East Anglia ONE North and East Anglia TWO Offshore Windfarms

Applicant's Comments on Relevant Representations

Appendix 2
Wave Climatology Clarification Note

Applicant: East Anglia ONE North Limited
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Applicable to East Anglia ONE North and East Anglia TWO

Revision Summary				
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Table of Contents

Glossary of Acronyms

Cefas	Centre for Environment, Fisheries and Aquaculture Science
DCO	Development Consent Order
EIA	Environmental Impact Assessment
EPP	Evidence Plan Process
ES	Environmental Statement
ETG	Expert Topic Group
GBS	Gravity Base Structures
MMO	Marine Management Organisation
MS	Method Statement

Glossary of Terminology

Applicant	East Anglia ONE North Limited
Construction, operation and maintenance platform	A fixed offshore structure required for construction, operation, and maintenance personnel and activities.
East Anglia TWO project	The proposed project consisting of up to 75 wind turbines, up to four offshore electrical platforms, up to one construction operation and maintenance platform, inter-array cables, platform link cables, up to one operational meteorological mast, up to two offshore export cables, fibre optic cables, landfall infrastructure, onshore cables and ducts, onshore substation, and National Grid infrastructure.
East Anglia ONE North project	The proposed project consisting of up to 67 wind turbines, up to four offshore electrical platforms, up to one construction operation and maintenance platform, inter-array cables, platform link cables, up to one operational meteorological mast, up to two offshore export cables, fibre optic cables, landfall infrastructure, onshore cables and ducts, onshore substation, and National Grid infrastructure.
East Anglia TWO windfarm site	The offshore area within which wind turbines and offshore platforms will be located.
East Anglia ONE North windfarm site	The offshore area within which wind turbines and offshore platforms will be located.
Evidence Plan Process	A voluntary consultation process with specialist stakeholders to agree the approach to the EIA and the information required to support HRA.
Generation Deemed Marine Licence (DML)	The deemed marine licence in respect of the generation assets set out within Schedule 13 of the draft DCO.
Horizontal directional drilling (HDD)	A method of cable installation where the cable is drilled beneath a feature without the need for trenching.
Inter-array cables	Offshore cables which link the wind turbines to each other and the offshore electrical platforms, these cables will include fibre optic cables.
Landfall	The area (from Mean Low Water Springs) where the offshore export cables would make contact with land and connect to the onshore cables.
Offshore	Area to seaward of nearshore in which the transport of sediment is not caused by wave activity.
Offshore cable corridor	This is the area which will contain the offshore export cables between offshore electrical platforms and landfall.
Offshore development area	The East Anglia TWO / East Anglia ONE North windfarm site and offshore cable corridor (up to Mean High Water Springs).
Offshore electrical platform	A fixed structure located within the windfarm area, containing electrical equipment to aggregate the power from the wind turbine generators and convert it into a more suitable form for export to shore.
Offshore export cables	The cables which would bring electricity from the offshore electrical platforms to the landfall. These cables will include fibre optic cables.
Offshore platform	A collective term for the construction, operation and maintenance platform and the offshore electrical platforms.
Platform link cable	Electrical cable which links one or more offshore platforms, these cables will include fibre optic cables.
Safety zone	A marine area declared for the purposes of safety around a renewable energy installation or works / construction area under the Energy Act 2004.

Scour protection	Protective materials to avoid sediment being eroded away from the base of the foundations as a result of the flow of water.
Transmission DML	The deemed marine licence in respect of the transmission assets set out within Schedule 14 of the draft DCO.

1 Introduction

1. The Marine Management Organisation (MMO) provided their relevant representation (Section 56 response) on the proposed East Anglia ONE North and East Anglia TWO windfarm projects (the Projects) to the Planning Inspectorate on 24th January 2020.

2. The MMO commented that "*Whilst the MMO acknowledges that the ES concludes that there will be no significant impacts on the wave climate, given the proposed project's greater proximity to the coastline (in comparison to previous OWF projects) and the long term uncertainty described in paragraph 3.1.1.1 above*[1]*, we recommend that wave data is collected at a location situated between the proposed site and the "East Anglia sensitive coast" receptor prior to construction (baseline) and for a sufficient period post-construction. This would allow an assessment of the accuracy of potential impacts on wave climatology modelled and consequently, the validity of the ES conclusions. For example, this could involve the deployment of an acoustic wave and current (AWAC) profiler or wave buoy*" for both projects.

3. The Applicant has sought to provide clarity on the conclusions regarding wave climate, and why in the context of the assessed impacts, wave data collection is not considered to be required.

4. This note has collated and drawn upon information which was presented in various documents submitted as part of the DCO application in October 2019. There is no new information contained within this note.

5. This document is applicable to both the East Anglia ONE North and East Anglia TWO applications, and therefore is endorsed with the yellow and blue icon used to identify materially identical documentation in accordance with the Examining Authority's (ExA) procedural decisions on document management of 23rd December 2019. Whilst for completeness of the record this document has been submitted to both Examinations, if it is read for one project submission there is no need to read it again.

[1] Paragraph 3.1.1.1 concerned the MMOs caution regarding potential cumulative impacts on physical processes from offshore wind farms and the outputs of modelling. MMO further state that a change in baseline condition of 5% was previously agreed to represent the accepted threshold of significance and that this 5% figure is nominal and should be treated with caution.

2 Wave Climatology Clarification Note

2.1 Prior Engagement

6. The Applicant has engaged with specialist stakeholders through a voluntary Evidence Plan Process (EPP) in order to agree the approach to the Environmental Impact Assessment (EIA). This has been undertaken on an iterative process via Expert Topic Group (ETG) meetings with the specialist stakeholders.

7. Wave modelling was undertaken in response to comments provided by the Centre for Environment, Fisheries and Aquaculture Science (Cefas) on the Physical Processes Method Statement (MS) which was submitted by the Applicant via the EPP.

8. A meeting was held on 18th October 2017 with Cefas, MMO and Natural England to discuss comments raised in relation to the Physical Processes MS and specific concerns with the methodology used to assess the impact on sensitive receptors, both from a single windfarm and cumulatively, of a change in the wave regime.

9. The Applicant subsequently produced a briefing note on Individual Project and Cumulative Wave Modelling. Following stakeholder review, the MMO confirmed in writing on 15th November 2017 that they and Cefas were satisfied with the approach taken. This document has been submitted with the Development Consent Order applications for both projects as ***Appendix 7.2*** (APP-455).

2.2 East Anglia ONE North and East Anglia TWO project alone Assessments

10. The impact of potential changes to the wave regime on the 'East Anglian sensitive coast' have been assessed under three receptors groupings: Norfolk Natura 2000, Suffolk Natura 2000 and Non-designated sand banks. Further details and description of features are provided in ***Table 7.10*** of ES ***Chapter 7 Marine Geology, Oceanography and Physical Processes*** (APP-055).

11. ***Section 7.6.2.2*** considers changes to the wave regime due to the presence of wind turbine foundation structures. This section cites the strong evidence base demonstrating that even under a worst-case scenario of the largest diameter gravity base structure (GBS), changes in wave regime are typically less than 10% of baseline wave heights and are relatively localised in spatial extent (up to a few percent across an area extending several tens of kilometres). This is confirmed in studies by Seagreen (2012), ETSU (2000 & 2002), Lambkin et al (2009), Ohl et al (2001) and Cefas (2005).

12. A comparison with East Anglia ONE wave modelling is provided, which as a worst case considered 240 GBS structures with a basal diameter of 50m and up to 10m in height above the sea bed. Impacts on non-designated sand banks were assessed as not significant under the most conservative model incorporating the largest storm events. In comparison to the worst-case scenarios at East Anglia ONE North (67 x 250m wind turbines with 53m diameter GBS or 53 x 300m wind turbines with 60m diameter GBS)) and East Anglia TWO (75 x 250m wind turbines and 60 x 300m wind turbines), the modelling for East Anglia ONE is considerably more conservative in terms of the number of foundations considered.

13. Expert-based assessment suggests, therefore, that both the magnitude and spatial extent of effects on the wave climate at the East Anglia ONE North and East Anglia TWO windfarm sites would be less than those previously assessed for East Anglia ONE, particularly for non-designated sand banks.

14. With respect to impacts on Norfolk Natura 2000 and Suffolk Natura 2000 receptors, the wave climate modelling results presented in ***Figure 7.6*** (APP-108) for East Anglia ONE North and East Anglia TWO show that the effects on baseline conditions cover only a small spatial extent. The magnitude of modelled changes in significant wave height is typically **less than 1%** only a short distance away from the windfarm array. Impacts on the Norfolk Natura 2000 and Suffolk Natura 2000 receptors have therefore been assessed as **no impact for both projects.**

2.3 East Anglia ONE North and East Anglia TWO cumulative Assessments

2.3.1 Methodology

15. The cumulative assessments were undertaken in two stages, primarily because establishing a single wave model over an extensive area of sea bed, with fine resolution grids over all windfarm projects to be included within the cumulative assessments, would have been computationally inefficient.

16. Instead, therefore, an Auxiliary Wave Model (***section 4.1.4.1*** of ***Appendix 7.2 Individual Project and Cumulative Wave Modelling*** (APP-455)) was set up to examine the potential for interactions between the Hornsea Offshore Wind Farm projects and the former East Anglia Zone.

17. Following this, the Main Wave Model (***section 4.1.4.2***) was used to consider cumulative effects between the Norfolk Boreas, Norfolk Vanguard, East Anglia ONE, East Anglia ONE North, East Anglia TWO, East Anglia THREE, Greater Gabbard and Galloper windfarms.

2.3.2 Results

2.3.2.1 Auxiliary Model

18. Effects arising from Hornsea Projects 1, 2 and 3 on the former East Anglia Zone were tested for waves approaching from due north (N) and north-northeast (NNE), under both 1 in 1 year and 1 in 50 year return period events.

19. The zone of effect under the tests performed does not extend sufficiently so as to interact with the former East Anglia Zone (magnitude of change <2%). Therefore, no potential for cumulative effects on the wave regime exists between the Hornsea Projects 1, 2 and 3 and East Anglia ONE North and East Anglia TWO respectively (***section 4.1.4.1***) and this was subsequently screened out from further assessment in the EIA (***Table 7.37*** of ***Chapter 7 Marine Geology, Oceanography and Physical Processes*** (APP-055)).

2.3.2.2 Main Wave Model

20. ***Section 4.1.4.2*** presents the results of wave modelling undertaken to assess the potential cumulative effects of the proposed projects with other existing and proposed windfarm projects in the relevant section of the southern North Sea. The modelling is based on a worst-case scenario with respect to the spatial extent of the windfarm boundaries. Key cumulative wave modelling outputs are summarised in ES ***Figure 7.8*** (APP-110) for the Projects.

21. The cumulative zone of effect arising from the Norfolk Boreas, Norfolk Vanguard East, Norfolk Vanguard West, East Anglia ONE, East Anglia ONE North, East Anglia TWO, East Anglia THREE, Greater Gabbard and Galloper windfarms is considerably greater in spatial extent than that arising from each of these projects individually.

22. Under some wave approach directions, the zone of cumulative effect can impinge upon some of the identified sensitive receptors as presented in ES ***Figure 7.8*** (APP-110) and shown in ***Figure 1***. The effects under all approach directions are seen to extend over the greatest area under the lower (1 in 1 year) return period event for the reason associated with the higher (1 in 50 year) return period events having longer wave periods, which are less affected by the foundation structures.

N

Norfolk Boreas

Norfolk Vanguard West

Norfolk Vanguard East

East Anglia THREE

East Anglia ONE

Galloper

Greater Gabbard

Galloper

Greater Gabbard

Legend

East Anglia TWO Windfarm Site

East Anglia ONE North Windfarm Site

Offshore Windfarm

East Anglian Sensitive Coast Receptors

Nearby Non-Designated Banks

Norfolk

Suffolk

Percentage Change in Significant Wave Height (%)

- Above 2.0
- 1.5 - 2.0
- 1.0 - 1.5
- 0.5 - 1.0
- 0.0 - 0.5
- -0.5 - 0.0
- -1.0 - -0.5
- -1.5 - -1.0
- -2.0 - -1.5
- Below -2.0
- Undefined Value

3 - Percentage Changes in Baseline Wave Height Arising Cumulatively from all Other Projects Under a 1 in 1 Year Return Period Event (Waves From NNE)

5 - Percentage Changes in Baseline Wave Height Arising Cumulatively from all Other Projects Under a 1 in 1 Year Return Period Event (Waves From E)

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East Anglia TWO and East Anglia ONE North

Zone of Potential Cumulative Influence on the Wave Regime and East Anglian Sensitive Coast

Drg No	EA1N-EA2-DEV-DRG-IBR-001090
Rev	1
Date	20/02/20
Figure	1

Datum: WGS 1984 Projection: Zone 31N

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23. However, the magnitude of change in baseline significant wave heights across these zones of extended influence is <1% where it reaches the location of the identified receptors and is mostly <2% elsewhere. It is only to the immediate west (reduction) and/or east (increase) of Norfolk Vanguard West, Norfolk Vanguard East, East Anglia THREE, proposed East Anglia ONE North project and proposed East Anglia TWO project (marginally) that the change in baseline significant wave height exceeds 2%, and in all these areas the change remains <5%. Therefore, despite a comparatively larger zone of influence from the projects cumulatively, rather than individually, and despite the zone of influence covering several of the identified receptors (including the Suffolk and Norfolk coasts) the magnitude of change under the 1 in 1 year return period event from due east remains insignificant for the cumulative assessments.

24. Cumulatively with other windfarms, the proposed East Anglia ONE North and East Anglia TWO projects would cause **no significant cumulative impact on the baseline wave regime or the identified receptors** (***section 7.7.1*** of ***Chapter 7 Marine Geology, Oceanography and Physical Processes***)**.**

2.4 Conclusions and Summary

25. The worst-case scenario for cumulative wave modelling assumed that GBS structures would be used for 100% of wind turbine foundations for East Anglia ONE North and East Anglia TWO. Project Descriptions were available for East Anglia ONE and East Anglia THREE, and ‘as built’ information was available for Greater Gabbard, Galloper (main wave model). ‘As built’ information was also available for Hornsea Project 1 (auxiliary model).

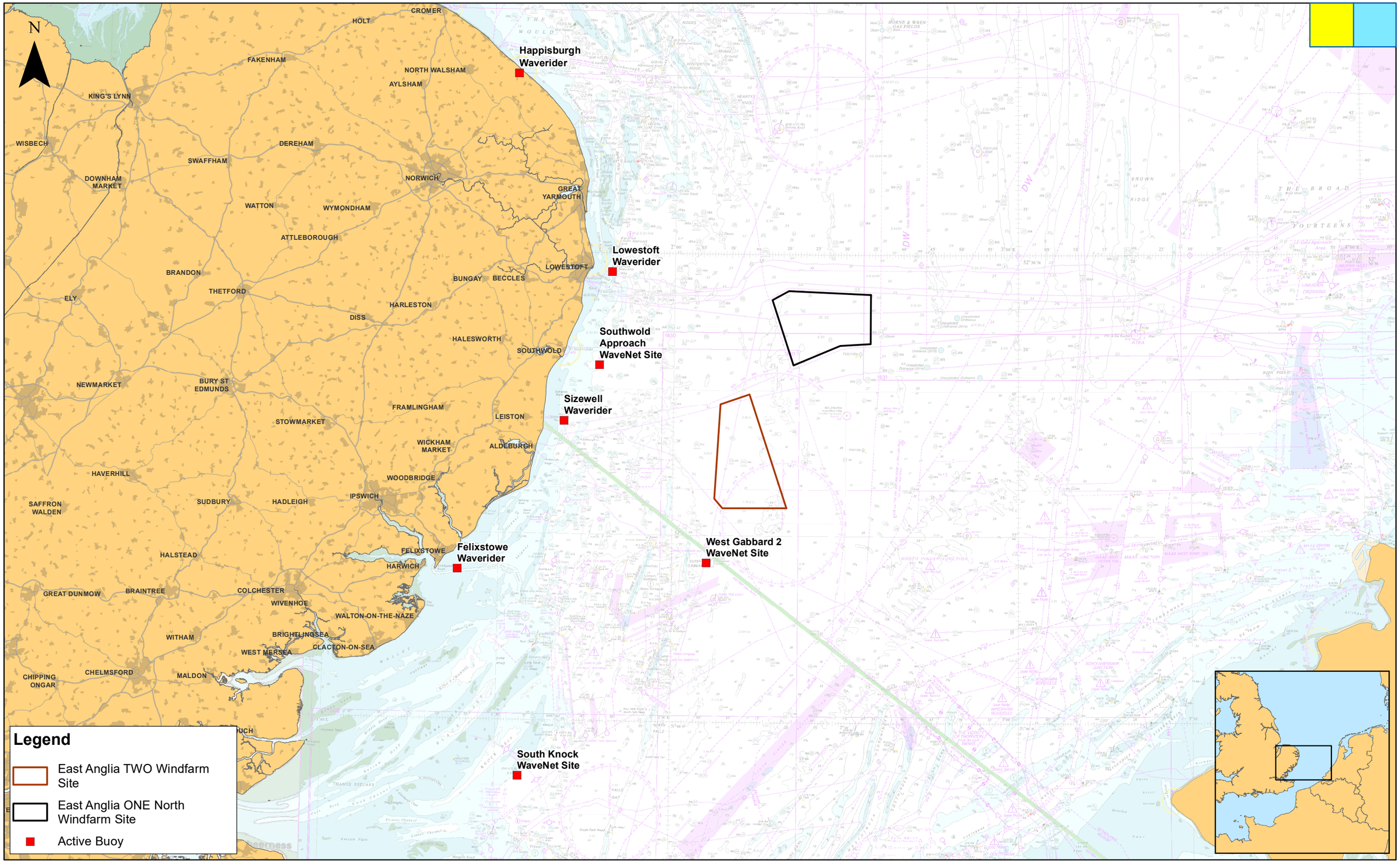
26. For Norfolk Boreas, Norfolk Vanguard (main wave model) and Hornsea Projects 2 and 3 (auxiliary model) offshore windfarms, ‘as built’ details were not available at the time of study and therefore their worst-case parameters were assumed in the models. Therefore, the worst-case outputs of the models can be considered highly conservative in comparison to actual potential impacts as it is highly unlikely that GBS will be used.

27. Project alone impacts are assessed as having no impact upon the receptors of the ‘East Anglian sensitive coast’, whilst cumulative impacts are assessed as not significant and considerably within the 5% threshold agreed with MMO and Cefas through the EPP. It is acknowledged that this threshold figure is nominal, however the magnitude of change in baseline significant wave heights at these receptors is <1%. There is temporal variability in the baseline wave climate and with impact magnitudes of <1% predicted, there would be great difficulty in discerning changes in the baseline with any degree of confidence.

28. It is important to note that there is already an existing deployment of the ‘Sizewell’ and ‘Southwold Approach’ Waverider buoys which are owned and

operated by Cefas (***Figure 2***) on the East Anglia coast. This serves as an effective time series for wave climate data which is arguably of more value than the deployment of any additional wave buoys.

29. The MMOs acknowledgement of the conclusions of the ES with regards to no significant impacts on the wave climate is noted, however the need for wave monitoring during construction and operation is considered disproportionate by the Applicant for the reasons provided above.



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East Anglia TWO and East Anglia ONE North

Cefas Waverider Buoy Locations

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Rev	1
Date	20/02/20
Figure	2

Datum: WGS 1984 Projection: Zone 31N

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