record of the Historic Environment (NRHE) maintained by Historic England, comprising data for terrestrial and marine archaeological sites, find spots and archaeological events;
- The National Heritage List for England maintained by Historic England, comprising data of designated heritage assets including sites protected under the Protection of Military Remains Act 1986 and the Protection of Wrecks Act 1973; and
- The Norfolk Historic Environment Record (NHER), comprising a database of all recorded terrestrial and marine archaeological sites, find spots and archaeological events within the county and offshore.

75. Further sources included:

- The Coastal and Intertidal Zone Archaeological Network (CITiZAN);
- Relevant mapping including Admiralty Charts, historic maps and Ordnance Survey; and
- Relevant documentary sources and grey literature held by Wessex Archaeology, and those available through the Archaeological Data Service and other websites.

76. With respect to the offshore cable corridor, the baseline set out in the PEIR for Norfolk Vanguard, also relevant to the baseline for Norfolk Boreas, can be summarised as follows:

- Seabed Prehistory:
    - 43 features of palaeographic potential in the offshore cable corridor seen in the sub-bottom profiler data; and
    - Potential for *in situ* and reworked archaeological and palaeoenvironmental material from the Lower, Middle and Upper Palaeolithic and Mesolithic.
- Maritime and Aviation:
    - 27 geophysical anomalies (seabed features) described as A1 (Anthropogenic origin of archaeological interest);
    - 715 geophysical anomalies (seabed features) described as a2 (Uncertain origin of possible archaeological interest);
    - Potential for further maritime archaeological material, dating from the Mesolithic period up to the present day, which has not previously been identified; and

- Potential for the discovery of previously unknown aircraft material.

- Intertidal:
  - 21 previously recorded heritage assets within the intertidal zone (up to MHWS) at the landfall at Happisburgh South; and
  - Potential for further archaeological material to be buried within intertidal deposits, including potential for Palaeolithic material of international importance to be present within the study area at the landfall where Cromer Forest Bed Formation survives *in situ*.

- Historic Seascape Character and setting:
  - Specific associations with 20th century military activity and the Anglo-Dutch wars of the 17th century.

77. The DBA for Norfolk Boreas will draw upon the existing DBA undertaken for Norfolk Vanguard and it is not proposed a further Norfolk Boreas standalone technical DBA report is produced, rather the DBA for Norfolk Boreas will be presented as part of the Norfolk Boreas PEIR chapter. The DBA for Norfolk Boreas will be informed by the available data outlined below.

- The Norfolk Vanguard DBA (as discussed above);
- Geophysical data (sub-bottom profiler, sidescan sonar, multibeam echosounder and magnetometer) acquired from the Norfolk Boreas site (full coverage) during a further offshore survey campaign in 2017, which has been assessed by Wessex Archaeology (see Section 3.1);
- Draft deposit model prepared by Wessex Archaeology and informed by offshore geotechnical data acquired for Norfolk Vanguard and Norfolk Boreas and subject to geoarchaeological assessment by Wessex Archaeology (see Section 3.2);
- Onshore geotechnical data and the results of a geoarchaeological watching brief and subsequent geoarchaeological analysis undertaken by Wessex Archaeology for Norfolk Vanguard during 2017;
- The results of a walkover survey of the intertidal zone undertaken in November 2017, carried out to:
  - Ground truth known non-designated heritage assets;
  - Examine the potential for any further heritage assets to be present; and
  - Recover and map any archaeological material which may be observed on the surface.

- Background British Geological Survey (BGS) geological information and relevant Admiralty Charts for the study area;
- Existing archaeological studies and published sources including, but not limited to:
    - North Sea Palaeolandscapes Project (e.g. Gaffney et al, 2009);
    - Norfolk Rapid Coastal Zone Archaeological Survey (Robertson et al, 2005);
    - Full legacy of archaeological project work directed at the Happisburgh coastal area such as the Ancient Human Occupation of Britain Project (e.g. Ashton et al, 2010); and
    - Archaeological evaluation report for Environment Agency's removal of failed sea defences at Happisburgh (e.g. Birks, 2016).

78. The approach to archaeology below MHWS will also be guided by the outcomes of ongoing consultation for Norfolk Vanguard where relevant. This would include specific requirements and information which may emerge from an expert topic group including representatives from the AHOB and PAB research teams in respect to the landfall at Happisburgh South.

3.1 Results of Initial Geophysical data analysis

79. Geophysical data (sub-bottom profiler, sidescan sonar, multibeam echosounder and magnetometer) was acquired from the Norfolk Boreas site by Fugro during an offshore survey campaign in 2017. The raw data was provided to Wessex Archaeology for archaeological assessment and preliminary results for the assessment of seabed features have been provided pending final analysis and reporting.

80. The preliminary results indicate the presence of nine A1 anomalies (anthropogenic origin of archaeological interest), 535 geophysical anomalies (seabed features) described as A2 (uncertain origin of possible archaeological interest) and three locations classified as A3 (historic record without corresponding geophysical anomaly). These anomalies within the Norfolk Boreas site are in addition to those within the offshore cable corridor which were assessed as part of the Norfolk Vanguard PEIR and described in Paragraph 78 above.

81. The three A3 records all relate to obstructions recorded by the UKHO but not seen in the geophysical data. Although nothing was seen on the seabed surface at these locations it is possible that buried material could still be present.

82. The 535 A2 anomalies include bright reflectors (19), dark reflectors (95), debris or large objects (103), ropes/chains (11), mounds (7) areas of seabed disturbance (46)

and magnetic only anomalies (254). It is anticipated that these would be further refined following the finalisation of the results and final reporting from Wessex Archaeology which will be provided with the PEIR.

83. Five of the A1 anomalies correspond to wrecks previously recorded by the UKHO, three of which are of unknown identity. One of the two identified wrecks is the *Koningen Regentes*, a paddle steamer built in 1895 and which operated as a ferry between the Netherlands and the UK until the outbreak of the First World War. The ship was refitted as a hospital ship and was in service repatriating prisoners of war when it was torpedoed and sunk by German submarine in 1918. In 2010 the wreck was described by divers as being broken up and scattered with the paddles still showing above the seabed.

84. The remaining wreck is that of the British supply vessel *Vulcan Service* which sunk in 1990 after colliding with a gas rig whilst delivering supplies on Christmas Day. As a modern vessel, this is not considered to be of archaeological interest. Four further A1 anomalies, described as debris in the preliminary results, are all located in proximity to this wreck and are potentially associated with it. The archaeological interest of these items of debris will be assessed further as part of the PEIR and based upon the final assessment results and reporting from Wessex Archaeology.

85. The archaeological assessment of sub-bottom profiler data is being incorporated with the results of initial geoarchaeological analysis (see Section 3.2 below) and will also be reported on in the PEIR.

3.2 Results of Initial Geoarchaeology analysis

86. 61 vibrocores were acquired from the Norfolk Boreas site by Fugro during October 2017. The preliminary core logs were provided to Wessex Archaeology for review and each vibrocore was assigned either a high, medium or low priority status based on their perceived geoarchaeological significance. The vibrocores collectively comprise a sequence of Pleistocene clays/sandy clays, in places overlain by peat most probably of early Holocene date, and sealed by more recent marine shelly sands (Wessex Archaeology, 2017b).

87. Vibrocores identified as high priority were retained and sent to Wessex Archaeology for further geoarchaeological recording. Vibrocores assigned a medium priority status were monitored by a geoarchaeologist during geotechnical logging and sampling at Fugro House, Wallingford (31st October – 1st November 2017). Low priority cores were logged without a geoarchaeologist present but with advice given to geotechnical engineers on recognising and retaining sediments of archaeological and geoarchaeological significance.

88. Five vibrocores were assigned a high priority status and retained for further work (Wessex Archaeology, 2017b). Three of these contain semi-terrestrial peat deposits of high geoarchaeological significance with the remaining two having the greatest recorded depths of Pleistocene clay/sandy clay, considered to represent the Brown Bank Formation. Of the 8 vibrocores assigned a medium priority status, none were found to contain deposits of geoarchaeological significance during monitoring of geotechnical sampling and logging.

89. Geoarchaeological recording of the high priority cores is currently underway and the results will inform the PEIR for Norfolk Boreas. This will also be considered alongside the results of geoarchaeological assessment being progressed for Norfolk Vanguard which includes a draft deposit model prepared by Wessex Archaeology.

3.3 Results of intertidal walkover survey

90. A walkover of the intertidal zone was undertaken in order to ground truth heritage assets identified within the study area at the landfall. No intact and *in situ* heritage assets were identified during the walkover. The primary observation related to the presence of red brick remains scattered and dispersed in the broad location recorded for the Happisburgh Low Lighthouse, located behind the former, now ruined, breakwaters. Scattered brick, stone, breeze blocks and large flints (stones and larger pieces only) were also observed in the general vicinity of the recorded position of two former pillboxes, now demolished.

91. However, it was also noted that land-slides/ cliff falls occur regularly and, during the visit, a member of the public indicated that the morphology of the beach could change on a weekly basis. Since the site visit in November 2017, severe winter storms largely stripped the beach of sand and resulted in further cliff erosion, reported to be a regular occurrence at this location.

4 IMPACT ASSESSMENT METHODOLOGY

4.1 Defining Impact Significance

92. The impact assessment methodology adopted for archaeology and cultural heritage will define those assets likely to be impacted by the proposed scheme. The assessment will not be limited to direct physical impacts, but will also assess possible indirect impacts upon the setting of heritage assets, whether visually, or in the form of noise, dust and vibration, spatial associations and a consideration of historic relationships between places and the historic seascape character.

93. More specifically the impact assessment will present:

- The perceived heritage significance (importance) of any heritage assets identified as being affected, both designated and non-designated;
- The anticipated magnitude of effect (change) upon those assets and their settings;
- The significance of any identified impacts upon those assets and their settings; and
- The level of any harm (or benefit) and loss of heritage significance (importance).

94. In the absence of an industry standard methodology for heritage impact assessment within the framework of EIA, the impact assessment methodology adopted will take account of overarching principles presented in policy and guidance:

- National Planning Policy Framework (NPPF) (Department for Communities and Local Government, 2012);
- Marine Policy Statement (HM Government, 2011);
- The Setting of Heritage Assets: Historic Environment Good Practice Advice in Planning Note 3 (Historic England, 2015);
- Conservation Principles: Policy and Guidance for Sustainable Management of the Historic Environment (Historic England, 2008); and
- The adopted East Inshore and Offshore Marine Plans (HM Government, 2014).

95. Hence, the impact assessment methodology adopted will differ from the standard approach adopted more generally within the PEIR/ES, for other technical disciplines. The standardised and tailored EIA matrices will provided a useful framework for the identification and appropriate responses to identified impacts. However, when analysing impacts upon heritage setting and heritage significance, the outcomes of the matrix-based approach will be qualified through expert judgement and further comments / arguments based upon the heritage specific legislation, policy and guidance documents available (see Section 5 below), and using the fundamental concepts from the NPPF of benefit, harm and loss.

4.1.1 Sensitivity

96. The sensitivity of a receptor (heritage asset) is a function of its capacity to accommodate change and reflects its ability to recover if it is affected. However, while impacts to a heritage asset's setting or character can be temporary, impacts which result in damage or destruction of the assets themselves, or their relationship with their wider environment and context, are permanent. Once destroyed a heritage asset cannot recover. For this reason, the sensitivity of heritage assets assessment of impacts is defined solely by their heritage significance (archaeological importance). The heritage significance of an asset, the determination of which is outlined below, can therefore be regarded as equating to its sensitivity.

97. The importance of a heritage asset is a function of a range of factors. The Marine Policy Statement (2011) states that the value of heritage assets to this and future generations lies in their heritage interest, which may be archaeological, architectural, artistic or historic.

98. In accordance with this definition, the importance of heritage assets are assessed by examining the asset's age, type, rarity, survival and condition, fragility and vulnerability, group value, documentation, associations, scientific potential and outreach potential. These factors help to characterise a heritage asset and to assess how representative it is in comparison to other similar archaeological, architectural, artistic or historic heritage assets. In terms of scientific potential, reference will also be made to relevant research frameworks such as *The North Sea Prehistory Research and Management Framework* (Historic England, 2009).

99. In the majority of cases, statutory protection is only provided to a site or feature judged to be an above average example in regard to these factors. The criteria used for assessing the importance of intertidal and offshore archaeology are specified in in **Table 4.1**.

100. Where uncertainty occurs, the precautionary approach is to assign high importance. This precautionary approach represents good practice in archaeological impact assessment and reduces the potential for impacts to be under-estimated.

Table 4.1 Indicative (outline) criteria for determining archaeological importance

Sensitivity	Definition
High	• Assets of acknowledged international / national importance (e.g. World Heritage Sites, Scheduled Monuments, Protected Wreck Sites and undesignated assets of the quality and importance to be designated under national and international legislation) • Assets that can contribute significantly to acknowledged international / national research objectives
Medium	• Assets that contribute to regional research objectives

Sensitivity	Definition
	• Assets with regional importance, educational interest or cultural appreciation
Low	• Assets that contribute to local research objectives • Assets with local importance, educational interest or cultural appreciation • Assets that may be heavily compromised by poor preservation and/or poor contextual associations
Negligible	• Assets with no significant importance or archaeological / historical interest
Unknown	• The importance / existence / level of survival of the asset has not been ascertained (or fully ascertained/understood) from available evidence

101. It is crucial that for each asset there is a narrative accompanying the assessment which clearly sets out the reasoning (in accordance with the above factors) and the measure of professional judgment employed in assessing the importance of that asset.

4.1.2 Magnitude

102. The classification of the magnitude of effect on heritage assets takes account of such factors as:

- The physical scale and nature of the anticipated disturbance; and
- Whether specific features or evidence would be lost that are fundamental to the historic character and integrity of a given asset, and its understanding and appreciation.

103. Both direct physical and indirect non-physical (e.g. visual, setting) impacts on heritage assets are considered relevant. Impacts may be adverse or beneficial. Depending on the nature of the impact and the duration of development, impacts can also be temporary and / or reversible or permanent and / or irreversible.

104. The finite nature of archaeological remains means that physical impacts are almost always adverse, permanent and irreversible; the 'fabric' of the asset and, hence, its potential to inform our historical understanding, will be removed. By contrast, effects upon the setting of heritage assets will depend upon the scale and longevity of the development and the sensitivity with which the landscape is re-instated subsequent to decommissioning / demolition, if applicable.

105. The indicative criteria used for assessing the magnitude of adverse effect with regard to archaeology and cultural heritage are presented in **Table 4.2** below.

Table 4.2 Indicative criteria for assessing magnitude of effect (adverse)

Magnitude	Definition
High	• Total loss of or substantial harm to an asset. • Complete and permanent loss of, or change to, those characteristics of an asset's setting which contribute to its significance, such as could be caused by its disassociation with its historical setting.
Medium	• Partial loss of, harm to or alteration of an asset which will substantially affect its significance. • Substantial change to the key characteristics of an asset's setting, which falls short of being a total disassociation with the historical context, or a more total loss which is temporary and/or reversible.
Low	• Minor loss of or alteration to an asset which leave its current significance largely intact. • Minor and/or short term changes to setting which do not affect the key characteristics and in which the historical context remains substantially intact.
Negligible	• Minor alteration of an asset which does not affect its significance in any notable way. • Minor and short term, or very minor and reversible, changes to its setting which do not affect the key characteristics of the asset's significance.

106. The magnitude of effect with respect to beneficial effects will be specific to the type of benefit, as this sits outside established criteria for measuring the magnitude of anticipated 'harm' to a heritage asset. Positive/beneficial effects will be assessed on a case by case basis with criteria established within the PEIR as relevant to specific identified impacts.

4.1.3 Significance

107. An initial indication of impact significance is gained by combining the predicted magnitude of effect and heritage significance (importance) in accordance with the impact assessment matrix provided in **Table 4.3** below.

Table 4.3 Indicative 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*

108. As with the definitions of magnitude and sensitivity, the matrix will be clearly defined by the assessor within the context of that assessment. Indicative impact significance categories with regard to adverse effects are shown in **Table 4.4.**

Table 4.4 Indicative Impact Significance Categories (adverse effects)

Impact Significance	Definition
Major (Substantial)	May equate to substantial harm or total loss of the value of a designated heritage asset (or asset worthy of designation) such that development may not be consented unless substantial public benefit is delivered by the project. Effective/acceptable mitigation options may still be possible, to offset and/or reduce residual impacts to satisfactory levels.
Moderate (Less than Substantial)	Less than substantial harm to the value of a designated heritage asset (or asset worthy of designation) such that the harm should be weighed against the public benefit delivered by the project to determine consent. Effective/acceptable mitigation options are likely to be possible, to offset and/or reduce residual impacts to satisfactory levels.
Minor (Slight)	Harm to a designated or non-designated heritage asset that can be adequately compensated through the implementation of a programme of industry standard mitigation measures.
Negligible	Impact that is nil, imperceptible and not significant.

109. As specified with regard to the magnitude of effect above, a measure of beneficial effects sits outside established criteria for understanding harm or loss. The NPPF addresses public benefit, which should outweigh any harm of loss, but the individual merits of beneficial impacts from a scheme with respect to heritage require consideration on a case by case basis. In the event that such impacts are identified in the PEIR, significance categories for positive effects would be defined to support the accompanying narratives based upon professional judgement.

110. Note that for the purposes of the EIA, 'major' and 'moderate' impacts are generally deemed to be significant (in EIA terms). In addition, whilst minor impacts are not significant in their own right, it is important to distinguish these from other non-significant (negligible) impacts as they may contribute to significant impacts cumulatively or through interactions between heritage assets or elements of the historic environment (historic landscape).

111. Embedded mitigation (for example where potential impacts to known heritage assets are avoided through AEZs and micro-siting through design) will be referred to and included in the initial assessment of impacts as part of the PEIR/ES. If the impact does not require mitigation (or none is possible) the residual impact will remain the same. If however, mitigation is required then there will be an assessment of the post-mitigation residual impact.

5 POTENTIAL IMPACTS

112. Direct impacts on heritage assets, either present on the seafloor or buried within seabed deposits, may result in damage to, or total destruction of, archaeological material or the relationships between that material and the wider environment (stratigraphic context or setting). These relationships can often be crucial to developing a full understanding of an asset.

113. Indirect impacts to heritage assets may occur as a result of changes to the processes acting upon a site as a result of windfarm construction, operation or decommissioning. Buried heritage assets that become exposed to marine processes, due to increased wave/tidal action for example, will deteriorate faster than those protected by sediment cover. Conversely, if increased sedimentation results in an exposed site becoming buried this may be considered a beneficial impact.

114. In assessing impacts to the setting of heritage assets, defined as 'the surroundings in which an asset is experienced' (Historic England, 2015: 2), it is necessary to consider visual considerations and other environmental factors such as noise, dust and vibration, spatial associations, and consideration of the historic relationship between places. Restrictions on access during construction, for example, may also impact the setting of a heritage asset if individuals are prevented from experiencing that asset in its surroundings.

115. Impacts to the historic seascape character will occur with the introduction of new elements causing a change in that character which may affect present perceptions of that seascape across an area.

116. Sections 5.1 to 5.4.5 present information on the impacts which will be considered within the EIA.

5.1 Potential Impacts during Construction

5.1.1 Direct impacts to known heritage assets

117. It is anticipated that direct impacts to known heritage assets would not occur. This would be due to the application of embedded mitigation (e.g. AEZs and micro-siting through design).

118. The preliminary results of the geophysical interpretation of the Norfolk Boreas site has revealed a number of anomalies of archaeological interest which are described in Section 3.1 . Within the offshore cable corridor there are 27 such anomalies including 17 wrecks previously recorded by the UKHO. Each of these would be avoided through the application of AEZs. Furthermore, there are 715 anomalies of possible archaeological interest within the offshore cable corridor which would

either be avoided through micro-siting of design or further investigated to provide additional information to determine their archaeological interest.

5.1.1.1.1 Approach to assessment

119. The locations, nature and extent of known heritage assets will be established through the DBA incorporating the results of the geophysical and geoarchaeological assessments and the walkover survey at the landfall.

120. Further survey to be undertaken post-consent and pre-construction (e.g. geophysical survey, geotechnical survey and ROV/diver survey) will supplement initial assessments undertaken for EIA in order to inform the required embedded mitigation.

121. The nature of embedded mitigation to prevent impacts to known heritage assets will be agreed in consultation with Historic England and Norfolk County Council through the Norfolk Vanguard and Norfolk Boreas EPPs.

5.1.2 Direct impacts to potential heritage assets

122. Unavoidable direct impacts to potential (as yet undiscovered) archaeology could occur through any activity which disturbs the seabed, which makes contact with the seabed or, with regard to heritage assets with height (i.e. shipwrecks), which occurs in the water column. Direct impacts may also occur during activities at the landfall which disturb intertidal deposits.

123. Any adverse effects would likely be permanent and irreversible in nature.

5.1.2.1.1 Approach to assessment

124. The potential for previously undiscovered archaeological material to be present within the footprint of the development will be established through the DBA incorporating the results of the geophysical and geoarchaeological assessments and the walkover survey at the landfall.

125. Measures to mitigate the effect of unavoidable impacts will be identified and described in the EIA including, for example, the implementation of the Offshore Renewables Protocol for Archaeological Assessment (ORPAD) (The Crown Estate, 2014). The Protocol will ensure that any unexpected discoveries of archaeological material are addressed in a timely and appropriate manner.

5.1.3 Indirect impacts associated with the effect of changes to physical processes

126. Changes to erosion and sedimentation regimes during construction could cause indirect impacts to heritage assets (i.e. increased sediment erosion leading to

degradation of newly exposed assets, or increased sediment accretion leading to protection from degradation through burial).

5.1.3.1.1 Approach to assessment

127. Physical processes will be assessed as part of the EIA process based upon new and existing survey data acquired for the development. The approach to assessment is set out in the method statement for marine physical processes (document reference PB5640-004-021, which can be provided on request) and will be included as Chapter 8 in the PEIR. The results of this assessment, and the nature of any significant effects upon physical processes from the development, will be reviewed and assessed to identify any potential indirect impacts to intertidal and offshore archaeology.

5.1.4 Impacts to setting and Historic Seascape Character

128. Potential impacts to the setting of onshore heritage assets from activities offshore will be addressed in the onshore archaeology chapters of the PEIR and ES.

129. Historic England's guidance on setting (2015) notes how the setting of buried heritage assets may not be readily appreciated by a casual observer, but retain a presence in the landscape. In the case of submerged heritage assets, although some wreck sites have a setting which can be experienced and appreciated within their seascape, by divers or visitors on boat trips for example (e.g. wreck sites at the Needles on the Isle of Wight) most fully submerged archaeological sites are not 'readily appreciated by a casual observer'.

130. With respect to the setting of offshore heritage assets, therefore, potential impacts associated with visual considerations and factors such as noise, dust and vibration (i.e. how an asset is experienced) are of limited relevance for submerged assets. However, it is important to consider setting in terms of spatial associations and the historic relationship between places and as part of the historic character of the seascape.

131. For example, the study *East Coast War Channels in the First and Second World War* (Firth, 2014) examines the spatial extent of navigation channels and minefields between the Thames and the Scottish border during both wars and the heritage assets that are associated with these channels. The use and loss of the wrecks against the wider backdrop of hostile military action along the east coast means that their setting should be considered to contribute to their significance.

5.1.4.1.1 Approach to assessment

132. The assessment will consider the capacity for the setting and character of the historic seascape to accommodate change associated with the construction of

Norfolk Boreas. This will take account of the fact that construction activities and additional vessel traffic would occur in the context of one of the busiest shipping channels between south-east England and mainland Europe and there is already an influence on the seascape from the existing features such as gas rigs and their service vessels within the site.

133. The assessment of the historic seascape character will set out the historic cultural influences which shape present seascape perceptions across marine and coastal areas. The aim will be to demonstrate any potential change to that historic seascape from the construction of Norfolk Boreas. The EIA will reference the Historic Seascape Characterisation work undertaken by Historic England for this area (Newcastle University, 2014) in order to establish the capacity of the presently perceived historic character to accommodate that change.

5.2 Potential Impacts during O&M

5.2.1 Direct impact to known heritage assets

134. It is anticipated that direct impacts to known heritage assets will not occur during the operation phase due to the retention of embedded mitigation (e.g. AEZs) throughout the project lifecycle.

5.2.1.1.1 Approach to assessment

135. The approach to assessment will be as for construction outlined above.

5.2.2 Direct impacts to potential heritage assets

136. Unavoidable direct impacts to potential (as yet undiscovered) archaeology could occur through ongoing maintenance required for the wind farm infrastructure, including vessel anchors/jack ups and repair/replacement of turbines/cables.

137. Any adverse effects would likely be permanent and irreversible in nature.

5.2.2.1.1 Approach to assessment

138. The approach to assessment will be as for construction outlined above.

5.2.3 Indirect impacts associated with the effect of changes to physical processes

139. Changes to erosion and sedimentation regimes from the physical presence of the wind farm infrastructure during operation could cause indirect impacts to heritage assets. The approach the assessment for marine physical processes is set out in the corresponding method statement (document reference PB5640-004-021) and will be included as Chapter 8 in the PEIR.

5.2.3.1.1 Approach to assessment

140. The approach to assessment will be as for construction outlined above.

5.2.4 Impacts to setting and Historic Seascape Character

141. The physical presence of the wind farm infrastructure once installed could impact the setting and character of heritage assets and the wider seascape.

5.2.4.1.1 Approach to assessment

142. The approach to assessment will be as for construction outlined above.

5.3 Potential Impacts during Decommissioning

5.3.1 Direct impact to known heritage assets

143. It is anticipated that direct impacts to known heritage assets will not occur due to the retention of embedded mitigation (e.g. AEZs) throughout the project lifecycle.

5.3.1.1.1 Approach to assessment

144. The approach to assessment will be as for construction outlined above.

5.3.2 Direct impacts to potential heritage assets

145. The extent of any impact will depend on the presence, nature and depth of any such remains and the nature of decommissioning (i.e. cables and foundations left in place will have no further impact whilst removal could result in new impacts to archaeological material).

146. Any adverse effects would likely be permanent and irreversible in nature.

5.3.2.1.1 Approach to assessment

147. It is anticipated that a full EIA will be carried out ahead of any decommissioning works to be undertaken.

5.3.3 Indirect impacts associated with the effect of changes to physical processes

148. If components are left in place, there will be no effect upon physical or coastal processes. If components are removed, the effects could be similar to those described during construction.

5.3.3.1.1 Approach to assessment

149. It is anticipated that a full EIA will be carried out ahead of any decommissioning works to be undertaken.

5.3.4 Impacts to setting and Historic Seascape Character

150. A change will occur with the decommissioning of the wind farm with the partial or complete removal of the wind turbines and associated infrastructure resulting in further change to the character, reminiscent of the pre-wind farm character.

5.3.4.1.1 Approach to assessment

151. It is anticipated that a full EIA will be carried out ahead of any decommissioning works to be undertaken.

5.4 Potential Cumulative Impacts

152. Cumulative impact assessment will be carried out in accordance with the document Guidance for Assessment of Cumulative Impacts on the Historic Environment from Offshore Renewable Energy issued by COWRIE (Oxford Archaeology 2008).

5.4.1 Direct impact to known heritage assets

153. Direct cumulative impacts to known heritage assets are unlikely to occur due to the avoidance of known archaeological sites and features identified through EIA for constructed and planned projects as part of the consenting process.

5.4.1.1.1 Approach to assessment

154. The approach to assessment will be as for construction outlined above and will be the same under Scenario 1 and Scenario 2.

5.4.2 Direct impacts to potential heritage assets

155. With regard to potential archaeological sites, although the effect of unavoidable impacts will be mitigated by agreed measures, the cumulative impact of multiple unavoidable impacts from multiple projects to the archaeological resource will need to be considered as part of the EIA.

156. For example, the extents of palaeolandscapes, from various periods, are largely unmapped and may be confined within a 'project area', but may equally extend beyond the bounds of a project. Likewise, shipwrecks and aircraft within the study area form part of a wider body of data relating to maritime and aviation networks which extend beyond the boundary of the Norfolk Boreas offshore project area and the wider region.

157. It is possible that unique aspects of former landscapes and seascapes may be lost as a result of projects, plans and activities both within and beyond the east coast region. In addition, if a site is damaged or destroyed, comparable sites elsewhere

may increase in importance as a result of greater rarity and any future direct impacts will be of greater significance. Thus, a cumulative impact is expected to occur.

158. However, together with the accumulation of archaeologically interpreted geophysical and geotechnical data carried out for offshore developments in recent years, the information provided by chance discoveries is contributing significantly to a greater understanding of the offshore archaeological resource. As such, these unavoidable impacts and the data and records produced in mitigating their effects can also be regarded as a significant, positive cumulative effect. Any positive effect, however, must be demonstrated by the completion of studies to professional archaeological standards, and the results produced must be made publicly available.

5.4.2.1.1 Approach to assessment

159. Under Scenario 1 the potential for multiple unavoidable impacts to occur from both Norfolk Vanguard and Norfolk Boreas would be considered. This will include consideration of the potential for previously undiscovered archaeology to be present across both projects, as well as other offshore developments within 100km of Norfolk Boreas. Under Scenario 2, Norfolk Vanguard would not be included.

160. However, it is unlikely that the nature of unavoidable impacts, if they should occur, would be fully understood until after such impacts had occurred. Therefore, it is difficult to quantify the difference between Scenario 1 and Scenario 2 for assessment purposes. Cumulative impact would, therefore, be described qualitatively under both scenarios.

5.4.3 Indirect impacts associated with the effect of changes to physical processes

161. Changes to physical processes, which in themselves may not be significant on a project level, may have a significant cumulative effect when considered alongside other offshore and coastal developments across the region.

5.4.3.1.1 Approach to assessment

162. The cumulative effect of Norfolk Boreas in terms of physical processes will be assessed as part of the EIA. The approach to assessment is set out in the method statement for marine physical processes (document reference PB5640-004-021) and will be included as Chapter 8 in the PEIR. The results of the physical processes assessment will be employed to undertake a full assessment of potential cumulative indirect impacts to heritage assets. If no cumulative impacts are identified for marine physical processes, then there will consequently be no cumulative indirect impacts upon archaeology or heritage from changes to prevailing patterns of erosion or sedimentation.

5.4.4 Impacts to setting and Historic Seascape Character

163. As for direct impacts to potential heritage assets, discussed above, the extents of palaeolandscapes and maritime and aviation networks, as part of the historic seascape, may extend beyond the bounds of a project. Therefore, the assessment of the cumulative impact upon this seascape is imperative to understanding the ability of an area to accommodate change associated with new developments.

5.4.4.1.1 Approach to assessment

164. Further consideration will be given to this potential cumulative scenario as part of the EIA, particularly in respect to the wider East Coast offshore wind industry alongside other marine and coastal developments.

5.4.5 Potential Transboundary Impacts

165. Transboundary impacts may occur where a planned activity results in an effect within a transboundary context (i.e. across state borders). For offshore archaeology this could comprise:

- Wrecks or aircraft of non-British, European nationality subject to impact from development which may fall within the jurisdiction of another country;
- Indirect impacts to heritage assets in neighbouring sea areas if cumulative effects of changes to physical processes extend across borders;
- Potential for developments, individually and cumulatively, to impact palaeolandscapes and historic seascapes which may extend across borders; and
- Sensitivities in conjunction with local community groups and interests.

5.4.5.1.1 Approach to assessment

166. Transboundary impacts stemming from changes to marine physical processes were scoped out for Norfolk Vanguard as tidal ellipses showed that all movement would be in a north south direction and would not cross the international boundary. This is also anticipated to be the case for Norfolk Boreas although this will be further assessed in the PEIR.

167. Transboundary impacts to wrecks or aircraft of non-British, European nationality which may fall within the jurisdiction of another country, are not expected to occur. The implementation AEZs will prevent direct impacts to known archaeological receptors while unexpected discoveries of potential wrecks or aircraft from other countries will be managed through the archaeological assessment of pre-construction geophysical survey data in combination with the implementation of a protocol for archaeological discoveries (e.g. ORPAD). If wrecks or aircraft of non-British nationality are discovered during the course of the development, further

advice would be sought regarding the legal status of the remains in their country of origin.

168. A significant positive transboundary impacts is anticipated though the acquisition of survey data which will contribute to an international understanding of palaeolandscapes and maritime and aviation archaeology which transgress North Sera territorial boundaries. For example, in recent decades there have been considerable advances in research of submerged landscapes and it has been recognised that offshore wind activities represent a significant opportunity to both acquire data and implement targeted survey and sampling to inform understanding of North Sea submerged landscapes in accordance with co-ordinated strategies across national boundaries. The potential for Norfolk Boreas to contribute to this data sharing across national boundaries will be explored as part of the PEIR.

5.5 Written Scheme of Investigation

169. In accordance with the Scoping Opinion provided by the Planning Inspectorate, and associated advice provided within Historic England's letter of 6th June 2017 (Appendix 3 of the Scoping Opinion), a draft Outline WSI for archaeology below MHWS will be prepared and provided with the DCO application for Norfolk Boreas. The WSI will set out the following measures for agreement with Historic England and the MMO:

- Expected methodological approach to post-consent survey, including a commitment to obtaining archaeological advice in planning such surveys, and archaeological assessment of acquired data;
- Embedded mitigation (e.g. AEZs and micro-siting to avoid sites) that will be integrated into the project design to prevent impacts to known heritage assets; and
- The procedures that would be put in place for unknown assets discovered during pre-construction or construction activity (e.g. ORPAD).

170. This would include a suitable mitigation strategy to be applied if significant features or remains are identified within the intertidal zone at the landfall at Happisburgh.

171. The WSI will be prepared in accordance with relevant guidance including, but not limited to:

- The Model Clauses for Archaeological Written Schemes of Investigation (Crown Estate, 2010);
- Historic Environment Guidance for the Offshore Renewable Energy Sector, prepared by Wessex Archaeology for COWRIE (Wessex Archaeology, 2007);
- Offshore Geotechnical Investigations and Historic Environment Analysis, prepared by EMU ltd for COWRIE (Gribble and Leather, 2011); and

- Marine Geophysics Data Acquisition, Processing and Interpretation. Guidance prepared by (Plets et al, 2013).

172. Through the consenting process the WSI will be agreed as a point in time document as a means to ensure enforcement of the agreed mitigation measures through the DCO and DML. Specific methodological requirements and any required revisions (e.g. to the nature and extent of AEZs) will be addressed through Method Statements, as required, to underpin the delivery of the WSI. This will include the issue of a revised mitigation strategy as relevant to the final design of generation and transmission assets once a final decision is made (post-consent) as to which options covered by the assessment of the worst case scenario will be implemented.

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