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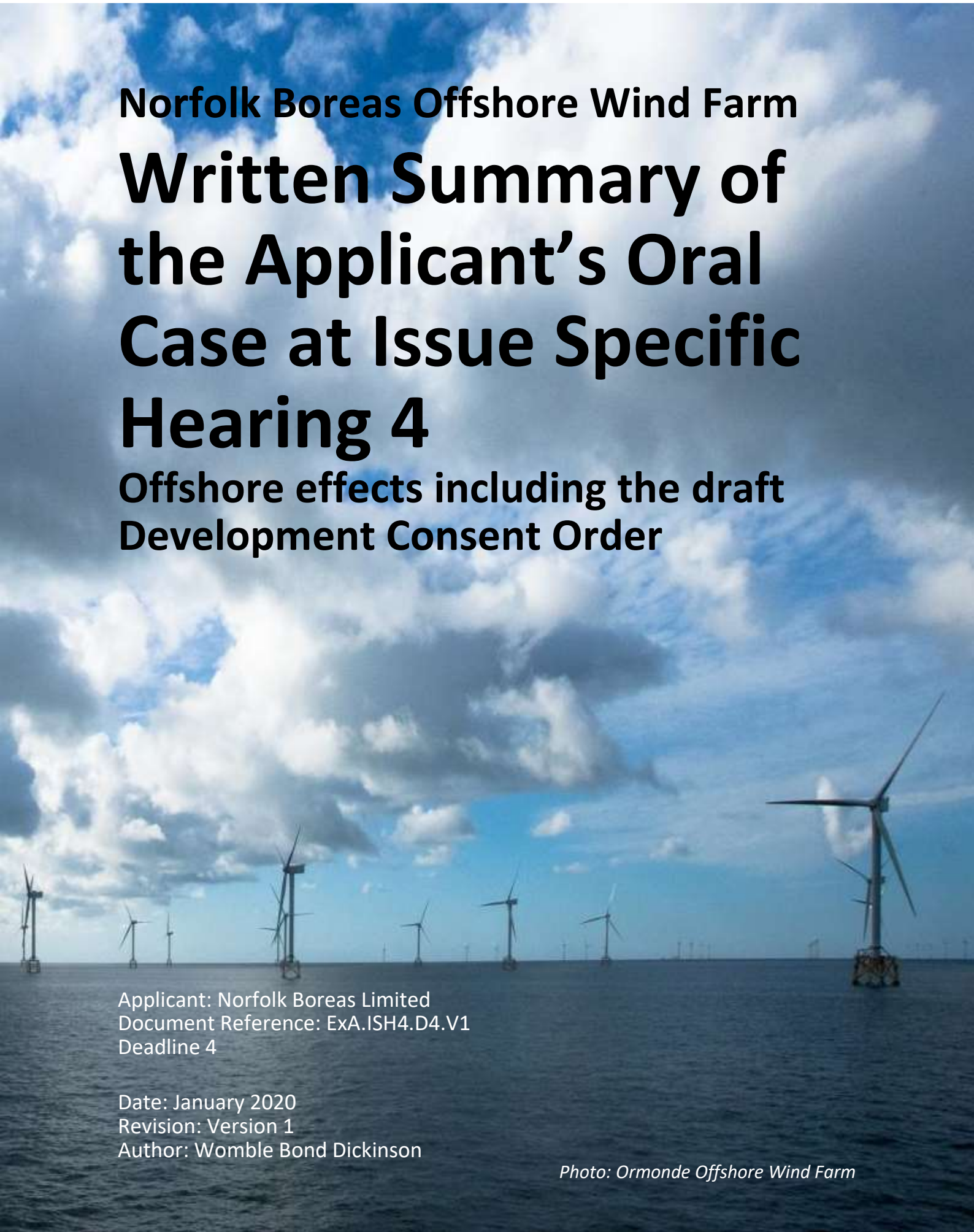


Norfolk Boreas Offshore Wind Farm

Written Summary of the Applicant's Oral Case at Issue Specific Hearing 4

Offshore effects including the draft Development Consent Order

Applicant: Norfolk Boreas Limited
Document Reference: ExA.ISH4.D4.V1
Deadline 4

Date: January 2020
Revision: Version 1
Author: Womble Bond Dickinson

Photo: Ormonde Offshore Wind Farm

Date	Issue No.	Remarks / Reason for Issue	Author	Checked	Approved
29/01/2020	01D	First draft for Deadline 4	JT	VR	JL
30/01/2020	01F	Final draft for Deadline 4	JT	VR	JL

Glossary of Acronyms

AEoI	Adverse Effect on Integrity
AHOB	Ancient Human Occupation of Britain
ASI	Automatic Identification System
DCO	Development Consent Order
dDCO	Draft Development Consent Order
DML	Deemed Marine Licence
EIA	Environmental Impact Assessment
EIFCA	Eastern Inshore Fisheries and Conservation Authority
ExA	Examining Authority
FLCP	Fisheries Liaison and Co-existence Plan
HDD	Horizontal Directional Drilling
HHW	Haisborough, Hammond and Winterton
JNCC	Joint Nature Conservation Committee
M	Metre
Mbgl	Metres below ground level
MCA	Marine and Coastguard Agency
MGN	Marine Guidance Note
MHW	Mean High Water
MLW	Mean Low Water
MMO	Marine Management Organisation
NE	Natural England
NFFO	National Federation of Fishermen's Organisation
NRA	Navigation Risk Assessment
OOOMP	Outline Offshore Operations Maintenance Plan
PAB	Pathways to Ancient Britain
SAC	Special Area of Conservation
sCRM	Stochastic Collision Risk Modelling
SIP	Site Integrity Plan
SoCG	Statement of Common Ground
SPA	Special Protection Area
TH	Trinity House
WSI	Written Scheme of Investigation

Written Summary of Oral Submissions: ISH 4 Offshore effects including the draft Development Consent Order

1.1 Issue Specific Hearing 4 (**ISH**) on Offshore effects including the draft Development Consent Order for Norfolk Boreas took place on 22 January 2020 at 10:00am at Blackfriars Hall, St Andrew's Plain, Norwich NR3 1AU.

1.2 A list of the Applicant's participants that engaged in the ISH can be located at Appendix 1 of this note.

1.3 The broad approach to the ISH followed the form of the agenda published by the Examining Authority (the **ExA**) on 14.01.2020 (the **Agenda**).

1.4 The ExA, the Applicant, and the stakeholders discussed the Agenda items which broadly covered the areas outlined below.

Item	ExA Question / Context for discussion	Applicant's Response
AGENDA ITEM 2 – Archaeological Written Scheme of Investigation		
	i. To understand how micro-survey of potential archaeological assets at the offshore sites and landfall HDD prior to construction activities will be planned and executed.	The Applicant explained that: • It is recognised that the landfall is located in proximity to previously investigated archaeological sites at Happisburgh and that finds and palaeoenvironmental evidence discovered within the Cromer Forest Bed Formation here are of international importance for studies of the Palaeolithic. • Early consultation was carried out with Historic England and with members of the Ancient Human Occupation of Britain (AHOB) and Pathways to Ancient Britain (PAB) projects (who were responsible for the excavation and ongoing research regarding the Palaeolithic sites at Happisburgh) in respect to the proposed landfall. This early consultation revealed agreement that potential data acquired from the project at the landfall (geophysical and geotechnical) would provide an opportunity for further study which would outweigh any risk to the (pre)historic environment. • No deposits resembling the Cromer Forest-Bed Formation were encountered at the landfall during onshore ground investigations for the Norfolk Vanguard Project. Furthermore, the geoarchaeological assessment of the onshore cores concludes that if Cromer-Forest-Beds do survive, they are likely to be found at significant depth (>20mbgl) and below the planned depth for HDD. • The relationship between the Cromer Forest Bed onshore and sub-seabed deposits in the nearshore and offshore environments are uncertain. However, the results of further ground investigations within the project boundary, planned post consent in consultation with the steering group including members of the

		AHOB and PAB project teams as well as Historic England and the projects' (geo)archaeological contractor, will contribute to a greater understanding of the deposits within the wider study area. • The overarching approach to survey and investigation, including consideration of HDD at the landfall, is presented in the Outline Written Schemes of Investigation (WSIs) for both onshore and offshore (APP-696 and APP-697). [The onshore WSI covers the transition pits and entry for the HDD and the offshore covers any intertidal and subtidal surveys as well as the subtidal including exit point of the HDD]. • Options for HDD at the landfall have been considered against an understanding of the sub-surface deposits to provide confidence that any HDD technique would avoid impacts to these deposits of potential Palaeolithic interest. • The assessment includes an envelope which would cover various HDD techniques. With regards to potential impacts on archaeological assets, there would be little difference between the various techniques as all would have the following: o A bore completed from land to sea which would be large enough to receive a duct from the exit point which would be beyond the 5m depth contour. The drill profile would be designed such that it would pass under the cliffs and intertidal area at a depth of at least 10m. o Geophysical and geotechnical data would be used to microsite the drill exit point and the shallow part of the drill on approach to the exit point to avoid any Archaeological assets; the splays contained within the red line boundary offer the opportunity for micrositing the entry and exit points – the exact location of which will be agreed with the MMO and Historic England through the WSI (APP-697); and o Avoidance of the intertidal area due to the commitment for a long HDD method. The drill profile will also be designed so that it does not impact upon the Cromer forest bed, which is known to contain archaeological sensitives.
	ii. To understand how delivery of embedded mitigation, e.g. AEZs, and actions to be taken would be secured in the post-consent offshore archaeological WSI.	The Applicant noted the request to explain the relationship between the Offshore In-Principle Monitoring Plan (8.12 / APP-703) and the conditions within the Deemed Marine Licences (DMLs). The Applicant has subsequently updated the Note on Requirements (3.3. / APP-022) and submitted this at Deadline 4, which also addresses Action Point 2 from the hearing. With respect to the AEZs and WSI: • The approach to embedded mitigation, including establishing and implementation of AEZs and the further investigation of anomalies and subsequent micro-siting requirements or further investigation is set out in the Outline (Offshore) WSI. • The requirement for an Offshore Archaeological WSI is set out in the draft Development Consent Order (DCO) for Norfolk Boreas, under Condition 14(1)(h) of the Generation DMLs (DCO Schedules 9 and 10),

		Condition 9(1)(h) of the Transmission DMLs (DCO Schedules 11 and 12) and Condition 7(1)(g) of the Project interconnector DML (DCO Schedule 13). • The draft DML conditions states that the licensed activities or any part of those activities must not commence until an "*archaeological written scheme of investigation in relation to the offshore Order limits seaward of mean low water, which and must accord with the outline written scheme of investigation (offshore) and industry good practice, in consultation with the statutory historic body*" is submitted to and approved in writing by the MMO. • The requirement for a WSI applies equally to both pre-construction surveys as well as any planned pre-commencement surveys which might occur prior to the main phases of work. This is provided for by Conditions 14(2) (Schedule 9-10) / Condition 9(2) (Schedule 11-12) / and Condition 7(2) (Schedule 13)) which states that *"Pre-commencement surveys and archaeological investigations and pre-commencement material operations which involve intrusive seabed works must only take place in accordance with a specific written scheme of investigation which is itself in accordance with the details set out in the outline offshore written scheme of investigation (offshore), and which has been submitted to and approved by the MMO."* • It is also important to note that, while the Outline WSI states its application to both offshore and intertidal project areas (below Mean High Water (MHW)) it is acknowledged that the draft text of the DML states the application of the WSI to areas below Mean Low Water (MLW) only, thereby excluding the intertidal zone. However, it has been agreed that the text be amended so that it is clear that the offshore WSI also needs to cover the intertidal area, requiring a change in the wording of the DML from MLW to MHW. The Applicant has made this change in the latest version of the dDCO (document reference 3.1) submitted at Deadline 4.
AGENDA ITEM 3 – Shipping and Navigation		
	i. To clearly understand from the Applicant, preferably visually, the restrictions to navigation between the northern extremity of the Proposed Development and Sean Field PP and PD infrastructure (including separation distance between infrastructure and safety zones during construction and maintenance).	The Applicant referred to Figure 22.1 from the Navigation Risk Assessment (NRA APP 569, 6.3.15.1) (shown to the ExA during the issue specific hearing) and explained that this figure is a visual aid to support consideration of Marine Radar effects and it should be considered alongside the text within the Navigational Risk Assessment (NRA). The Applicant confirmed that outside of statutory safety zones there are no restrictions on navigation within or around the Norfolk Boreas site boundary. Regular operators within the Norfolk Boreas study area were identified based on marine traffic survey data (Automatic Identification System (AIS)). The NRA includes the responses received and at no point during consultation were any concerns raised with regards to Sean Field PD PP complex. Therefore no specific image was included within the NRA.

		In order to address this item a further submission (Figure 1, included at Appendix 2 of this note) has been prepared by the Applicant which shows the location of the Sean Field PD PP complex and its proximity to the Norfolk Boreas site boundary. It also notes the minimum spacing between the statutory safety zone around the Sean Field PD PP complex and an assumed 500 metre safety zone around the Norfolk Boreas site boundary. However, the Applicant will not have permanent safety zones during operation, with safety zones only being in place during construction and major maintenance operations.
	ii. To understand how vessels navigate within WTG arrays and the likelihood of impact of single line of orientation to recreational vessels and commercial fishing vessels.	The Applicant is in agreement with the Maritime and Coastguard Agency (MCA) and Trinity House (TH) on the approach to layouts as demonstrated by the areas 'agreed' in the corresponding Statements of Common Ground (SoCG) (REP2-049 MCA SoCG and REP2-040 TH SoCG). Given that at this stage a final layout is not available and the Applicant has not yet made a firm decision on developing a single or multiple lines of orientation (depending on many factors such as seabed condition, turbine types etc.) a process for layout agreement post consent has instead been agreed which includes the use of Development Principles (APP-714, 8.23) as per Deemed Marine Licence (DML) Condition 14(1)(a) (Schedule 9-10) and Condition 9(1)(a) (Schedule 11-12) which states that a Design Plan must be submitted to the Marine Management Organisation (MMO), MCA, and TH in accordance with the parameters defined within the Development Principles. The Development Principles give consideration to the Marine Guidance Note (MGN) 543 guidance which states - *In order to minimise risks to surface vessels and/or Search and Rescue (SAR) helicopters transiting through an Offshore Renewable Energy Installation (OREI), structures (turbines, substations etc) should be aligned and in straight rows or columns. Multiple lines of orientation provide alternative options for passage planning and for vessels and aircraft to counter the environmental effects on handling i.e. sea state, tides, currents, weather, visibility etc. Developers should plan for at least two lines of orientation unless they can clearly demonstrate that fewer is acceptable.* The Applicant notes that the MCA has a preference for two lines of orientation, but in line with the guidance the Applicant may look to develop a layout with a single line of orientation and will aim to demonstrate 'that fewer [than two lines] is acceptable' and safe by the submission of a safety justification as required by the MCA. The Applicant notes that due to the limited likelihood of commercial vessels navigating through the array, limited recreational activity due to the distance offshore and the fact that fishing vessels are engaged in fishing and not transiting there is anticipated to be limited third party transits within the site. Regardless, the NRA demonstrates that a single line of orientation is safe given that vessels will be able to either take straight line courses or alter within the array as desired given the space available.

		The Applicant disagrees with the MCA's position that all the stakeholders have a preference for two lines of orientation given that evidence collated to date from AIS and Radar surveys shows that while vessels do often navigate in straights lines, they do not typically follow rows or columns. The concession on the Applicant's part to maintain at least one line of orientation is to address MCA concern with regards to search and rescue helicopter access.
AGENDA ITEM 4 – Fishing		
	i. To understand whether assessment of magnitude of effects on fisheries should be based on a percentage loss of access to grounds and whether cumulative impact assessment of past losses or restrictions of access to fishing grounds would represent double counting.	The ExA requested an update with regard to the issue around the inclusion of past losses in the cumulative assessment. This had been raised by the National Federation of Fishermen's Organisations (NFFO) and VisNed in their Written Representation (REP2-076). The Applicant noted that consultation with the NFFO and VisNed is on-going through the Statement of Common Ground (SoCG) (REP2-043). Any progress on this and other issues which may be of concern to NFFO/VisNed will be reported within the updated SOCG, which is to be submitted at Deadline 6. The Applicant noted that is confident that, as described in their current position in the SoCG with NFFO/VisNed, and in the Applicant's Comments on Written Representations (REP3-007), inclusion of past losses in the cumulative assessment (through consideration of the impact of existing projects and activities) would effectively result in double counting of their impact. The Applicant's position on this specific issue can be summarised as follows: • The characterisation of fishing activity included in the commercial fisheries baseline takes account of the most recent five years of available fisheries data and further complemented with information gathered during consultation with fisheries stakeholders. The effect from projects which may have been under construction or operational during the period of time for which data is presented in the baseline would be reflected in the outcomes of the analysis of fisheries data and therefore in the baseline upon which the cumulative impact assessment was undertaken. As such, inclusion of those projects in the cumulative assessment would represent double counting of their impact
	ii. To understand whether the Fisheries Co-Existence and Liaison Plan as drafted is sufficient to mitigate risk to fishing vessels in the vicinity of service vessels related to survey, construction and maintenance activities	The Applicant clarified that the purpose of the outline Fisheries Liaison and Co-existence Plan (FLCP) (APP-710) is to provide a high-level description of the aspects which will be given consideration in the final FLCP – to be produced post consent, once construction plans for the project become better defined. The production of the FLCP post consent is an enforceable condition as it is secured under the draft Development Consent Order (DCO) (Condition 14(1)(e), Schedules 9-10 and Condition 9(1)(e), Schedules 11-12) and will require approval from the Marine Management Organisation (MMO) at that time. As it has been previously noted in the Applicant's comments on Responses to the Examining Authority's Written Questions (REP3-003), in order to facilitate co-existence and avoid and reduce potential impacts to the fishing industry, in addition to appropriate liaison and communication, a range of procedures will be

		developed. As described in the outline FLCP these are anticipated to include consideration of various aspects relevant to minimising interactions between project vessels and commercial fishing, including but not limited to: • Development of a code of good practice for contracted vessels; • Development of a fisheries guidance document to reduce interaction with fishing activity and provide response procedures; • The provision of procedures for the safe recovery of lost or snagged fishing gear; and • The development of procedures for claims of loss or damage of fishing gear. It is therefore the Applicant's view that the outline FLCP submitted with the Application gives appropriate consideration to aspects relevant to minimising interactions and safety issues between project vessels and fishing vessels.
AGENDA ITEM 5 – Marine Mammals		
a) Noise Monitoring		
	i. To explore concerns regarding noise disturbance to cetaceans from foundation construction using various piling and non-piling techniques and the opportunities to minimise noise by foundation design.	The Applicant noted that: • A range of foundation options are being considered for Norfolk Boreas, including monopile, jacket (tripod or quadropod), gravity base, suction caisson and TetraBase. Of these, monopiles, jackets and TetraBase foundations may require piling. • Impact piling was assessed as the worst-case for underwater noise. This has been agreed with Natural England and the Marine Management Organisation (MMO). • There is still the potential for noise disturbance to cetaceans from foundation construction using non-piling techniques and other piling techniques, although the impact ranges are likely to be less than those for impact piling. • Alternative foundation options are being considered to help minimise the disturbance from underwater noise, however, there is currently no guarantee that any of these options would be suitable for the construction of Norfolk Boreas. • The BLUE hammer is not currently commercially available and was therefore not included as an option in the Norfolk Boreas Southern North Sea (SNS) Special Area of Conservation (SAC) Site Integrity Plan (SIP). However, the BLUE hammer is currently being developed and further research is required to understand potential noise levels and possible disturbance ranges. • There is the need for better understanding of noise levels and behavioural responses to vibration piling before recommending its use to mitigate impact piling.

		• Once the final foundation type and installation method has been determined the underwater noise from foundation construction using any other piling or non-piling techniques will be assessed to determine, if, or what mitigation could be required. • The DML condition (Schedule 9-10, Condition 14(1)(f) and Condition 14(1)(m) Part 4) refers to 'piled foundations', and therefore any alternative piling techniques are already covered by the condition.
	ii. To understand whether the additional construction techniques including vibro-piling and 'blue hammer', proposed for Norfolk Vanguard, referenced in the SoS letter, are appropriate to Norfolk Boreas.	The Applicant confirmed that it had been discussed and agreed with Natural England and the MMO that the wording of the current condition (condition 14(1)(f) of Schedules 9-10 and Condition 9(1)(f) of Schedule 11-12) was sufficiently wide to encompass other piling techniques. Therefore, it is agreed that there is no change required to the wording of the condition for Norfolk Boreas. The Applicant also understands that Norfolk Vanguard will be making similar submissions in response to the letter from the Secretary of State, The Applicant explained that: • The DML condition (Schedule 9-10, Part 4) refers to 'piled foundations', and therefore this would cover vibro-piling and BLUE hammer (as they are both a type of piling technique). Therefore, the two techniques are already covered by the condition. • Vibro-piling and BLUE hammer are in the early stages of development, it is therefore not possible to provide information on the likely noise levels. These are potential measures which could be considered during the development of the SNS SIP and MMMP, along with a wide range of other potential mitigation solutions. • The selected mitigation measures will be based on the final design of Norfolk Boreas and best available information prior to construction and through consultation. • The SNS SIP ensures that there will be no AEOI as dDCO S*chedules 9 and 10 Part 4 condition 14(1)(m) and Schedules 11 and 12 Part 4 condition 9(1)(l)* requires that construction cannot commence until "*the MMO is satisfied that the plan, provides such mitigation as is necessary to avoid adversely affecting the integrity (within the meaning of the 2017 Regulations) of a relevant site, to the extent that harbour porpoise are a protected feature of that site*." • Once the final foundation type, installation method or the use of alternative installation methods have been determined these will be assessed for the potential risk for any physical or permanent auditory injury and the requirement for mitigation measures in the Marine Mammal Mitigation Protocol (MMMP). They will also be assessed for the potential for any significant disturbance of harbour porpoise in the Southern North Sea SAC in relation to the Conservation Objectives. If there is the potential for significant disturbance that could affect the integrity of the site, effective mitigation measures and/or management measures will be determined through the development of the SNS SIP.

	iii. To explore whether noise monitoring is necessary for more than just the first few piles of each foundation type.	The Applicant confirmed that it had discussed and agreed with Natural England and the MMO that measurements of underwater noise for the first four pile types will be undertaken as a minimum. The Applicant confirmed that: • Where possible, the monitoring could extend to include a location of potential high resistance where higher hammer may be required. However, it had been agreed with Natural England and the MMO that no change to the wording of the condition (*Condition 19(2) of Schedules 9 and 10 and Condition 14(2) of Schedules 11 and 12 of the DCO*)was required. The condition already includes the option for the MMO to request further underwater noise monitoring, if required, as explained below: o Construction noise monitoring would be required if piled foundations are used (in accordance with *Condition 19(2) of Schedules 9 and 10 and Condition 14(2) of Schedules 11 and 12* of the DCO. o Monitoring would include measurements of noise generated by the installation of the first four piled foundations of each piled foundation type to be installed in order to validate the assumptions made within the ES. o Noise monitoring results must be provided to the MMO within six weeks of the installation of the first four piled foundations of each piled foundation type. o If in the opinion of the MMO in consultation with Natural England, the assessment shows significantly different impacts to those assessed in the Environmental Statement (ES) or failures in mitigation, then all piling activity must cease until an update to the marine mammal mitigation protocol and further monitoring requirements have been agreed. o The requirements and need for any further underwater noise monitoring for more than the first four piles of each foundation type needs to be determined on why the additional noise monitoring is required and what specific questions it would be addressing. • Currently the noise monitoring of the first four piles of each foundation type is deemed sufficient to determine if the predicted modelled noise levels are comparable with the actual measured noise levels. Although, the MMO has the option to request further noise monitoring if there is not enough evidence that actual noise levels are not within the predicted noise levels.
	iv. To understand the need to monitor marine mammals themselves which has been raised by NE & TWT.	The Applicant noted that Natural England and TWT agree with a strategic and collaborative approach to marine mammal monitoring. The In Principle Monitoring Plan (IPMP) (REP1-029) provides the framework to agree monitoring requirements with the MMO prior to construction. Section 4.5.2 of the IPMP acknowledges that there may be little purpose or advantage in site specific monitoring and a strategic approach may be more appropriate.

		However, marine mammal monitoring, if required, will be agreed in the development of the final Monitoring Plan pre-construction. The Applicant is aware that TWT advocates the introduction of a conditioned underwater noise fund, whereby all offshore wind farm developments should contribute funding and participate in the delivery of strategic monitoring. The Applicant acknowledges TWT's proposal for an underwater levy. However, there is currently no mechanism for a fund to deliver this strategic mitigation. The Applicant is supportive of strategic initiatives and will continue to work alongside other developers, the MMO, Natural England and TWT.
	v. To identify whether there are any construction techniques, other than piling, under consideration that could result in noise impacts.	The Applicant confirmed that it had discussed and agreed with Natural England and the MMO that impact piling has been assessed as the worst-case. The Applicant understands that both Natural England and the MMO are content and have no concerns in respect of other construction activities. Underwater noise from impact piling was assessed as the worst-case for underwater noise. However, in addition, piling noise modelling was also conducted for other construction activities (see Section 12.7.3.3 in Chapter 12 of the ES, APP-225), some of which could be relevant to the installation of foundations using methods other than impact piling, this included dredging, drilling, cable laying, rock placement, trenching and vessel noise. The assessment in Section 12.7.3.3 in Chapter 12 of the ES (APP-225), shows that the potential impact range would be very small for any risk of auditory injury and the areas of possible behavioural response were also small with the magnitude for any impact assessed as negligible for both. As discussed under Item (i) above, once the final foundation type and installation method has been determined the underwater noise from any other installation techniques during construction will be assessed, and as outlined above, if required, this will be taken into account in the final SNS SIP and MMMP.
b) Mitigation		
	i. To understand concerns regarding the appropriateness of JNCC 2010 guidelines and the effectiveness of in-situ methods for mitigation, including soft-starts, marine observers, passive acoustic monitoring, etc. To consider whether there are newer, proven, alternatives such as bubble curtains, which could be adopted.	The Applicant has agreed with Natural England that the JNCC 2010 guidance outlines the minimum requirements and, as outlined in Section 12.7.1 in Chapter 12 of the ES [APP-225], mitigation will be finalised during the pre-construction phase, and will consider the latest developments, guidance, requirements and information for the most appropriate and effective mitigation methods required. The Applicant also noted that: • Limitations on the effectiveness and suitability of possible mitigation methods will also be taken into account. For example, the use of bubble curtains in different environmental conditions, including water depth and current speed. The most appropriate mitigation methods also need to be considered, for example, there is the potential for disturbance from some mitigation measures, such as bubble curtains,

		due to increased vessels and rings of bubbles, therefore they may not reduce the risk of disturbance and can increase the duration of disturbance, but can reduce noise levels and impact ranges. Therefore, it may be more appropriate for reducing risk of permanent auditory injury, e.g. from UXO. There also needs to be consideration on the availability of possible mitigation options. • The mitigation required will be agreed in consultation with the MMO, Natural England, and where appropriate, The Wildlife Trust (TWT) and Whale and Dolphin Conservation (WDC). • Mitigation in the SNS SIP is secured through the *draft DCO at Schedules 9 and 10 Part 4 Condition 14(m) and Schedules 11 and 12 Part 4 Condition 9(l)* which states: *In the event that piled foundations are proposed to be used, the licensed activities, or any phase of those activities must not commence until a Site Integrity plan which accords with the principles set out in the in principle Norfolk Boreas Southern North Sea Special Area of Conservation Site Integrity Plan has been submitted to the MMO and the MMO is satisfied that the plan, provides such mitigation as is necessary to avoid adversely affecting the integrity (within the meaning of the 2017 Regulations) of a relevant site, to the extent that harbour porpoise are a protected feature of that site.*
c) In-combination effects		
	i. To fully understand the arguments regarding whether in-combination effects are likely to cause AEOI.	The Applicant welcomed the confirmation that the MMO and Natural England agree that the SIP mechanism is the best approach to address in-combination effects from piling on the Southern North Sea SAC. In addition, the draft Review of Consent (RoC) HRA (BEIS, 2018)[1] has recommended that preconstruction Marine Licences contain a condition requiring a SIP (similar to the SNS SIP). The Applicant also agrees with Natural England (as outlined in the SoCG (REP2-025)), that a strategic mechanism is required from the Regulator to ensure that disturbance from in-combination effects can be limited to an acceptable level to ensure no AEoI.
	ii. To review positions between the Applicant, WDC, NE and MMO regarding the appropriateness of using the SIP at consenting stage to address the in-combination impacts from piling.	
d) Water Quality		
	i. To understand the potential in-combination effects of changes to water quality on harbour porpoise.	The Applicant welcomed and concurred with Natural England's and the MMO's confirmation that water quality is not an issue for marine mammals from the project alone and there is no potential for any in-combination effects. The Applicant also understands that Natural England will be writing to the SoS outlining that this is not an issue for Norfolk Vanguard.

[1] BEIS (2018). Record of The Habitats Regulations Assessment Undertaken Under Regulation 65 of the Conservation of Habitats and Species (2017), and Regulation 33 of The Conservation of Offshore Marine Habitats and Species Regulations (2017). Review of Consented Offshore Wind Farms in the Southern North Sea Harbour Porpoise SCI (now SAC).

AGENDA ITEM 6 – Benthic Ecology		
a) Haisborough, Hammond and Winterton (HHW) SAC		
	i. To understand the implications to Norfolk Boreas of the SoS letter to Norfolk Vanguard regarding specific mitigation solutions that would address the potential effects of cable protection on the SAC features. This will also investigate the implications of the possibility that micro siting may not be possible.	**Mitigation** The work that has been undertaken to mitigate the potential effects of cable protection on the HHW SAC is as follows: • During the EIA phase the Applicant made the commitment to reduce the maximum number of export cables from six down to two, reducing the possible amount of cable protection by two thirds. • Following submission of the application, the Applicant has committed to reducing the maximum area of cable protection installed within the SAC, if required as a result of an inability to bury cables to the optimum depth, from 10% of the export cable to 5%. This reduces the amount of cable protection from 40,000m^2 to 20,000m^2. This commitment is reflected in the updated outline HHW SIP which was provided at Deadline 1 (REP1-033) and the dDCO (document 3.1, REP1-008). • The Applicant has also undertaken further work to identify the areas where cable protection is more likely to be placed within the SAC. This study is presented in Appendix 3 of the updated outline HHW SIP [REP1-033]. The study illustrates that the areas where cable protection is likely to be placed do not overlap with the areas identified by Natural England and JNCC as areas to be managed as *S.spinulosa* reef. We understand that Natural England welcome this study but would like to see a firm commitment as an outcome of this work. Therefore, the Applicant is prepared to make a new commitment to install no cable protection in the priority areas to be managed as reef within the HHW SAC, unless otherwise agreed with the MMO in consultation with NE. This commitment will ensure there is **no permanent habitat** loss in the priority areas and therefore cable protection would have no potential to impede the recovery of the Sabellaria reef feature to favourable condition. **Background data and required level of scientific certainty in determining no AEOI** The Applicant introduced Charlotte Johnston – an independent expert on UK seabed habitat conservation and Marine Protected Areas, who previously led the JNCC team that identified all 20 UK offshore SACs and prepared Conservation Objectives and Advice on Operations for each site – to provide an independent and fresh perspective on the designation of the HHW SAC and to comment on the level of scientific certainty in determining (no) AEOI. The Applicant noted that SACs are identified by the European Commission as areas where sustainable development is allowed and they are not 'no go' areas. Activities which do not adversely affect the

		conservation status of the features of the site are not restricted. In addition, the areas to be considered Annex I sandbank or reef habitat for HHW SAC do not cover the whole area of the site in the maps produced by NE and JNCC (Annex A in RR-099) where 'areas to be managed as reef' are identified. It is relevant that there are three significant areas of scientific uncertainty in the evidence underlying Natural England's advice on Annex I habitats within the HHW SAC: i. Uncertainty in accurately defining the extent and distribution of Annex I reef (see Annex A of NE & JNCC advice to MMO 11 Sept 2015 provided as part of Natural England's Relevant Representation (RR-099), leading to identification of "area to be managed as reef" based on sediment characteristics and modelling with precautionary margins added around records of reef; ii. Uncertainty in determining the spatial extent and degree of impact of fishing activities on reef within the site; and iii. Uncertainty as to the current condition of Annex I habitat within the site, reflected in the need for indirect assessment by vulnerability rather than use of actual monitoring data on habitat condition. The conservation objective to 'recover' Annex I reef is also based on vulnerability assessment rather than survey data (noting that the 2013 JNCC conservation objective for reef was to "maintain or recover", in acknowledgement of the above scientific uncertainties). The vulnerability assessment identified *Sabellaria* reef as *sensitive* to physical loss and disturbance, then considered *exposure* to activities that might result in these pressures. The exposure assessment is highly precautionary based on the assumption that fishing effort occurs throughout the site and that it is currently not restricted (apart from the EIFCA area recently closed to bottom fishing). That level of precaution is appropriate for *initial* advice on the conservation interests of the site to highlight to developers and managers what they must consider in their various assessments, and particularly for managers of marine activities such as fishing that are not licensed to a particular location or subject to prior environmental assessment. But that level of precaution is not merited when considering a licensed activity in a fixed location which has been subject to detailed assessment and mitigation. Given the level of scientific uncertainty in determining the extent of the reef and its current condition (noting that scientific certainty is not possible to obtain) and the mitigation now agreed by the Applicant, the assertion that NE cannot be confident of no AEoI for Annex I habitat is not proportionate to the risk of potential small effects on the site in the worst case scenario. That is particularly true for *Sabellaria* reef, as *Sabellaria spinulosa* is not rare, it is very common within the southern North Sea and Channel; a very small area of the site could potentially be temporarily affected and there is strong scientific evidence for rapid recolonization of habitat subject to temporary disturbance. **Use of Site Integrity Plan (SIP)/Grampian Condition for the HHW SAC**

		The Applicant explained that it had had an opportunity to briefly consider Natural England's position statement, submitted prior to the examination, on the use of the Site Integrity Plan for the Haisborough, Hammond and Winterton Special Area of Conservation (HHW SAC) and the Applicant's use of a Grampian condition to secure the delivery of this plan. The Applicant responded with some high level comments although, as required by Action Point 8, the Applicant agreed to respond in detail on the question of the use of the Grampian condition and the related Site Integrity Plan for the HHW SAC at Deadline 5: (a) Importantly, the Applicant explained that it has not and is not deferring an Appropriate Assessment through the use of a Grampian condition. A full Habitats Regulations Assessment (HRA) has been provided which concludes, with no reliance on the Grampian condition, that there is no adverse effect on integrity. Whilst it is correct that the final number and precise route of the cable has yet to be determined the HRA has been undertaken on the basis of a worst case scenario. (b) With the mitigation secured in the SIP, and not necessarily in reliance on the Grampian condition at this point, the Applicant's position is that the project will not hinder or impede the restore objective for the HHW SAC, and any residual impacts are therefore de minimis and inconsequential. (c) It is accepted that the extent of future recovery of the *Saballeria* and therefore its future location at the point of cable installation, cannot be known during the consenting process. The intention of the SIP and the Grampian condition is to provide a mechanism to verify that the Appropriate Assessment undertaken now remains accurate at the point of cable installation. This is no different to conditions which have previously required verification of assessments at the point of construction to confirm avoidance of Annex 1 habitats. (d) Natural England referred to the Secretary of State's letter in respect of the Norfolk Vanguard Project. The Applicant noted that this letter concerns cable protection only. It does not deal with the question of cable installation. The question arises on cable protection due to Natural England's position that cable protection will result in a permanent impact, notwithstanding that *Saballeria* may colonise the cable protection itself. The Secretary of State is also clear that a derogation case is only required in the absence of identified mitigation measures to address impacts of cable protection. In this respect, further mitigation is being put forward which ensures cable protection is not deployed in priority areas for reef. It is in these areas where Natural England's view is that there is high confidence of recovery. Accordingly, avoidance of cable protection in these areas will ensure that the restore objective is not hindered or impeded. (e) On the question of the Grampian nature of the condition, given the context that the condition is seeking to verify the assessment previously undertaken, there is every prospect that it can be discharged in the timescales for DCO implementation. The Applicant has undertaken a number of

		studies to give confidence that the mitigation proposed can be delivered with certainty. For example, to support the reduced amount of cable protection, and to support the commitment not to use cable protection in priority areas. The reference to "where possible" would still ensure that any impacts are de minimis and inconsequential given the scale of the cable installation and cable protection proposed and the ability of *Saballeria* to recover post cable installation. (f) With regard to Natural England's approach on previous projects, the Applicant stated that it did not consider the use of the SIP for the HHW SAC to be any different to the use of the SIP for the Southern North Sea SAC (SNS SAC). In both cases, it will not be known until construction whether any impacts will actually arise in practice. The fact that this relates to in-combination piling impacts in the case of the SNS SAC, or to the extent of recovery of the *Sabellaria* in the case of the HHW SAC is immaterial. In both cases a number of mitigation measures are proposed by the Applicant and, in the case of the HHW SAC, irrespective of the extent of reef recovery in the intervening period, the Applicant considers that the impacts will be de minimis and will not impede the restore objective. (g) The Applicant also considers that if Natural England and the MMO's position was to be accepted, it would never be possible to rule out adverse effect on integrity for any project which had an effect on saballeria due to its ephemeral nature. This is of course not the intention of the Habitats Regulations which seeks to ensure that sustainable development is not precluded from European sites. (h) In conclusion, whilst the Applicant is willing to explore with Natural England and the MMO an alternative way of providing them with comfort that once the extent of recovery is known this will not change the previous assessment - that the project will not impede or hinder further restoration - the Applicant considers that the HHW SIP and Grampian condition is an appropriate way of achieving this. **Micrositing** The Applicant drew a distinction made between micrositing for cable installation and micrositing for cable protection and noted that this needed to be considered separately. • **Micrositing for cable installation** is routing the cables so that they avoid known areas *S.spinulosa* reef at the time of construction; • **Micrositing for cable protection** is not installing cable protection within the priority areas to be managed as *S.spinulosa* reef, as the advice from Natural England is that the placement of cable protection in these areas may affect the conservation objective to restore in these areas. The work undertaken to identify areas where cable protection is most likely to be required (Appendix 3 of the SIP) demonstrates that it is highly likely that micrositing of cable protection would be 100% successful and, as set out above, the Applicant will commit to avoid placing cable protection in the priority areas.

		In addition, to put the maximum area occupied by cable protection into perspective with the areas to be managed as *S.spinulosa* reef, the Applicant presented a figure demonstrating the size of the area which would be occupied by cable protection (see Figure 2, Appendix 3 of this note). The Blue area in Figure 3 is 0.023% of the size of the areas to be managed as *S.spinulosa* reef.
	ii. To understand the strategy for disposal of sediments within the SAC, including the need for a condition specifying particle size, modelling of deposition and protection of Annex 1 reef.	The Applicant explained its approach as follows: • The final sediment disposal strategy will be agreed with the MMO in consultation with Natural England and included within the final HHW SIP. For the avoidance of doubt clarity on this point was added to the updated outline HHW SIP (REP1-033); • However, in order to provide assurance that the Applicant is committed to mitigating any effects on sandbanks as far as possible, the Applicant has made the following commitments within the updated document: o Dispose of any material dredged from the seabed for sandwave levelling (also referred to as pre-sweeping) in a linear "strip" along the cable route; and o Dispose of material close to the seabed. This will be achieved through the use of fall pipe (also referred to as a down pipe) employed by the dredging vessel. • This is also combined with the prior commitment to not dispose of seabed material within 50m from *S.spinulosa* reef. • It is recognised that it may not be possible to fully observe all the criteria proposed for sediment disposal at all locations and therefore when determining the location of disposal areas within the SAC the following hierarchy of criteria would be used: o Priority 1 – material to be disposed of no closer than 50m to any *S.spinulosa* reef (see section 5.4). o Priority 2- Dispose of material up drift of the cable route, to allow infill to occur as quickly as possible following cable installation. o Priority 3 - Dispose of material as close as possible to cable route. In relation to the particle size condition, the Applicant explained:

		• It considers that the mitigation as proposed by the Applicant is the most reliable and efficient way of ensuring that there is no overall change in sediment composition, and that with this mitigation there is no need for a condition specifying particle size. • That the SIP ensures that any disposal strategy will be agreed with the MMO in consultation with Natural England and therefore all necessary requirements of the strategy and mitigation would require approval by the MMO prior to construction. • That the practicality (for any industry) of sampling all dredged sediment and areas within the disposal site in order to determine 95% similarity is unfeasible. The Applicant explained that as the sediment will be disposed of close to the seabed, using a fall pipe, there is no need for modelling because this method of disposal will not result in a significant sediment plume. Finally, the Applicant stated that it was confident that the mitigation proposed is also the best way to ensure that there is no adverse effect on Annex 1 reef as a result of sediment disposal.
	iii. To understand how AEZs and A2 anomalies overlay on the Sabellaria Spinulosa reef features where the cable corridor transits the HHW SAC and how this may influence opportunities for micro siting of the cable route and the possible minor amendments to Red Line Boundary or exclusions related to fishery bylaws.	The Applicant presented a Figure with both areas to be managed as *S.spinulosa* reef and AEZs. This figure is Figure 1 of the Clarification Note on Optimising cable routeing through the HHW SAC (ExA.AS-8.D4.V1). The Applicant explained that: • There are nine locations where AEZs have been proposed within the HHW SAC. These are shown in the Figure 1. Also presented in this figure is the EIFCA byelaw area, which we understand is to be submitted in March/April and then would come into effect in the Autumn (WQ8.5.4. REP2-069), and the areas to be managed as *S.spinulosa* reef. • This Figure illustrates that there would be sufficient space to microsite around both AEZs and areas to be managed as *S.spinulosa* reef. As requested by the ExA, the Applicant presented a second Figure with areas to be managed as *S.spinulosa* reef, A2 anomalies and AEZs, this figure is Figure 2 of the Clarification Note on Optimising cable routeing through the HHW SAC (ExA.AS-8.D4.V). The Applicant explained that: • It should be noted that the A2 anomalies presented in the figure are single data points and do not represent a geographical area on the map, which makes it appear more congested than would be the case on the ground. • It should be recognised that very few of the A2 anomalies presented on the figure would result in AEZs. The Applicant noted the Examining Authority's request for a clarification note outlining how cable routeing through the HHW SAC would be optimised to manage risks of potential additional archaeological constraints

		affecting the conservation objectives of the SAC. The Applicant has submitted this note at Deadline 4 (Optimising cable routeing through the HHW SAC (ExA.AS-8.D4.V).
	iv. To understand the regulators views on whether O & M activities should be excluded from the SAC, and implications for the Applicant.	The Applicant confirmed agreement with the MMO that cable protection in new areas placed during operation was subject to an additional licence and the OOOMP reflects this. The Applicant noted that neither the MMO or Natural England raised concerns in respect of any other O&M activities.
	v. To explore potential implications of a scenario where AEOI cannot be excluded with the Applicant, regulators and IPs including whether there are any feasible alternative solutions, any imperative reasons of overriding public interest for the project and any in-principle compensatory measures.	The Applicant concurred with the ExA, NE and the MMO that there was nothing further to add on this topic in view of the discussions under Agenda Item 6a) i).
AGENDA ITEM 7 – Offshore Ornithology		
a) In-combination impacts of kittiwake, gannet and auks of Flamborough and Filey Coast SPA, black backed gull of the Alde-Ore Estuary SPA		
	i. To understand the implications to Norfolk Boreas of the SoS letters to Norfolk Vanguard and Hornsea Three (for kittiwake) regarding additional requirements for further mitigation to lessen or avoid any adverse effects on the integrity of these sites, to include possible compensatory measures.	In relation to the Norfolk Vanguard letter, the Applicant noted that the letter requested information in respect of two species - Kittiwake and Lesser Black-backed Gull. The letter requests information on mitigation measures not discussed during the examination or, in the alternative, evidence in respect of a derogation case. The focus of discussion for Norfolk Vanguard is, therefore, primarily on further mitigation. The Norfolk Vanguard applicant is exploring further mitigation and has held various meetings with Natural England and the MMO to discuss this. With respect to actions taken by Norfolk Boreas to minimise potential impacts as far as possible, the Applicant confirmed it had been exploring options for mitigation and this has included consideration of alternative turbine models and increasing the rotor draught height. The Applicant confirmed that a draught height increase of at least 5m (from 22m to 27m above highest astronomical tide, HAT) will be adopted, and that preliminary collision modelling has indicated that mortality rates will be reduced by at least 25% compared with the values submitted in the original application and at Deadline 2). Investigations on these matters are ongoing and the Applicant proposed that rather than submitting an update on design (and corresponding impacts) at Deadline 4 or Deadline 5, which may then become superseded by a later design update, further submissions on project revisions and associated ornithological impacts will not be made until Deadline 6. At this deadline it is also proposed that the updated assessment is included in revised integrity matrices. This timetable has the additional benefit that the cumulative and in-combination assessments will be able to include any design revisions which are proposed for the Hornsea Project Three and Norfolk Vanguard wind

		farms, which are due for submission on the 14th and 28th February respectively. This approach was discussed and agreed with Natural England at a meeting held shortly before the hearing on the 22nd January. Subsequently the Applicant noted Action Point 12 to provide an '*Update on collision risk analysis and deterministic modelling for kittiwake and lesser black-backed gull and further mitigation or compensatory measures'* by Deadline 5. The Applicant therefore proposes to submit project-alone assessments at Deadline 5 with the cumulative and in-combination assessments following at Deadline 6, once the Hornsea Project Three and Norfolk Vanguard applicants have submitted their responses to the Secretary of State (assuming these contain updated assessments).
	ii. To consider the Applicant's comments that RSPB has misinterpreted the PVA results, and the implications of this.	The Applicant noted that that this question was directed primarily at the RSPB, however the Applicant presented what it considered to be the source of disagreement between the Applicant and the RSPB, and the reasons for this. The question refers to responses made by the Applicant at Deadline 2 with respect to comments made by the RSPB in their written representation (REP2-096). The RSPB stated that the Applicant's assessment showed there would be reductions in the population sizes as a consequence of the predicted impacts (by given percentages values, e.g. at paragraph 4.3.24 the RSPB state: *The Applicant concludes that there will no adverse effect on the integrity of the Flamborough and Filey Coast SPA as a result of collision mortality to kittiwakes alone (para. 253 of the Information for HRA (doc. 5.3; APP-201)) or in-combination (para. 254 of the Information for HRA (doc. 5.3; APP-201)). However, for the in-combination assessment, the Applicants own calculations indicate that there will be a decrease in the SPA kittiwake population of around 16% in the lifetime of the project.* The RSPB made reference in this statement (and others in the same document) to the counterfactuals of population size (CPS). This is a measure of the relative size of the impacted population compared to the unimpacted population at the end of the simulation period (in this case 30 years). This is not the same as a decrease in population size (as stated above by the RSPB and throughout REP2-096) which the Applicant considers to imply a decrease relative to the current size. It was this aspect which lead the Applicant to suggest that the RSPB appeared to have misinterpreted the population model outputs. In the RSPB's submission dated 21st January 2020, a detailed description of the CPS was presented which matches the Applicant's understanding of this measure (as summarised above). While this confirms the RSPB's understanding of the methods involved it does not address the fact that the Applicant considers the phrasing used by the RSPB in REP2-096 was potentially misleading in this respect and this is the aspect that the Applicant identified. The Applicant welcomed the RSPB's confirmation and agreement that this is not what the CPS represents, however the RSPB, rather than acknowledging that their phrasing was potentially misleading have suggested that the Applicant is making a semantic point. However, the Applicant considers it

		important to be as clear as possible in describing such technical matters and that the avoidance of potentially ambiguous statements should be a priority for all parties. Furthermore, the results referred to by the RSPB in REP2-096 were derived from the density independent PVA models. These models permit unlimited population growth which is biologically unrealistic (but preferred by the RSPB and Natural England). Thus, the comparison is between populations which grow exponentially with the consequence that very large differences can occur between the impacted and non-impacted after a simulated growth period of 30 years. The fact that the impacted population is predicted to be, for example, 16% smaller after 30 years, does not mean there will be a 16% decline: both populations may in fact have increased, albeit at different rates, which generates the differences in size reported. Further details on this and other points made by the RSPB in their representation (dated 20th January[2]) will be submitted by the Applicant at Deadline 5. The Applicant also welcomed Natural England's agreement with the Applicant's interpretation.
	iii. To understand from NE what its view is regarding the Applicant's assessments provided at D2, and whether there is agreement on no AEOI for each SPA.	This question was directed at Natural England but the Applicant also outlined its understanding of the situation. Natural England's preliminary responses were provided to the Applicant on the 9th January 2020 (and the Applicant understands this response will be included in Natural England's Deadline 4 submission). This response includes consideration of points made on precaution and assessment methods, however no comments were included on the conclusions of the assessment. At Deadline 5 the Applicant will provide detailed comments and responses to Natural England's Deadline 4 submission. In advance of that, and in relation to the comments on precaution the Applicant received from Natural England on the 9th January 2020, the Applicant notes that these have been discussed in detail in previous submissions. However, the key point which the Applicant has made is that while the individual components of precaution can be justified to a greater or lesser extent, it is the combination of these precautions (e.g. precautionary collision modelling, precautionary breeding season duration, precautionary apportioning rates to designated sites and precautionary population modelling) that results in an over-precautionary assessment as a whole. The Applicant considers that Natural England has to date not provided clarity on their position with respect to the accumulation of precaution through the assessment. With respect to the assessment methods used in the Deadline 2 ornithology update (REP2-035), the Applicant welcomed the detailed response from Natural England which listed all of the requests that have now

[2] https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010087/EN010087-001564-RSPB%20-%20Comments%20on%20Boreas%20Offshore%20Ornithology%20Assessment%20Update.pdf

		been included in the Norfolk Boreas updated offshore ornithology assessment and consider that, with the exception of collision estimates for the Dogger Bank Creyke Beck wind farm (use of the consented values, rather than the Non-material change update, which will be included in the update at Deadline 6, see below) there are no further methodological updates required. The Applicant also noted that Natural England highlighted in their submissions that while they will not be able to rule out some cumulative impacts and adverse effect on integrity (AEoI) for the project in-combination with other plans or projects at this stage, this is not expected to be the case for the project alone. Therefore the Applicant understands that Natural England is in agreement that there are no project alone significant impacts and no project alone AEoI. Furthermore, this conclusion does not include allowance for the additional impact mitigation that the Applicant is proposing (an increase in rotor draught height by at least 5m from 22m above HAT to a minimum of 27m above HAT).
b) Collision Risk Modelling		
	N/A	With respect to collision risk modelling, the Applicant provided the ExA with an update on the status of the Marine Scotland stochastic collision risk model (sCRM). At the previous offshore ornithology issue specific hearing the Applicant noted that there were outstanding concerns with the sCRM as it generated different mean estimates to those obtained using the deterministic Band model. This aspect was addressed by the model developer, however while running further tests on the sCRM the Applicant identified a difference in how the sCRM and deterministic Band model utilise seabird flight height data and this can result in different mean predictions. This difference has been brought to the attention of Marine Scotland and the sCRM developer as well as representatives of the statutory nature conservation bodies (SNCBs) including Natural England. Natural England has advised that as a consequence of this the SNCBs intend to produce a guidance note on use of the sCRM, however as this is not expected to be available in the time frame of the Norfolk Boreas examination, Natural England had agreed that all collision risk modelling for the project should continue to be undertaken using the deterministic Band model, with uncertainty presented through the use of upper and lower confidence estimates from seabird density data.
	i. To understand the need, or otherwise, for PVA for little gull of Greater Wash SPA.	The Applicant noted that Natural England had made no request for a little gull PVA. Furthermore the predicted project alone mortality for the Greater Wash SPA population was 0.5 individuals. As discussed in REP2-035, this is below the 1% threshold of detectability and therefore there is no risk of an adverse effect on the SPA integrity. The in-combination impact was assessed as between 5 and 8 individuals. The designated SPA population is 1,255, but this is part of a regional population of between 10,000 and 75,000. For the most precautionary combination, using the smallest (worst-case) regional population of 10,000 and the higher mortality figure (8, derived from figures for the consented wind farm designs) this could increase background mortality by 3.2%, while for a slightly less precautionary population estimate of 20,000 and the lower mortality value (5, equating to built wind farm designs, see REP2-035 for further explanation) the increase in mortality would be 1% and for the population of 75,000 the worst case mortality would equate to a 0.4% increase in mortality. The Applicant also noted that an in-combination mortality of 7 (i.e. almost exactly the same level of

		mortality for Norfolk Boreas), as predicted for the Triton Knoll NMC was considered by the SoS not to result in AEoI on the basis that: "*Such a small impact would be undetectable in the SPA population."* On this basis the Applicant concluded there would be no risk of an AEoI for the project alone or in-combination and believes that Natural England has also agreed that there is no in-combination AEoI for this species (while noting that little gull collisions are not available for all wind farms which could contribute to the total).
	ii. To understand whether a range-based approach to CRM for flight height estimates is appropriate.	The Applicant noted that this question is a reference to Natural England's comments in their relevant representation (RR-099) that option 1 collision modelling figures should be presented alongside the option 2 figures which are used in the assessment of impacts. The Applicant has discussed this with Natural England and agreed that because the estimates of seabird flight height provided by digital aerial survey companies is (by their own admission) unreliable, the Applicant would present collisions calculated using site specific flight height estimates as provided to the Applicant by the survey contractor, but that these would not be used in the impact assessment. Instead the assessment is based on Band model option 2 which uses seabird flight height estimates calculated by the British Trust for Ornithology (BTO; Johnston et al. 2014a,b) from a large dataset of flight height observations. The option 2 collision estimates presented by the Applicant in the original application gave upper and lower 95% confidence intervals for seabird density, avoidance rate and flight height. These outputs have revealed that the greatest range is obtained from the seabird densities, and Natural England refer to these in their consideration of the assessment. Consequently for the Deadline 2 submission, the upper and lower collision risk estimates presented were those derived from seabird densities, and it is proposed that the same approach will be taken for future submissions.
	iii. To explore whether as-built or consented wind farms should be considered for in-combination effects.	The Applicant explained that it had been considering the issue of headroom and, in doing so, a further point had arisen. This is that it is not just *consented* figures which have been used in the collision risk model. It had become apparent that in some cases the worst case *assessment* figures have been used, as opposed to the figures which are relevant to the *consented* schemes. Therefore there are two tiers to the headroom submission: • assessed versus consented; and • consented versus as-built. On the matter of assessed versus consented, the Applicant had identified three projects where the worst case assessed figures as opposed to the consented figures have been used and which are of particular relevance to the current assessment. In each case either the original Development Consent Order, or a non-material change, or a section 36 variation has reduced the parameters in the consent from what was originally assessed as the worst case. Therefore as for the East Anglia ONE decision, which was discussed at the previous hearing, the Applicant's position is that it is without doubt that headroom has been created by those

		three projects and that such headroom is "legally secured". The only question then is how much headroom exists, the extent to which this can be agreed with Natural England and, if so, how that affects the conclusions for in-combination collision risk assessment. The three projects identified of relevance in this particular case were Hornsea One, Triton Knoll and Race Bank. On consented versus as-built, there are a number of reasons why the Applicant considered that the as-built scheme (and its associated parameters) is "legally secured". This is partly due to the way in which the deemed marine licence (DML) conditions require approval of final layouts and certification of final layouts on completion of construction. In essence the Applicant's submission is no different to the MMO's and Natural England's recent (draft) advice on cable protection, that new areas of cable protection cannot be installed following certification that construction has completed. This is not least because in the 8 cases which the Applicant had so far considered, the age of the environmental information is now in excess of seven years. As Natural England states in their recent position statement on new areas of cable protection, environmental information which is more than five years old would be considered out of date and updated environmental information would be required. This includes any requirement for a further Habitats Regulation Assessment, which would therefore amount to a material change requiring a fresh consent. To illustrate this point further the Crown Estate recently launched an application process for wind farms to apply for extensions. Some of the extensions being taken forward relate to projects which the Applicant has identified as having headroom between the consented and as-built figures. However there is no suggestion that those projects will build out under an existing consent. In fact the Crown Estate's plan level appropriate assessment noted that a separate appropriate assessment, and therefore a new application, would need to be undertaken for each project. In summary, the Applicant's position is that it is without doubt that there is legally secured headroom between the assessed and consented figures. In addition the Applicant's position is that it would be irrational for Natural England and the MMO not to accept that "legally secured" headroom exists between the consented and the as-built projects given their respective positions and previous advice on new areas of cable protection. As such, the only remaining question, and the Applicant acknowledged that this is a significant question, is the extent to which headroom can be modelled and the figures agreed with Natural England, such that it can be taken into account in in-combination assessments to reduce the current level of in-combination impact. Finally, in accordance with Action Point 14, the Applicant has provided a worked example of how headroom can be modelled using Hornsea Project One at Appendix 4 of this note. This considers the difference between the 'assessed' and 'consented' and between 'consented' and 'as-built' figures for Hornsea Project One.. Once the principle is agreed, the Applicant can therefore gather data to provide examples of collision

		risks between the assessed .v. consented collision numbers for Triton Knoll, and Race Bank (noting that it may not be possible to recalculate Race Bank using this method in view of the different collision model used).
c) Level of precaution in the assessment		
	i. To consider the arguments relating to precaution and the conclusions drawn from applying density dependence, and the Applicant's conclusion of no AEOI even when applying precaution.	The Applicant summarised its concerns about precaution in the ornithological assessment as follows. The key point is that while individual components of precaution are generally justified and reasonable in isolation, it is the accumulation of these at various stages in the impact assessment that results in the overall conclusions being based on an assessment which is over-precautionary. The Applicant presented a detailed discussion of this in its deadline 2 submission (REP2-035) and Natural England has provided a response to the Applicant on the 9th January (and the Applicant understands this response will be included in Natural England's Deadline 4 submission) which addresses their reasons for applying precaution to the individual elements, however the Applicant considers that Natural England has not provided a response on this accumulation aspect and therefore the Applicant maintains their position that the conclusions are over-precautionary. The Applicant's example of this for collision risk is as follows: • Collisions are predicted with ranges for uncertain/variable parameters (e.g. nocturnal activity, seabird density, flight heights, etc.). The justification for most of these are considered to be appropriate, although some, such as flight speed and nocturnal activity are probably overestimated. • Breeding seasons connectivity to Special Protection Areas (SPAs) is then based on the higher rates derived from available evidence (for example the Applicant presented evidence that this should be 26% for kittiwake from the Flamborough and Filey Coast SPA, while Natural England has estimated this could be up to 100% and advised (using the same data sources) that this should be 86%). • The months defined as the breeding season vary for different species but can be defined as the core period and the full period, the latter of which overlaps with periods when some birds recorded in offshore surveys are migrating through to or from colonies further north. As a consequence the early and late months almost certainly include an unknown but probably substantial (site depending) proportion of birds migrating to other colonies. However, this is not taken into account in the methods for assessment advised by Natural England and it is assumed that all birds in these shoulder months are ones from the focal SPA. • All of the above considerations are compounded in cumulative / in-combination assessment. In addition, cumulative and in-combination assessment also include over-estimation of impacts for other wind farms which derives from the reduction in impacts due to reduced design envelopes which typically occurs along the route from assessed to consented to built wind farms. • The total mortalities as derived through the above process are then assessed using density independent population models. Although there can be circumstances when density dependent models are more precautionary, for the populations of current interest, these aspects are considered very unlikely to be applicable and therefore it is reasonable to state that the density independent

		population models used generate precautionary predictions of impact consequence (i.e. the predicted population effects are larger than those obtained when density dependent regulation is included). • Overall therefore, the Applicant's concern is that in an effort to ensure uncertainty is reflected in precautionary assessment, the individual elements of precaution as advised by Natural England, are combined without due consideration for the accumulation of precaution and the unrealistically over-precautionary conclusions that are consequently obtained.
AGENDA ITEM 8 – Draft Development Consent Order		
	i. To consider the implications for the Norfolk Boreas DMLs of the proposed amendments put forward by the SoS in its letter in relation to Norfolk Vanguard in paragraphs 30-33 inclusive [REP3-012].	Cable Exposure Timeframe • The Applicant confirmed it was content to amend the dDCO at Condition 9(12) (Schedule 9-12), Condition 4(12) (Schedule 11-12), and Condition 3(12) (Schedule 13) to accept the reduction from five days to three days to notify of any cable exposure. The Applicant has updated this wording in the dDCO submitted at Deadline 4. Lighting and Marking, and Operations and Maintenance Programme • The Applicant explained that there was no need for a Lighting and Marking Plan given that the provisions are covered by Condition 10 and 11 of the Generation DMLs (Schedule 9-10), Condition 5 and 6 of the Transmission DMLs (Schedule 11-12) and Condition 4 of the Project Interconnector DML (Schedule 13) as well as the requirements under MGN543. • The Applicant also confirmed that the Operations and Maintenance Programme is covered by Condition 14(1)(j) of the Generation DMLs (Schedule 9-10), Condition 9(1)(j) of the Transmission DMLs (Schedule 11-12) and Condition 7(1)(i) of the Project Interconnector DML (Schedule 13). • The Applicant does not therefore propose to amend the dDCO further in this regard and the Applicant understood that this was the agreed position with the MCA as demonstrated in the SoCG with the MCA (REP2-049).

APPENDIX 1: THE APPLICANT'S LIST OF APPEARANCES

1. **John Houghton**, Senior Counsel, **Womble Bond Dickinson**; and **Victoria Redman**, Partner, **Womble Bond Dickinson**
   Speaking on behalf of Norfolk Boreas Limited:
   - In response to the Examining Authority's questions and for general advocacy

2. **Victoria Cooper**, Senior Marine Heritage Consultant, Royal HaskoningDHV (**RHDHV**)
   Speaking on behalf of Norfolk Boreas Limited on:
   - Offshore archaeology

3. **Sam Westwood**, Principle Risk Analyst, **Anatec**
   Speaking on behalf of Norfolk Boreas Limited on:
   - Shipping and navigation
   - Layout of turbines and safety

4. **Sara Xoubanova**, Senior Consultant **Brown and May Marine Ltd**;
   Speaking on behalf of Norfolk Boreas Limited on:
   - Impacts on fishing interests
   - Fisheries Co-existence and Liaison Plan

5. **Jen Learmonth**, Senior Marine Biologist, **RHDHV**
   Speaking on behalf of Norfolk Boreas Limited on:
   - Marine mammals

6. **Rob Driver**, Offshore Grid Manager, **Vattenfall**
   Speaking on behalf of Norfolk Vanguard Limited on:
   - Offshore construction, design and physical processes

7. **David Tarrant**, Senior Environmental Consultant, **RHDHV**
   Speaking on behalf of Norfolk Boreas Limited on:
   - Marine ecology
   - Benthic ecology and HHW SAC Site Integrity Plan
   - HRA implications

8. **Charlotte Johnston**, Principal Consultant **Crangon Ltd**
   Speaking on behalf of Norfolk Boreas Limited on:
   - Benthic ecology (Annex I *Sabellaria* reef)

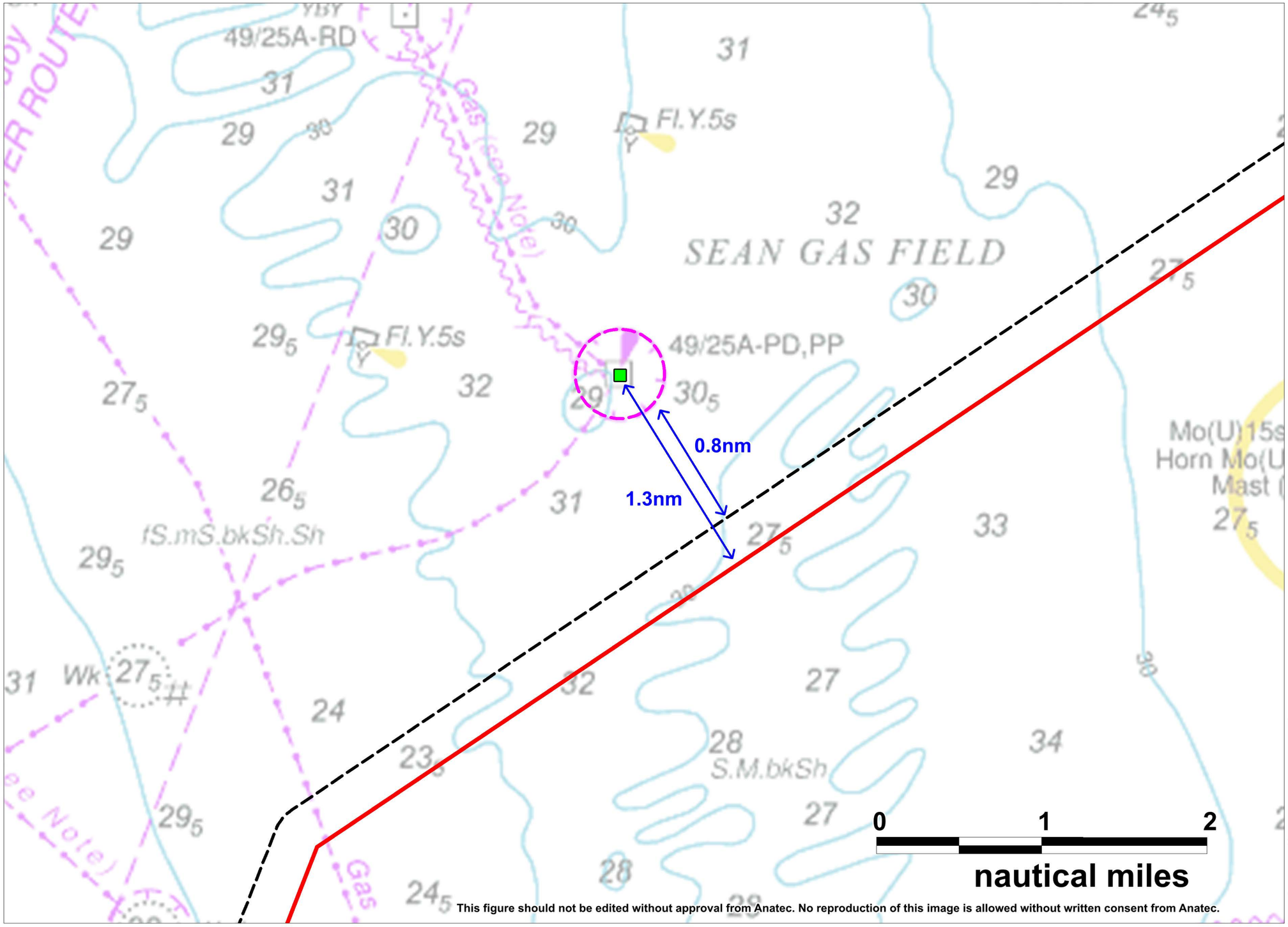
9. **Jen Learmonth**, Senior Marine Mammal Consultant, **RHDHV**
   Speaking on behalf of Norfolk Boreas Limited on:
   - Marine mammals

10. **Mark Trinder**, Principal Ornithologist, **McArthur Green Limited**.
    Speaking on behalf of Norfolk Boreas Limited on:
    - Offshore ornithology

11. **Jake Laws**, Consents Manager, **Vattenfall**
    Speaking on behalf of Norfolk Boreas Limited on:
    - Any other matters including project updates (if necessary).

APPENDIX 2

FIGURE 1: SEAN FIELD



Site Boundaries

- Norfolk Boreas Site
- 500m Buffer

Sean

- Sean Complex (PD, PP)
- 500m Safety Zone

PROJECT NAME
A4417 Norfolk Boreas

FIGURE TITLE
Sean Complex Overview

REVISION: REV 00

DATE: 22/01/2020

anatec

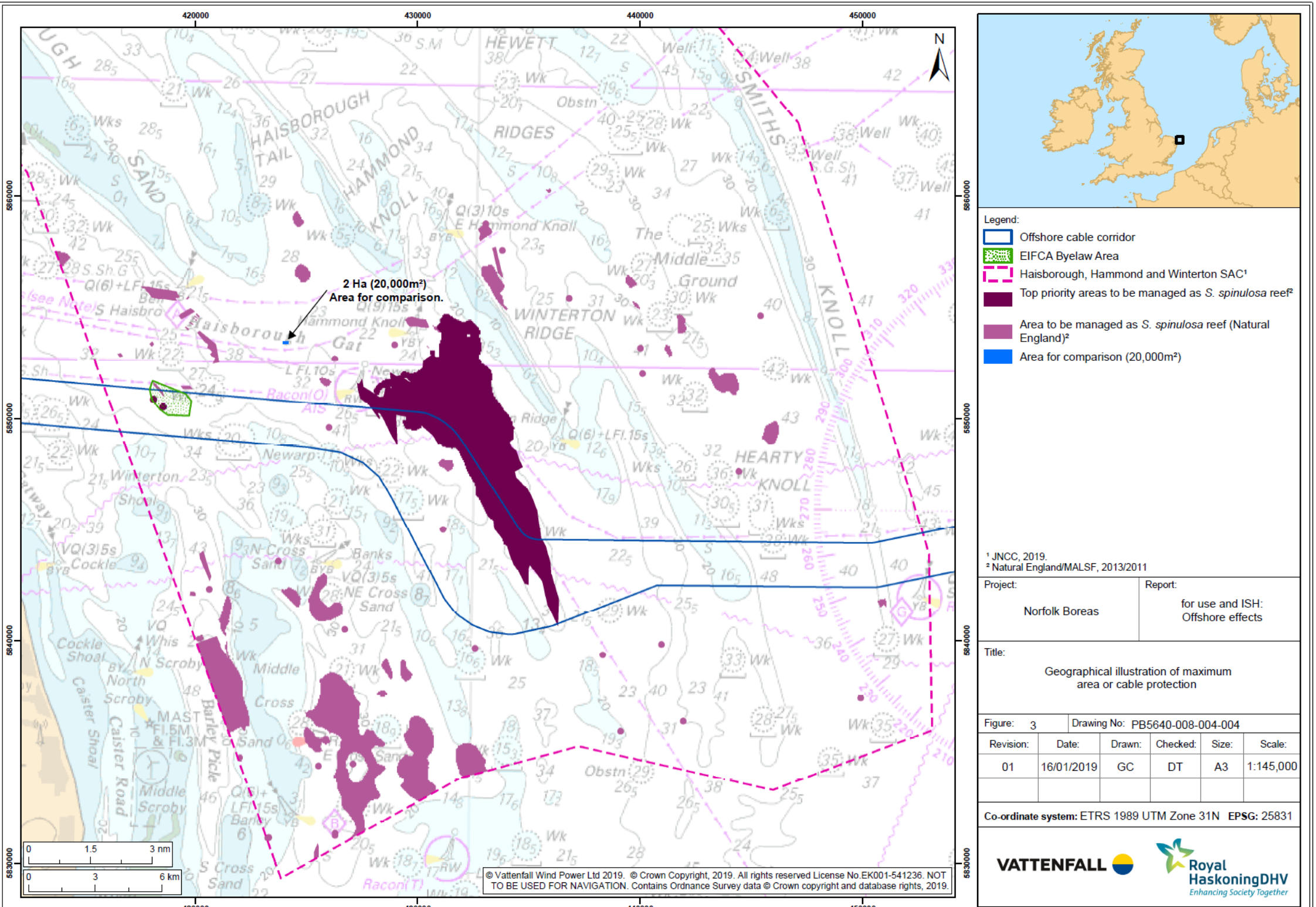
CO-ORDINATE SYSTEM
Mercator WGS84

DRAWN: DS

CHECKED: SW

APPENDIX 3

FIGURE 2: GEOGRAPHICAL ILLUSTRATION OF MAXIMUM AREA OF CABLE PROTECTION



Legend:

- Offshore cable corridor
- EIFCA Byelaw Area
- Haisborough, Hammond and Winterton SAC[1]
- Top priority areas to be managed as *S. spinulosa* reef[2]
- Area to be managed as *S. spinulosa* reef (Natural England)[2]
- Area for comparison (20,000m²)

[1] JNCC, 2019.
[2] Natural England/MALSF, 2013/2011

Project:	Report:
Norfolk Boreas	for use and ISH: Offshore effects

Title: Geographical illustration of maximum area or cable protection

Figure: 3 | Drawing No: PB5640-008-004-004

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
01	16/01/2019	GC	DT	A3	1:145,000

Co-ordinate system: ETRS 1989 UTM Zone 31N **EPSG:** 25831

VATTENFALL

Royal HaskoningDHV
Enhancing Society Together

APPENDIX 4

HEADROOM EXAMPLE

1.1 To illustrate the effect on collision estimates of using built vs. assessed or consented wind farm designs, the following comparison has been conducted for the Hornsea One wind farm using kittiwake as an example.

1.2 The original Hornsea Project One application (ES) was based on 332 3.6MW turbines, and consent was granted for up to 240 5MW turbines. It was stated in Smart Wind (2014)[3] that this reduced collision risks for gannet and kittiwake by 13%, however as far as the Applicant has been able to determine, no updated collision modelling was submitted in to the Hornsea Project One examination. In 2016 a Non-material change (NMC) application[4] was submitted (and subsequently approved) which proposed maximum turbine numbers of either 203 (6MW), 174 (7MW) or 152 (8MW), depending on which turbine was selected. Each of these achieved the generating limit of 1200MW (amended to 1218MW, as set out in the NMC). The wind farm has now completed construction using 7MW turbines, and therefore 174 turbines have been installed.

1.3 Using the collision modelling update method developed by MacArthur Green for The Crown Estate[5] it is straightforward to update the original collision predictions using the 'common currency' excel spreadsheet. This tool recalculates collision mortality using three pieces of information: the assessed (or consented) wind farm parameters and associated collision mortalities and the revised (consented or built) turbine parameters. This process avoids the requirement to re-run the collision model and therefore removes the need to obtain the complete set of input data (seabird densities, etc.) from the wind farm applications.

1.4 Table 1 below presents a summary of the collision estimates which demonstrate that the Hornsea Project One kittiwake collisions to be used in cumulative and in-combination assessments should be reduced to correspond with the built wind farm (174 x 7MW turbines) rather than the current figures which corresponds to the assessed design (332 x 3.6MW). The reduction in annual kittiwake EIA collisions obtained for Hornsea Project One from the assessed to consented designs is 13%, as noted above, and from assessed to as built is 43%, a reduction in mortality of 52, from 123 to 71. The equivalent reduction for birds apportioned to the FFC SPA from Hornsea Project One is from 41 to 24.

[3] Smart Wind (2014) Hornsea Offshore Wind Farm Project One The Applicant's Written Response to Deadline V Application Reference: EN010033 14 May 2014

[4] Hornsea Project One Name Plate Capacity And Limit Of Deviation Work Area Dco Amendments Supporting Statement. https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010033/EN010033-002874-DONG%20Energy%20HOW01%20DCO%20Amendments%20Supporting%20Statement

[5] Trinder, M 2017. Estimates of Ornithological Headroom in Offshore Wind Farm Collision Mortality. Unpublished report to The Crown Estate (submitted as Appendix 43 to Deadline I submission Hornsea Project Three: https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010080/EN010080-001095-DI_HOW03_Appendix%2043.pdf)

Table 1: Assessed versus built Hornsea Project One Wind Turbine Generators (WTGs) and impact on kittiwake

Impact scale	Assessed WTGs	Consented WTGs	Built WTGs	Assessed kittiwake CRM	Consented kittiwake CRM (estimated as 13% reduction from assessed)	Built kittiwake CRM	Headroom (reduction from assessed to built), number and percentage
EIA	332	240	174	123	*107*	71	52 (43%)
HRA				41	*36*	24	17 (41%)

1.5 Furthermore, similar declines can be obtained for other wind farms, and these can be calculated with readily available data on turbine designs and mortality estimates using the tool developed for this purpose (the validity of this method is demonstrated in Annex 1), rather than needing to extract the original input parameters which can be difficult to obtain for older wind farm projects (and sometimes were not included).

1.6 Thus, once legal certainty can be obtained regarding a wind farm's built design, following the submissions made by the Applicant under Agenda Item 7(b)(iii), collision estimates can be quickly and easily updated for use in cumulative and in-combination assessment.

Annex 1

Hornsea 1 CRM calculations – demonstration of revisions to collision estimates

1. To demonstrate the difference in collision mortality obtained for a wind farm's built design compared to its assessed one, data and calculations for the Hornsea Project One wind farm are presented below. This has focussed on EIA kittiwake, but similar results are obtained for all species. The source data from SmartWind (2013)[6] were obtained from application documents (copied below) and used as inputs to the Band collision model.

2. Seabird density data are presented in Table C.164, assessed wind farm data in Table C.133 and the associated collision predictions for the assessed wind farm in Table C.169.

[6] Hornsea Offshore Wind Farm Project One Environmental Statement Volume 5 – Offshore Annexes Chapter 5.5.1 Ornithology Technical Report PINS Document Reference: 7.5.5.1 APFP Regulation 5(2)(a) July 2013 https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010033/EN010033-000566-7.5.5.1%20Ornithology%20Technical%20Report.pdf

Results Years 1 and 2 sub-zone 1

Table C.164 Densities of flying birds at Hornsea sub-zone 1 development area between March 2010 and February 2012. Data gathered during ship-based surveys.

Species	Density (birds/km2) Jan	Density (birds/km2) Feb	Density (birds/km2) Mar	Density (birds/km2) Apr	Density (birds/km2) May	Density (birds/km2) Jun	Density (birds/km2) Jul	Density (birds/km2) Aug	Density (birds/km2) Sep	Density (birds/km2) Oct	Density (birds/km2) Nov	Density (birds/km2) Dec
Fulmar	0.19	0.07	0.29	0.04	0.24	0.41	0.23	0.11	0.10	0.04	0.04	0.00
Gannet	0.24	0.07	0.43	0.07	0.03	0.02	0.07	0.14	0.18	0.35	0.55	0.04
Kittiwake	0.34	0.36	0.49	0.19	0.07	0.71	1.27	0.69	0.77	0.34	0.88	0.24
Little Gull	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	2.62	0.25	0.00
Common Gull	0.02	0.03	0.01	0.03	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.01
Great Black-backed Gull	0.22	0.11	0.13	0.05	0.04	0.01	0.05	0.05	0.22	0.03	0.13	0.15
Lesser Black-backed Gull	0.02	0.00	0.00	0.03	0.07	0.07	0.11	0.10	0.02	0.00	0.00	0.03
Herring Gull	0.01	0.02	0.04	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.02	0.09
Large gulls combined	0.25	0.13	0.17	0.09	0.12	0.07	0.16	0.15	0.24	0.03	0.16	0.27
Common Tern	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.01	0.33	0.06	0.00	0.00
Arctic Tern	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.06	0.00	0.01	0.00	0.00
Guillemot	0.57	0.23	0.38	0.03	0.07	0.04	0.10	0.00	0.07	0.07	0.13	0.33
Razorbill	0.27	0.03	0.22	0.09	0.01	0.05	0.08	0.00	0.02	0.16	0.08	0.03
Guillemot/Razorbill	0.84	0.26	0.60	0.12	0.08	0.09	0.18	0.00	0.09	0.22	0.21	0.36
Common/Arctic Terns combined	0.00	0.00	0.00	0.00	0.10	0.02	0.00	0.07	0.33	0.07	0.00	0.00
Arctic Skua	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00
Great Skua	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00

Table C.133 Parameters used in collision rate modelling, for two wind farm variants at Hornsea project 1.

Variant	Number of blades	Rotation speed (rpm)	Rotor radius (m)	Minimum rotor height	Maximum blade width (m)	Pitch (°)	Number of turbines	Latitude (DD)
332 x 3.6MW	3	13.0	60	22	4.2	15[1]	332	53.89
150 x 8MW	3	11.9	89	22	5.9	15[1]	150	53.89

[1] *Data based on nominal value.*

Table C.169 Results of collision rate monitoring for Hornsea sub-zone 1 development area between March 2010 and February 2012. Potential number of collisions assuming an avoidance rate of 99%.

332 x 3.6MW

Species	Collisions per month with avoidance rate 0.99 Jan	Collisions per month with avoidance rate 0.99 Feb	Collisions per month with avoidance rate 0.99 Mar	Collisions per month with avoidance rate 0.99 Apr	Collisions per month with avoidance rate 0.99 May	Collisions per month with avoidance rate 0.99 Jun	Collisions per month with avoidance rate 0.99 Jul	Collisions per month with avoidance rate 0.99 Aug	Collisions per month with avoidance rate 0.99 Sep	Collisions per month with avoidance rate 0.99 Oct	Collisions per month with avoidance rate 0.99 Nov	Collisions per month with avoidance rate 0.99 Dec	TOTAL COLLISIONS PER YEAR WITH AVOIDANCE RATE OF 0.99
Fulmar	0	0	0	0	0	0	0	0	0	0	0	0	0
Gannet	6	2	12	2	1	1	2	5	5	10	13	1	60
Kittiwake	5	5	9	3	1	14	25	13	13	6	14	4	112
Little Gull	0	0	0	0	0	0	0	0	0	4	0	0	5
Common Gull	1	1	0	1	0	0	0	0	0	0	0	0	3
Great Black-backed Gull	33	15	22	9	8	2	9	9	37	4	20	22	188
Lesser Black-backed Gull	2	0	0	3	7	7	11	10	2	0	0	3	45
Herring Gull	1	4	7	1	2	0	0	0	0	0	4	14	32
Large gulls combined	27	13	21	11	16	10	21	19	29	3	17	29	216
Common Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Tern	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot	0	0	0	0	0	0	0	0	0	0	0	0	0
Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Guillemot/Razorbill	0	0	0	0	0	0	0	0	0	0	0	0	0
Common/Arctic Terns combin	0	0	0	0	0	0	0	0	0	0	0	0	0
Arctic Skua	0	0	0	0	0	0	0	0	0	0	0	0	0
Great Skua	0	0	0	0	0	0	0	0	0	0	0	0	0

150 x 8MW

TOTAL

3. It can be seen that the assessed annual collision prediction for kittiwake (Table C.169) at an avoidance rate of 99% was 112 (note that the current kittiwake avoidance rate of 98.9% was not presented, but multiplying 112 by ((1-0.0989)/(1-0.99)) updates this to an avoidance rate of 98.9% = 123).

4. Using the input data in Tables C.133 and C.164) the following values were entered into the Band excel collision model.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	**COLLISION RISK ASSESSMENT**			used in overall collision risk sheet								used in available hours sheet				
2	**Sheet 1 – Input data**			used in migrant collision risk sheet								used in large array correction sheet				
3				used in single transit collision risk sheet or extended model								not used in calculation but stated for reference				
4																
5		**Units**	**Value**		**Data sources**											
6	**Bird data**															
7	Species name		**Kittiwake**													
8	Bird length	m	0.39													
9	Wingspan	m	1.08													
10	Flight speed	m/sec	13.1													
11	Nocturnal activity factor (1-5)		3													
12	Flight type, flapping or gliding		flapping													
13					**Data sources**											
14	**Bird survey data**			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
15	Daytime bird density	birds/sq km		0.34	0.36	0.49	0.19	0.07	0.71	1.27	0.69	0.77	0.34	0.88	0.24	
16	Proportion at rotor height	%	3.7%													
17	Proportion of flights upwind	%	50.0%													
18					**Data sources**											
19	**Birds on migration data**															
20	Migration passages	birds		0	0	0	0	0	0	0	0	0	0	0	0	
21	Width of migration corridor	km	8													
22	Proportion at rotor height	%	75%													
23	Proportion of flights upwind	%	50.0%													
24		**Units**	**Value**		**Data sources**											
25	**Windfarm data**															
26	Name of windfarm site		**H1**													
27	Latitude	degrees	53.89													
28	Number of turbines		332													
29	Width of windfarm	km	38													
30	Tidal offset	m	0													
31		**Units**	**Value**		**Data sources**											
32	**Turbine data**															
33	Turbine model		**5MW turbine**													
34	No of blades		3													
35	Rotation speed	rpm	13													
36	Rotor radius	m	60													
37	Hub height	m	82	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
38	Monthly proportion of time operational	%		85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	
39	Max blade width	m	4.200													
40	Pitch	degrees	15													
41																
42																
43	**Avoidance rates used in presenting results**		95.00%													
44			98.90%													
45			99.00%													
46			99.50%													
47																
48																

5. Collision results were obtained as below.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	**COLLISION RISK ASSESSMENT**																		
2	**Sheet 2 – Overall collision risk**			**All data input on Sheet 1:**						from Sheet 1 - input data									
3				**no data entry needed on this sheet!**						from Sheet 6 - available hours									
4	Bird details:									from Sheet 3 - single transit collision risk									
5		Species		Kittiwake						from survey data									
6		Flight speed	m/sec	13.1						calculated field									
7		Nocturnal activity factor (1-5)		3															
8		Nocturnal activity (% of daytime)		50%															
9	Windfarm data:																		
10		Latitude	degrees	53.9															
11		Number of turbines		332															
12		Rotor radius	m	60															
13		Minimum height of rotor	m	82															
14		Total rotor frontal area	sq m	3754832															
15					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		**year average**	
16		Proportion of time operational	%		85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%		85.0%	
17																			
18	**Stage A – flight activity**																		
19		Daytime areal bird density	birds/sq km		0.34	0.36	0.49	0.19	0.07	0.71	1.27	0.69	0.77	0.34	0.88	0.24			
20		Proportion at rotor height	%	3.7%															
21		Total daylight hours per month	hrs		249	272	366	420	494	510	513	461	383	329	259	233			
22		Total night hours per month	hrs		495	400	378	300	250	210	231	283	337	415	461	511			
23		Flux factor			249122	250861	401373	#####	63929	644562	1177903	613278	626636	269139	635672	172966			
24																			
25	**Option 1 –Basic model – Stages B, C and D**																	**per annum**	
26		Potential bird transits through rotors			9218	9282	14851	5911	2365	23849	43582	22691	23186	9958	23520	6400		**194813**	
27		Collision risk for single rotor transit	(from sheet 3)	6.7%															
28		Collisions for entire windfarm, allowing for non-op time, assuming no avoidance	birds per month or year		**525**	**529**	**846**	**337**	**135**	**1359**	**2484**	**1293**	**1321**	**568**	**1340**	**365**		**11103**	
29																			
30	**Option 2–Basic model using proportion from flight distribution**				**1373**	**1383**	**2213**	**881**	**352**	**3554**	**6494**	**3381**	**3455**	**1484**	**3505**	**954**		**29028**	
31																			
32	**Option 3–Extended model using flight height distribution**			Gannet															
33		Proportion at rotor height	(from sheet 4)	9.7%															
34		Potential bird transits through rotors	Flux integral	0.0516	12847	12937	20699	8239	3297	33240	60744	31627	32315	13879	32781	8920		**271525**	
35		Collisions assuming no avoidance	Collision integral	0.00194	**411**	**414**	**662**	**264**	**106**	**1064**	**1944**	**1012**	**1034**	**444**	**1049**	**285**		**8689**	
36		Average collision risk for single rotor transit		3.8%															
37																			
38	**Stage E – applying avoidance rates**																		
39		Using which of above options?	**Option 1**	0.00%	525	529	846	337	135	1359	2484	1293	1321	568	1340	365		**11103**	
40																			
41	Collisions assuming avoidance rate		birds per month or year	95.00%	26	26	42	17	7	68	124	65	66	28	67	18		**555**	
42				98.90%	6	6	9	4	1	15	27	14	15	6	15	4		**122**	
43				99.00%	5	5	8	3	1	14	25	13	13	6	13	4		**111**	
44				99.50%	3	3	4	2	1	7	12	6	7	3	7	2		**56**	
45																			
46	Collisions after applying large array correction			95.00%	26	26	42	17	7	68	124	65	66	28	67	18		**555**	
47				98.90%	6	6	9	4	1	15	27	14	15	6	15	4		**122**	
48				99.00%	5	5	8	3	1	14	25	13	13	6	13	4		**111**	
49				99.50%	3	3	4	2	1	7	12	6	7	3	7	2		**56**	
50																			
51																			

6. As can be seen above, the annual kittiwake collisions at an avoidance rate of 99% (cell R43 above) is 111, which compares with the assessed figure of 112 above (this difference is expected to be due to rounding variations, since the input data were only presented to two decimal places) and at 98.9% (cell R42) the mortality is 122.

7. To estimate the built wind farm collisions, the Band spreadsheet was then updated using the turbine parameters presented in the Hornsea Project One NMC which correspond to the built wind farm (174 x 7 MW); Table 1.3 below.

Table 1.2: The three defined turbine scenarios based upon the numbers allowed under the DCO and the parameters that would have been used at the time of the DCO (note, of these options only the 8MW turbine was actually presented for the purposes of the DCO)

Parameter	6 MW	7 MW	8 MW
No. of turbines	200	171	150
Rotation speed (m/s)	11	10.5	10.2
Rotor radius (m)	77	86	89
Hub height (m)	98.45 (HAT)	107.45 (HAT)	110.45 (HAT)
Monthly proportion of time operational (%) (all months)	85	85	85
Blade width (m)	5	5.4	5.4
Pitch (°)	10	3	3

Table 1.3: Updated turbine parameters for the three defined turbine scenarios (bold text indicates where parameters differ from those presented in Table 1.2)

Parameter	6 MW	7 MW	8 MW
No. of turbines with the increase in name plate capacity	**203**	**174**	**152**
Rotation speed (m/s)	11	10.5	10.2
Rotor radius (m)	77	**77**	89
Hub height (m)	**98.35 (HAT)**	**113.99 (HAT)**	**110.35 (HAT)**
Monthly proportion of time operational (%) (all months)	85	85	85
Blade width (m)	5	**5**	5.4
Pitch (°)	**3**	3	3

8. The updated Band spreadsheet calculation, using the 7MW turbine parameters from table 1.3 above are presented below.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	**COLLISION RISK ASSESSMENT**			used in overall collision risk sheet								used in available hours sheet				
2	**Sheet 1 – Input data**			used in migrant collision risk sheet								used in large array correction sheet				
3				used in single transit collision risk sheet or extended model								not used in calculation but stated for reference				
4																
5		**Units**	**Value**		**Data sources**											
6	**Bird data**															
7	Species name		**Kittiwake**													
8	Bird length	m	0.39													
9	Wingspan	m	1.08													
10	Flight speed	m/sec	13.1													
11	Nocturnal activity factor (1-5)		3													
12	Flight type, flapping or gliding		flapping													
13					**Data sources**											
14	**Bird survey data**			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
15	Daytime bird density	birds/sq km		0.34	0.36	0.49	0.19	0.07	0.71	1.27	0.69	0.77	0.34	0.88	0.24	
16	Proportion at rotor height	%	3.7%													
17	Proportion of flights upwind	%	50.0%													
18					**Data sources**											
19	**Birds on migration data**															
20	Migration passages	birds		0	0	0	0	0	0	0	0	0	0	0	0	
21	Width of migration corridor	km	8													
22	Proportion at rotor height	%	75%													
23	Proportion of flights upwind	%	50.0%													
24		**Units**	**Value**		**Data sources**											
25	**Windfarm data**															
26	Name of windfarm site		**H1**													
27	Latitude	degrees	53.89													
28	Number of turbines		174													
29	Width of windfarm	km	38													
30	Tidal offset	m	0													
31		**Units**	**Value**		**Data sources**											
32	**Turbine data**															
33	Turbine model		**7MW**													
34	No of blades		3													
35	Rotation speed	rpm	10.5													
36	Rotor radius	m	77													
37	Hub height	m	113.99	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
38	Monthly proportion of time operational	%		85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	
39	Max blade width	m	5.000													
40	Pitch	degrees	3													
41																
42																
43	**Avoidance rates used in presenting results**		95.00%													
44			98.90%													
45			99.00%													
46			99.50%													

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	**COLLISION RISK ASSESSMENT**																		
2	**Sheet 2 – Overall collision risk**			**All data input on Sheet 1:**						from Sheet 1 – input data									
3				**no data entry needed on this sheet!**						from Sheet 6 – available hours									
4	Bird details:									from Sheet 3 – single transit collision risk									
5		Species		Kittiwake						from survey data									
6		Flight speed	m/sec	13.1						calculated field									
7		Nocturnal activity factor (1-5)		3															
8		Nocturnal activity (% of daytime)		50%															
9	Windfarm data:																		
10		Latitude	degrees	53.9															
11		Number of turbines		174															
12		Rotor radius	m	77															
13		Minimum height of rotor	m	113.99															
14		Total rotor frontal area	sq m	3241011															
15					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		**year average**	
16		Proportion of time operational	%		85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%		85.0%	
17																			
18	**Stage A – flight activity**																		
19		Daytime areal bird density	birds/sq km		0.34	0.36	0.49	0.19	0.07	0.71	1.27	0.69	0.77	0.34	0.88	0.24			
20		Proportion at rotor height	%	3.7%															
21		Total daylight hours per month	hrs		249	272	366	420	494	510	513	461	383	329	259	233			
22		Total night hours per month	hrs		495	400	378	300	250	210	231	283	337	415	461	511			
23		Flux factor			167557	168727	269359	#####	42998	433526	792246	412485	421469	181020	427547	116335			
24																			
25	**Option 1 –Basic model – Stages B, C and D**																	**per annum**	
26		Potential bird transits through rotors			6200	6243	9989	3976	1591	16040	29313	15262	15594	6698	15819	4304		**131029**	
27		Collision risk for single rotor transit	(from sheet 3)	5.8%															
28		Collisions for entire windfarm, allowing for non-op time, assuming no avoidance	birds per month or year		**306**	**308**	**493**	**196**	**79**	**792**	**1447**	**753**	**770**	**331**	**781**	**212**		**6466**	
29																			
30	**Option 2–Basic model using proportion from flight distribution**				**135**	**136**	**218**	**87**	**35**	**350**	**640**	**333**	**341**	**146**	**346**	**94**		**2863**	
31																			
32	**Option 3–Extended model using flight height distribution**			Gannet															
33		Proportion at rotor height	(from sheet 4)	1.6%															
34		Potential bird transits through rotors	Flux integral	0.0516	8641	8701	13922	5542	2217	22357	40856	21272	21735	9335	22048	5999		**182625**	
35		Collisions assuming no avoidance	Collision integral	0.00194	**277**	**278**	**446**	**177**	**71**	**715**	**1307**	**681**	**696**	**299**	**706**	**192**		**5844**	
36		Average collision risk for single rotor transit		3.8%															
37																			
38	**Stage E – applying avoidance rates**																		
39		Using which of above options?	**Option 1**	0.00%	306	308	493	196	79	792	1447	753	770	331	781	212		**6466**	
40																			
41	Collisions assuming avoidance rate		birds per month or year	95.00%	15	15	25	10	4	40	72	38	38	17	39	11		**323**	
42				98.90%	3	3	5	2	1	9	16	8	8	4	9	2		**71**	
43				99.00%	3	3	5	2	1	8	14	8	8	3	8	2		**65**	
44				99.50%	2	2	2	1	0	4	7	4	4	2	4	1		**32**	
45																			
46	Collisions after applying large array correction			95.00%	15	15	25	10	4	40	72	38	38	17	39	11		**323**	
47				98.90%	3	3	5	2	1	9	16	8	8	4	9	2		**71**	
48				99.00%	3	3	5	2	1	8	14	8	8	3	8	2		**65**	
49				99.50%	2	2	2	1	0	4	7	4	4	2	4	1		**32**	
50																			

9. As can be seen above, the Band derived total kittiwake annual collisions at 99% for the built scenario (174 x 7MW) are reduced to 65 (cell R43). Adjusting this figure from the avoidance rate of 99% to the current advised kittiwake rate of 98.8% gives a value of 71 (obtained as follows: 65 x ((1-0.989)/(1-0.99))). This is the appropriate kittiwake annual collision estimate for the built Hornsea Project One wind farm which should be used in cumulative assessments in place of the 123, derived from the assessed design, which is currently used.

10. The process outlined above requires that all the necessary input parameters are provided in the project assessment which has not always been the case. An alternative method, which only requires the old and new turbine parameters and original collision estimates was developed for The Crown Estate by MacArthur Green. Snapshots from the excel file that undertakes these updates are presented below. The collision values used were those for an avoidance rate of 98.9%, 123.

11. The table below contains the input turbine parameters for the assessed turbine inputs (332 x 5MW) and the built ones, as presented in the NMC (174 x 7MW).

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1							OLD					NEW						
2	Wind farm	Status	Date of consent	Consented no. turbines (max.)	Assessed no. turbines	Assessed turbine capacity (MW)	Rotor radius (m)	Hub height (m)	Average RPM	Max blade width (m)	Average blade pitch (deg.)	Actual no. turbines	Built turbine capacity (MW)	Rotor radius (m)	Hub height (m)	Average RPM	Max blade width (m)	Average blade pitch (deg.)
22	Hornsea 1	Consented	31/12/2014	240	332	3.6	60	82	13	4.2	15	174	7	77	113.99	10.5	5	3

12. The table below shows the parameters used and the calculated 'CRM adjustment' figure (0.5824, column L) which indicates the proportional adjustment to be made to the old collisions (123) to obtain the updated mortality of 71.6.

A	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
		OLD (application)				NEW (actual)					ANNUAL CRM				
wind farm	species	no. turbines	Radius	TRF	Pcollision	no. turbines	Radius	TRF	Pcollision	CRM adjustment	old CRM	model	AR	new CRM	headroom
Hornsea 1	Kittiwake	332	60	3754831.5	0.0671	174	77	3241011.5	0.0581	0.5824	123	1	98.9	71.6	51.4

13. As demonstrated here, this figure (71.6), was obtained with much fewer data requirements and is the same as that obtained through recalculation from the original dataset (using the Band spreadsheets), thereby demonstrating the validity of this method for the purpose of updating collision estimates.