

Hornsea Offshore Wind Farm

Project Two

In-Principle Monitoring Plan - Version 2

**Appendix EE to the Response submitted for Deadline V
Application Reference: EN010053**

12 November 2015

smartwind.co.uk

Document title	In Principle Monitoring Plan
Document Reference	Appendix EE In-Principle Monitoring Plan
Status	DRAFT
Version	V2
Date	12.11.2015
Project name	Hornsea Offshore Wind Farm, Project Two
Client	SMart Wind Ltd. on behalf of Optimus Wind Limited and Breesea Limited (together the 'Applicant')

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1 INTRODUCTION

1.1 Overview of the In Principle Monitoring Plan (IPMP)

- 1.1.1 The MMO and Natural England have requested that the Applicant produce an ‘in principle’ monitoring plan (IPMP) in order to agree the objectives of any monitoring required by the DMLs prior to the grant of consent. In doing so, this would enable all parties to have clarity on the rationale associated with relevant monitoring requirements and focus from the outset, and provide greater certainty on the limitations and deliverability of any monitoring.
- 1.1.2 This document has been prepared to comply with the above request. Note that it sets out the in-principle monitoring proposals for the marine environment only (i.e. seaward of Mean High Water Spring (MHWS)) encompassing both generation and transmission assets.
- 1.1.3 The primary aims of this document are to:
- Identify relevant offshore monitoring as required by the conditions of the draft DML conditions;
 - Establish the objectives of such monitoring; and
 - Set out the guiding principles for delivering any monitoring measures as required by the conditions contained within the draft DMLs.
- 1.1.4 It is intended that this document will provide the basis for further discussions with the MMO and the relevant SNCBs to agree the exact detail (timings, methodologies, etc.) of the monitoring that is required by the conditions of the DMLs. It should be noted that the final detailed plans for monitoring work will not be produced until closer to the time that the actual work will be undertaken. These in turn will be agreed with the MMO (as required by the conditions of the draft DMLs) in consultation with Natural England where necessary, acknowledging that it is not feasible to produce such specific plans until the Project has been through the final design process, which would normally follow a positive Financial Investment decision by the Project/company.

1.2 The Development

- 1.2.1 Hornsea Offshore Wind Farm Project Two will constitute up to two offshore wind generating stations with a total capacity of up to 1,800 MW and will include all associated offshore and onshore infrastructure. For the purposes of this IPMP, ‘offshore’ refers to the land and seabed seaward of the mean high water spring (MHWS) and ‘onshore’ refers to the land (and any seabed) landward of mean low water spring (MLWS). Any reference to the intertidal zone shall mean the area between MLWS and MHWS.
- 1.2.2 The area within the Hornsea Zone in which the Project’s turbines and inter-array cabling, as well as associated infrastructure such as offshore HVAC collector

substations, offshore HVDC converter stations and offshore accommodation platforms will be placed, has been labelled 'Subzone 2'.

- 1.2.3 The offshore cable route is approximately 150km in length and extends from the proposed landfall at Horseshoe Point in Lincolnshire, offshore in a north-easterly direction to the southern boundary of Subzone 2. From the proposed landfall point at Horseshoe Point, onshore cables will connect the offshore wind generating stations to the onshore substation (which could comprise up to two electrical transmission stations) a distance of approximately 40 km, which will in turn connect to the existing National Grid substation at North Killingholme in North Lincolnshire.
- 1.2.4 The Project comprises up to two offshore wind farms (Projects A and B) together with the associated development and grid connection for each project. Both wind farms have the same connection point into the National Grid substation and follow the same onshore and offshore cable route.
- 1.2.5 Project A and Project B are likely to be constructed by different operators: Optimus Wind Limited ('Optimus Wind') and Breesea Limited ('Breesea'), respectively. To facilitate this multi undertaker approach, the DCO provides for four DMLs, two for Optimus (Project A) (one for the generating station (DML A1) and one for the offshore transmission infrastructure (DML A2)) and two for Breesea (Project B) (again, one for the generating station (DML B1) and one for the offshore transmission infrastructure (DML B2)).
- 1.2.6 The works are described in such a way as to allow flexibility as to whether they form one or two wind generating stations together with the required associated development. This approach means that the consent granted will be flexible and will allow a commercial decision to be made post-consent on how Project Two will be built out.

2 GENERAL GUIDANCE AND PRINCIPLES

2.1 Guidance

2.1.1 There are a number of guidance documents and reviews to draw on when considering guiding principles in marine environmental monitoring. Of particular relevance to offshore wind farms is the recent independent review of post-consent environmental monitoring data undertaken by Fugro EMU Ltd on behalf of the MMO (MMO, 2014) and the MMO's subsequent recommendations.

2.2 Mitigation

2.2.1 It is important to note that the Project has reduced the potential for, or avoided significant impacts through mitigation measures developed and designed during the Project's application process. These include mitigation measures embedded in the project design as well as additional mitigation measures to be applied during construction, operation and decommissioning of the Project; further details regarding these measures will be prepared in consultation with and for agreement from the MMO in consultation with other bodies as deemed appropriate by the MMO.

2.2.2 Options for monitoring are appropriate to consider where it has not been agreed that there are no significant residual impacts (following mitigation), or where there is significant uncertainty in the assessment conclusions.

2.3 Principles

2.3.1 The guiding principles which apply to the in-principle monitoring approaches outlined in this document are as follows:

- All consent conditions (including those for monitoring) should be "*necessary, relevant to planning, relevant to the permitted development, enforceable, precise and reasonable in all other respects*" (the "six tests" set out in paragraph 206 of the National Planning Policy Framework, Department for Communities and Local Government, 2014).
- Monitoring should have a clear purpose and be designed to provide answers to specific questions where significant environmental impacts have been identified (Cefas, 2012; Glasson et al., 2011; OSPAR, 2008). As such (and in-line with the MMO's recommendations for targeted monitoring (MMO, 2014)), monitoring proposals should have an identified frequency (and/ or duration) and confirmed outputs, which provide statistically robust datasets designed to address the hypothesis being tested.
- Paragraph 2.6.51 of the National Planning Statement for Renewable Energy Infrastructure (EN-3) states that "*monitoring is to measure and document the effects of the development. This enables an assessment of the accuracy of the original predictions and may inform the scope of future EIAs*".

- The presence of a significant impact identified in the EIA (whilst necessitating mitigation) should not, in itself, necessarily lead to a requirement for monitoring. Monitoring should address significant evidence gaps or uncertainty relevant to the project, where it is realistic for those gaps to be filled or uncertainty reduced significantly. Monitoring should also be targeted at those features considered to be particularly sensitive to the impacts of the development, especially where these features are of economic or environmental importance. MMO (2014) advise that the greatest focus should be placed on impacts of concern for which the highest uncertainty remains. Such targeted monitoring is more likely to answer key uncertainties than broadscale / generic monitoring approaches.
- Proposals for monitoring should be based, where relevant, on the best practice and outcomes of the latest review of environmental data (i.e., best available evidence) associated with post-consent monitoring of licence conditions of offshore wind farms (MMO, 2014).
- An iterative approach should be taken whereby the scope and design of any new monitoring work should be based on a review of the findings of any preceding phases of monitoring or relevant survey work, including surveys carried out in support of the EIA for the Project. It is acknowledged that the MMO may require amendments to individual monitoring programmes if the evidence indicates the existing monitoring programme is not fit for purpose and/or impacts are not as predicted.
- Where site specific monitoring is undertaken pre and post construction it may be relevant to consider undertaking monitoring over non-consecutive years (for example post construction monitoring at years 1, 3 and 5, or years 1, 5 and 10) to explore potential for longer term trends.
- Under certain circumstances for addressing specific uncertainties it may be more appropriate to adopt a strategic approach to the monitoring (for example the bird collision assessment work that ORJIP is undertaking, or the consequence of harbour porpoise disturbance that DEPONS is addressing). Strategic work (potentially out with the boundary of the project) may be considered where contributing to the answering of a broader (that is still linked to the relevant Project receptors) is likely to offer greater ability to address key questions than any site specific monitoring may achieve. Such strategic work may need to be de-coupled from any specific phase of the development.

3 OVERVIEW OF MONITORING CONDITIONS SET OUT IN THE DCO

3.1 Schedules H and J (DML A1, Project A: Generation Assets and DML B1, Project B: Generation Assets)

3.1.1 Schedules H and J, Part 2 Condition 10 sets out plans that must be submitted for approval to the MMO at least four months prior to the intended start of construction or survey work (unless a different date is agreed in writing). The plans listed in Condition 10(2) cover a number of topics including detailed information on technical and engineering aspects of works and mitigation measures to be taken. Some have relevance to monitoring and are discussed in turn below.

3.1.2 Schedules H and J, Part 2 Condition 10(2)(a) requires the submission of a **construction and monitoring programme** that sets out survey methodologies for the pre-, during- and post-construction surveys required in Conditions 15, 16 and 17 (see paragraphs below) for approval by the MMO in consultation with the relevant statutory nature conservation body, at least four months prior to the commencement of any survey works detailed within.

3.1.3 Schedules H and J, Part 2 Condition 10(2)(c) requires a **project environmental management and monitoring plan**, to include details of:

(iii) a disposal plan detailing the locations, methods and timings of dredging and disposal, as well as disposal site monitoring requirements.

3.1.4 Schedules H and J, Part 2 Condition 10(2)(e) requires, in the event that driven or part-driven pile foundations are proposed to be used, the submission of a:

“... marine mammal mitigation protocol following current best practice as advised by the statutory nature conservation agencies, which may include, but is not limited to –

(i) identification of a Marine Mammal Mitigation Zone (MMMZ);

(ii) appointment of an appropriate number of suitably qualified marine mammal observer(s);

(iii) methods for the detection of marine mammals within the MMMZ whether visually (by the marine mammal observer(s)) or acoustically using Passive Acoustic Monitoring equipment or other means of detection;

(iv) a reporting methodology to enable efficient communication between the marine mammal observer(s) and the person responsible for approving commencement of piling;

(v) an appropriate soft start procedure whereby piling activities do not commence until an agreed time has elapsed and during which marine mammals have not been detected within the MMMZ;

(vi) where appropriate, methods for the application of acoustic deterrent devices; and

(vii) where appropriate, consideration of the use of noise reduction at source technologies”

3.1.5 Schedules H and J, Part 2 Condition 10(2)(g) requires the submission of a **written scheme of archaeological investigation** in relation to the Wind Farm Area, including monitoring during and post construction, where relevant.

3.1.6 Schedules H and J, Part 2 Condition 10(2)(h) requires a **marine mammal monitoring plan** setting out the circumstances in which marine mammal monitoring will be required and the monitoring to be carried out in such circumstances.

3.1.7 Schedules H and J, Part 2 Condition 10(2)(k) requires an **ornithological monitoring plan** setting out the circumstances in which ornithological monitoring will be required and the monitoring to be carried out in such circumstances.

3.1.8 Schedules H and J, Part 2 Condition 15 sets out the **pre-construction** monitoring and survey requirement, which are expected to comprise (unless otherwise agreed in writing by the MMO in consultation with the relevant statutory nature conservation body):

“...

(a) a high resolution swath bathymetric survey to include a 100% coverage and a side scan sonar survey of the part(s) of the Wind Farm Area in which it is proposed to carry out construction works and disposal activities under this licence;

(b) any ornithological monitoring required by the ornithological monitoring plan submitted in accordance with condition 10(2)(k);

(c) a survey to determine the location, extent and composition of any benthic habitats of conservation, ecological and/or economic importance (including Annex 1 Habitats) in the part(s) of the Wind Farm Area in which it is proposed to carry out construction works under this licence; and

(d) any marine mammal monitoring required by the marine mammal monitoring plan submitted in accordance with condition 10(2)(h).”

3.1.9 Schedules H and J Part 2 Condition 16(2) sets out the following requirements in relation to **construction phase** monitoring and surveys:

“...Subject to receipt from the undertaker of specific proposals pursuant to this condition, it is expected that the construction monitoring will comprise, in outline—

(a) unless the MMO agrees otherwise in writing, measurements of noise generated by the installation of the first four foundations of each discrete foundation type to be constructed under this licence where driven or part-driven pile foundations are used; and

(b) recording of any visual sightings or acoustic detection of marine mammals where required as part of the marine mammal mitigation protocol under condition 10(2)(e).”

3.1.10 Schedules H and J Part 2 Condition 16(5) further states that:

“Construction monitoring shall include vessel traffic monitoring by Automatic Identification System for the duration of the construction period. A report will be submitted to the MMO and the MCA at the end of each year of the construction period.”

3.1.11 Schedules H and J Part 2 Condition 17(2) sets out the following requirements in relation to **post-construction** monitoring and surveys:

“... Subject to receipt of specific proposals, it is expected that the post-construction surveys will comprise, in outline—

(a) any ornithological monitoring required by the ornithological monitoring plan submitted in accordance with Condition 10(2)(k);

(b) a high resolution swath bathymetric survey of the following to assess any changes in bedform morphology—

(i) a representative sample area, as may be agreed in writing with the MMO, of the part(s) of the Wind Farm Area within which construction works and disposal activities were carried out under this licence, and such further monitoring as may be required to ensure that the cables have been buried or protected; and

(ii) an area not to exceed 125 per cent of the predicted scour area around a selection of turbines, such selection to be based on the desk based assessment

(c) a survey to determine any change in the location, extent and composition of any benthic habitats of conservation, ecological and/or economic importance (including Annex 1 Habitats) identified in the preconstruction survey in the part(s) of the Wind Farm Area in which construction works were carried out. The survey design will be informed by the results of the preconstruction benthic survey;

(e) any marine mammal monitoring required by the marine mammal monitoring plan submitted in accordance with condition 10(2)(h); and

(f) vessel traffic monitoring by Automatic Identification System, for 28 days taking account seasonal variations in traffic patterns, for a maximum duration of one year post construction. A report will be submitted to the MMO and the MCA at the end of the first year after construction is completed.”

3.1.12 Schedules H and J do not specify any decommissioning survey requirements, however, Condition 19 requires plans for decommissioning to be submitted to the MMO for approval prior to any decommissioning activities being carried out.

3.2 Schedules I and K (DML A2, Project A: Transmission Assets and DML B2, Project B: Transmission Assets)

3.2.1 Schedules I and K, Part 2 Condition 10 sets out a series of plans that must be submitted for approval to the MMO at least four months prior to the intended start of

construction (unless a different date is agreed in writing). The plans listed in Condition 10(2) cover a number of topics including detailed information on technical and engineering aspects of works and mitigation measures to be taken. Some have relevance to monitoring and are discussed in turn below.

3.2.2 Schedules I and K, Part 2 Condition 10(2)(a) requires the submission of a **construction and monitoring programme** that sets out survey methodologies for the pre-, during- and post-construction surveys required in Conditions 15, 16 and 17 (see paragraphs below) for approval by the MMO in consultation with the relevant statutory nature conservation body at least four months prior to the commencement of any survey works detailed within.

3.2.3 Schedules I and K, Part 2 Condition 10(2)(c) requires a **project environmental management and monitoring plan**, to include details of:

(iii) a disposal plan detailing the locations, methods and timings of dredging and disposal, as well as disposal site monitoring requirements.

3.2.4 Schedules I and K, Part 2 Condition 10(2)(e) requires, in the event that driven or part-driven pile foundations are proposed to be used, the submission of a:

“... marine mammal mitigation protocol following current best practice as advised by the statutory nature conservation agencies, which may include, but is not limited to –

(i) identification of a Marine Mammal Mitigation Zone (MMMZ);

(ii) appointment of an appropriate number of suitably qualified marine mammal observer(s);

(iii) methods for the detection of marine mammals within the MMMZ whether visually (by the marine mammal observer(s)) or acoustically using Passive Acoustic Monitoring equipment or other means of detection;

(iv) a reporting methodology to enable efficient communication between the marine mammal observer(s) and the person responsible for approving commencement of piling;

(v) an appropriate soft start procedure whereby piling activities do not commence until an agreed time has elapsed and during which marine mammals have not been detected within the MMMZ;

(vi) where appropriate, methods for the application of acoustic deterrent devices; and

(vii) where appropriate, consideration of the use of noise reduction at source technologies”

3.2.5 Schedules I and K, Part 2 Condition 10(2)(g) requires the submission of a **written scheme of archaeological investigation** in relation to the offshore Order limits, including monitoring during and post construction, where required.

3.2.6 Schedules I and K, Part 2 Condition 10(2)(h) requires a

“proposed survey and reinstatement plan for Salicornia forming Annex 1 Habitat in the part(s) of the offshore Order limits within which it is proposed to carry out construction works comprised in Work No. [5A/5B], including the circumstances in which reinstatement will be required and the proposed methods of reinstatement.”

3.2.7 Schedules I and K Part 2 Condition 15 sets out the **pre-construction** monitoring and survey requirement, which are expected to comprise (unless otherwise agreed in writing by the MMO in consultation with the relevant statutory nature conservation body):

(a) a survey to determine the location, extent and composition of any benthic habitats of conservation, ecological and/or economic importance (including Annex 1 Habitats) in the part(s) of the offshore Order limits in which it is proposed to carry out construction works under this licence;

(b) a Phase 1 survey of the intertidal area within which it is proposed to carry out construction works;

(c) a high resolution swath bathymetric survey to include a 100% coverage and a side scan sonar survey of the part(s) of the offshore Order limits within which it is proposed to carry out construction works and disposal activities under this licence; and

(d) a grab survey and particle size analysis in the part(s) of the offshore Order limits within which it is proposed to carry out dredging and disposal activities relating to Work Nos. [3A/3B] and [4A/4B] under this licence within a period not greater than 12 months prior to the dredging and disposal activities to determine the extent of suitable herring spawning habitat within those areas.”

3.2.8 Schedules I and K Part 2 Condition 16(2) sets out the following requirements in relation to **construction phase** monitoring and surveys:

“...Subject to receipt from the undertaker of specific proposals pursuant to this condition, it is expected that the construction monitoring will comprise, in outline—

(a) unless the MMO agrees otherwise in writing, measurements of noise generated by the installation of the first four foundations of each discrete foundation type comprised in Work No. [2A/2B] to be constructed under this licence where driven or part-driven pile foundations are used; and

(b) recording of any visual sightings or acoustic detection of marine mammals where required as part of the marine mammal mitigation protocol under condition 10(2)(e).

3.2.9 Schedules I and K Part 2 Condition 16(5) further states that:

“Construction monitoring shall include vessel traffic monitoring by Automatic Identification System for the duration of the construction period. A report will be submitted to the MMO and the MCA at the end of each year of the construction period.”

3.2.10 Schedules I and K Part 2 Condition 17(2) sets out the following requirements in relation to **post-construction** monitoring and surveys:

“...Subject to receipt of specific proposals, it is expected that the post-construction surveys will comprise, in outline—

(a) a survey to determine any change in the location, extent and composition of any benthic habitats of conservation, ecological and/or economic importance (including Annex 1 Habitats) identified in the preconstruction survey in the part(s) of the offshore Order limits in which construction works were carried out. The survey design will be informed by the results of the preconstruction benthic survey;

(b) one high resolution swath bathymetric survey to be undertaken no sooner than six months following completion of construction works and disposal activities to include a 100% coverage of the part(s) of the offshore Order limits with a water depth no greater than 12 metres (referenced to Chart Datum) within which construction works and disposal activities were carried out under this licence to assess any changes in bedform morphology and such further monitoring as may be required to ensure that the cables have been buried or protected and sediment is able to move over any installed cable protection. The need for further surveys will be agreed in writing with the MMO following submission of the first year of survey data;

(c) one high resolution bathymetric survey of a representative sample area, as may be agreed in writing with the MMO, of the part(s) of the offshore Order limits with a water depth no greater than 12 metres (referenced to Chart Datum) within which construction works and disposal activities were carried out under this licence following the first major storm event the timing of which shall be agreed with the MMO in consultation with Natural England and the Environment Agency;

(d) a grab survey and particle size analysis in the part(s) of the offshore Order limits within which dredging and disposal activities relating to Work Nos. [3A/3B] and [4A/4B] were carried out under this licence within 12 months of the completion of the dredging and disposal activities to determine the extent of suitable herring spawning ground habitat within those areas; and

(e) vessel traffic monitoring by Automatic Identification System, for 28 days taking account seasonal variations in traffic patterns, for a maximum duration of one year post construction. A report will be submitted to the MMO and the MCA at the end of the first year after construction is completed.”

3.2.11 Schedules I and K do not specify any decommissioning survey requirements, however, Condition 19 requires a decommissioning plan to be submitted to the MMO for approval prior to any decommissioning activities being carried out.

4 IN PRINCIPLE PROPOSALS FOR MONITORING

4.1 Approach

- 4.1.1 The following sections set out the in-principle proposals for implementing the above monitoring conditions for the Project, drawing from Annex 4.5.5 (Enhancement Mitigation and Monitoring Commitments, Doc ref No: 7.4.5.5) of the Environmental Statement of the Project (SMartWind, 2015), as updated by the Applicant at Deadline I (ref Appendix V). The proposals have been grouped into the following topics:
- Marine processes;
 - Benthic subtidal and intertidal ecology;
 - Fish and shellfish ecology;
 - Marine mammals;
 - Ornithology;
 - Shipping and navigation; and
 - Marine archaeology.
- 4.1.2 For each topic, a table is presented which details the potential effects and receptor(s) for which monitoring is considered necessary, with links to the relevant DML conditions that set out monitoring requirements and, where relevant, requirements for submission of related plans. For each topic, the tables are divided into sections for pre-construction monitoring, construction monitoring, and post-construction monitoring. At this stage, no monitoring approaches are outlined for the decommissioning phase.
- 4.1.3 As per condition 10(2)(a)(iii) in Schedules H, I, J and K of the DCO, detailed survey plans must be submitted to the MMO for approval at least four months in advance of monitoring survey work commencing (following final scheme design).
- 4.1.4 This document outlines the rationale behind the proposed monitoring, with a view to reducing uncertainty when drafting the final plans post consent award. Following the iterative approach recommended in Section 2, it has been agreed with the MMO that increased knowledge and understanding based on survey outcomes may influence the design of subsequent monitoring work. The focus, requirements and methodologies for future monitoring for the Project may therefore differ from the outline approach presented in this document. Any such future modifications to monitoring approaches will be the subject of ongoing consultation between the undertaker, the MMO and its statutory advisers. The MMO has the ability to vary the DML conditions in this regard, in consultation with the Developer.

4.2 Marine processes

- 4.2.1 Table 1 provides information on the in-principle monitoring for marine processes during the pre-construction, construction- and post-construction phases.
- 4.2.2 Monitoring in relation to marine processes generally comprises bathymetric (geophysical) surveys (to consider seabed morphology and bathymetry). It is anticipated that methodologies for the surveys and monitoring will be required to follow the guidelines set out in Cefas (2012) and Ware and Kenny (2011), being cognisant of the outcomes of the post-consent monitoring review (MMO, 2014a and b).
- 4.2.3 It is noted that the primary drivers for the geophysical surveying that will inform any monitoring associated with marine processes, relates to the need to inform final engineering design (including the cable specification and installation plan) and navigational risk. The objectives set out within Table 1 relate solely to the marine processes aspects of this survey work and not any wider objectives.

Table 1 In-principle monitoring – marine processes

Potential effect	Receptor(s)	Monitoring approach	Monitoring objectives	Agreed	DCO ref.	Links to other monitoring
<i>Pre-construction monitoring</i>						
Impacts on bedform morphology from the installation and presence of Project	Bedform morphology and sediment transport	<u>Generation & Transmission Assets</u> High resolution swath bathymetric survey to include a 100% coverage and side scan sonar survey of part(s) of the	In the context of marine processes, the aim of this monitoring is to establish a baseline of bedform morphology ¹ within the array	Agreed	Schedules H, I, J & K Part, 2 10(2)(c)(iii)	Benthic ecology monitoring (Table 2), PSA (herring habitat) monitoring (Table

¹ For the purposes of this IPMP, 'seabed morphology' is considered to represent the form and structure of the seabed. This will enable any seabed features that are particularly sensitive to the proposed development to be identified, around which post construction monitoring can be focused.

Potential effect	Receptor(s)	Monitoring approach	Monitoring objectives	Agreed	DCO ref.	Links to other monitoring
infrastructure and disposal activities		<p>offshore Order limits in which it is proposed to carry out construction works and disposal activities under this licence, including any appropriate buffer around the site of each works.</p> <p>The extent of the buffer (required to inform micro-siting if required, cover any areas of scour, drill arisings and or cable protection) will be determined following final scheme design and a review of the specific construction activity, the associated effects and the receptors in question. The final requirement for the survey areas are subject to MMO approval.</p> <p>The specific need for and nature of any monitoring associated with the disposal activity will be defined within the disposal plan, which is to be submitted to the MMO for approval.</p>	<p>and export cable corridor, where construction activity (including dredging and or disposal) is proposed.</p> <p>The baseline will be used to inform post construction seabed morphology monitoring and disposal site monitoring. Specifically it will assist in the identification of any significant change in conditions following construction and will enable the relevant predictions made in the ES (where either potential for significant effect or uncertainty exists) to be validated.</p>		<p>Schedules H & J Part 2, 15(2)(a)</p> <p>Schedules I & K Part 2, 15(2)(c)</p>	<p>3), archaeological monitoring (Section 4.7), navigable depth monitoring (Table 7)</p>
<i>Construction monitoring</i>						
N/A				Agreed		

Potential effect	Receptor(s)	Monitoring approach	Monitoring objectives	Agreed	DCO ref.	Links to other monitoring
<i>Post-construction monitoring</i>						
Impacts on bedform morphology from the installation and presence of Project infrastructure and disposal activities	Bedform morphology and sediment transport	<p><u>Generation Assets</u></p> <p>A high resolution swath bathymetric survey of the following:</p> <ul style="list-style-type: none"> A representative sample area, as may be agreed in writing with the MMO, of the part(s) of the Wind Farm Area within which construction works and disposal activities were carried out under this licence and any such further surveys as required to ensure that cables have been buried; and An area not to exceed 125% of the predicted scour area around a selection of turbines, such selection to be based on the desk based assessment. <p>The specific locations for the targeted monitoring will be determined via a desk based assessment that draws on findings made within the ES, final scheme design and outputs of the baseline (pre-construction) monitoring.</p>	<p>The objectives of the Generation Assets monitoring (for marine processes) is to assess changes in bedform morphology at strategic locations within the array area where construction activity has taken place and to ensure cable burial has been effective.</p> <p>The objectives of the Transmission Assets generic seabed monitoring (for marine processes) is to assess any changes in bedform morphology and where necessary, that the cables have been buried or protected and sediment is able to move over any installed cable protection.</p> <p>The objectives of the Transmission Assets post</p>	Agreed	<p>Schedules H, I, J & K Part, 2 10(2)(c)(iii)</p> <p>Schedules H & J Part 2, 17(2)(b)</p> <p>Schedules I & K Part 2, 17(2)(b)</p>	Benthic ecology monitoring (Table 2), PSA (herring habitats) (Table 3), archaeological monitoring (Section 4.7), navigable depth monitoring (Table 7).

Potential effect	Receptor(s)	Monitoring approach	Monitoring objectives	Agreed	DCO ref.	Links to other monitoring
		<p>The specific need for and nature of any monitoring associated with any disposal activity in relation to the Generation Assets will be defined within the disposal plan.</p> <p><u>Transmission Assets</u></p> <p><i>General seabed monitoring</i></p> <p>One high resolution swath bathymetric survey to be undertaken no sooner than six months following completion of construction works and disposal activities to include a 100% coverage of the part(s) of the offshore Order limits with a water depth no greater than 12 metres (referenced to Chart Datum) within which construction works and disposal activities were carried out. Further monitoring may also be required to ensure that the cables have been buried or protected and sediment is able to move over any installed cable protection.</p> <p>An appropriate survey buffer will be applied to the area within which construction and disposal activities were</p>	<p>storm seabed monitoring (for marine processes) is to assess any changes in bedform morphology within the defined nearshore area following the first major storm event to ensure that cables remain buried and or the level of cable protection material remains appropriate.</p>			

Potential effect	Receptor(s)	Monitoring approach	Monitoring objectives	Agreed	DCO ref.	Links to other monitoring
		<p>carried out, the extent of which will be informed by predictions made within the ES and agreed through consultation with the MMO and its statutory advisors.</p> <p>The specific requirement for and nature of any monitoring to check on cable burial and or sediment movement over cable protection material, will be informed by the cable specification and installation plan.</p> <p>The need for further monitoring beyond the first post construction survey within the nearshore (water depths no greater than 12m) will be subject to review following consultation with the MMO on the outputs of the first year post construction monitoring reports.</p> <p>The specific need for and nature of any monitoring associated with any disposal activity in relation to the Transmission Assets will be defined within the disposal plan.</p> <p><i>Post storm seabed monitoring</i></p> <p>One high resolution bathymetric survey of a representative sample area, as may</p>				

Potential effect	Receptor(s)	Monitoring approach	Monitoring objectives	Agreed	DCO ref.	Links to other monitoring
		<p>be agreed in writing with the MMO, of the part(s) of the offshore Order limits with a water depth no greater than 12 metres (referenced to Chart Datum) within which construction works and disposal activities were carried out under this licence following the first major storm event the timing of which shall be agreed with the MMO in consultation with Natural England and the Environment Agency.</p>				

4.3 Benthic subtidal and intertidal ecology

- 4.3.1 Table 2 provides information on the in-principle monitoring for benthic ecology during the pre-construction, construction- and post-construction phases.
- 4.3.2 Monitoring of benthic communities generally includes benthic surveys (to consider habitat or species composition) and bathymetric surveys (primarily for engineering purposes and to consider navigational risk but also for seabed morphology). Both survey types (benthic and geophysical) are referred to in Table 2.
- 4.3.3 It is anticipated that methodologies for benthic ecology survey and monitoring will be required to follow the guidelines set out in Cefas (2012) and Ware and Kenny (2011), being cognisant of the outcomes of the post-consent monitoring review (MMO, 2014a and b).

Table 2: In-principle monitoring – benthic subtidal and intertidal ecology

Potential effect	Receptor(s)	Monitoring approach	Monitoring objectives	Agreed	DCO ref.	Links to other monitoring
<i>Pre-construction monitoring</i>						
Temporary habitat loss/disturbance from construction activity and installation of infrastructure Long term loss of seabed habitat through presence of foundations & scour protection	Benthic habitats (noting that protected features within the Humber SAC will require particular focus)	A survey to determine the location, extent and composition of any benthic habitats of conservation, ecological and/or economic importance (including Annex 1 Habitats) in the part(s) of the offshore Order limits in which it is proposed to carry out construction works under this licence. The habitats that require investigation will be determined by a desk based review of the ES findings and the final scheme	To establish a baseline on the distribution of key benthic habitats as identified from the desk based review. This baseline will inform disposal site monitoring and post-construction benthic monitoring and will serve to validate associated predictions made in	Agreed	Schedules H & J Part 2, 15(2)(c) Schedules I & K Part 2, 15(2)(a)	

Potential effect	Receptor(s)	Monitoring approach	Monitoring objectives	Agreed	DCO ref.	Links to other monitoring
		<p>design.</p> <p>The habitats may be surveyed by remote (geophysical) and / or ground-truthing techniques (grab and/or drop down video/camera). The appropriate method will be determined by a review of best practice techniques for the habitat(s) in question, which are identified through the ES literature review.</p> <p>The outputs of the pre-construction geophysical survey will be used to help define the habitats present and precise ground truthing locations.</p>	the ES.			
Temporary habitat loss/disturbance from construction activity and installation of infrastructure	Annex I habitat 'Salicornia and other annuals colonising mud and sand'	<p>A survey to establish the extent and nature of any Annex I <i>Salicornia</i> habitat.</p> <p>A single survey will be undertaken in advance of cable burial operations. The exact scope of the pre-construction survey will be developed in consultation with the relevant statutory nature conservation body and the EA, and will be incorporated into the proposed <i>Salicornia</i> Survey and Reinstatement Plan. It will likely consist of a single pre construction survey undertaken during the summer months</p>	To inform installation plans to minimise impacts and to establish a baseline from which to determine the effectiveness of any proposed mitigation measures (i.e., leaving undisturbed areas in order to seed areas of temporary habitat loss) and to assess the speed of recovery of this species in disturbed areas.	Agreed	<p>Schedules I and K, Part 2, Condition 10 (2)(h)</p> <p>Schedules I and K, Part 2, Condition 15(2)(b)</p>	

Potential effect	Receptor(s)	Monitoring approach	Monitoring objectives	Agreed	DCO ref.	Links to other monitoring
		(between July and early September) to coincide with the main period of vegetative growth of this species to ensure accurate abundance estimates can be made. The survey will likely be linked to the Phase I intertidal survey as discussed below.				
Temporary habitat loss/disturbance from construction activity and cable installation works	Intertidal benthic habitats	A Phase I survey of the intertidal area within which it is proposed to carry out construction works.	To establish a baseline on intertidal benthic habitat distribution so sensitive habitats can be avoided (where possible) during construction.	Agreed	Schedules I & K Part 2, 15(2)(b)	
<i>Construction monitoring</i>						
N/A				Agreed		
<i>Post-construction monitoring</i>						
Temporary habitat loss/disturbance from construction activity and infrastructure installation Long term loss of	Benthic habitats (noting that protected features within the Humber SAC will	Survey(s) to determine any change in the location, extent and composition of any benthic habitats of conservation, ecological and/or economic importance (including Annex 1 Habitats) identified in the pre-construction survey in the part(s)	To determine change in habitat location, extent and composition of key sensitive benthic habitats	Agreed	Schedules H & J Part 2, 17(2)(c) Schedules I & K Part 2,	

Potential effect	Receptor(s)	Monitoring approach	Monitoring objectives	Agreed	DCO ref.	Links to other monitoring
seabed habitat through presence of foundations & scour protection	require particular focus)	of the offshore Order limits in which construction works were carried out. The survey design (number and location of sample locations) will be informed by the results of the pre-construction benthic survey. The techniques used will match those deployed for the pre-construction baseline to ensure direct comparability.			17(2)(a)	
Temporary habitat loss/disturbance from construction activity and cable installation works	Annex I habitat 'Salicornia and other annuals colonising mud and sand'	<p>Survey(s) to determine the extent and nature of Annex I <i>Salicornia</i> habitat.</p> <p>It is predicted that any <i>Salicornia</i> habitat affected by the construction works and installation of the cable will recover within 12 months and so it is anticipated that the post-construction monitoring will comprise one survey approximately 12 months after completion of construction activities to confirm the recovery of any Annex I <i>Salicornia</i> Habitat detected during the pre-construction survey.</p> <p>The results of this survey will determine the need for any subsequent monitoring and/or reinstatement work, as set out within the Proposed <i>Salicornia</i> Survey and Reinstatement Plan.</p>	To determine the effectiveness of the proposed mitigation measures (i.e., leaving undisturbed areas in order to seed areas of temporary habitat loss), to validate the predictions relating to the speed of recovery of this species into disturbed areas and, to inform the need for any <i>Salicornia</i> reinstatement work (should it be required).	Agreed	Schedules I and K, Part 2 Section 10(2)(h)	

Potential effect	Receptor(s)	Monitoring approach	Monitoring objectives	Agreed	DCO ref.	Links to other monitoring
		<p>The exact scope of the post-construction survey(s) will be developed in consultation with the relevant statutory nature conservation body and the EA, and will be specified in the Proposed Salicornia Survey and Reinstatement Plan. The survey will be undertaken during the summer months (between July and early September) to coincide with the main period of vegetative growth of this species to ensure accurate abundance estimates can be made.</p>				


4.4 Fish and shellfish ecology

4.4.1 Table 3 provides information on the in-principle monitoring for fish and shellfish ecology during the pre-construction, construction and post-construction phases.

Table 3 In-principle monitoring – Fish and shellfish ecology

Potential effect	Receptor(s)	Monitoring approach	Monitoring objectives	Agreed	DCO ref.	Links to other monitoring
<i>Pre-construction monitoring</i>						
Temporary habitat loss/disturbance from sandwave clearance and disposal activity	Herring spawning habitat	<p>A grab survey and particle size analysis (PSA) in the part(s) of the offshore Order limits within which it is proposed to carry out dredging and disposal activities relating to Work Nos. [3A/3B] and [4A/4B] under this licence within a period not greater than 12 months prior to the dredging and disposal activities.</p> <p>The precise location of the survey and extent of sampling will be informed by a desk based review of the ES findings and the final scheme design.</p> <p>Techniques to characterise the habitats are likely to include geophysical data acquisition (associated with the pre-construction geophysical surveys) and ground-truthing through grab sampling and subsequent particle size analysis (PSA) of retrieved sediments.</p>	<p>To determine the extent of suitable herring spawning ground habitat within the areas identified.</p> <p>This baseline will inform post-construction monitoring and will serve to validate associated predictions made in the ES.</p>	Agreed	Schedules I & K Part 2, 15(2)(d)	Marine process monitoring (geophysical surveys) (Table 1)

Potential effect	Receptor(s)	Monitoring approach	Monitoring objectives	Agreed	DCO ref.	Links to other monitoring
<i>Construction monitoring</i>						
Underwater noise as a result of foundation installation (i.e., percussive piling)	Hearing-sensitive fish species	<p>Unless the MMO agrees otherwise in writing, measurements of noise generated by the installation of the first four foundations of each discrete foundation type to be constructed under this licence where driven or part-driven pile foundations are used.</p> <p>The transects monitored in the survey will be informed by the predictions for noise propagation within the ES.</p>	To obtain information to validate the noise propagation and source level attenuation predictions made in the ES.	Agreed	Schedules H, I, J & K Part 2, 16(2)(a)	
<i>Post-construction monitoring</i>						
Temporary habitat loss/disturbance	Herring spawning habitat	<p>Grab survey(s) and particle size analysis in the part(s) of the offshore Order limits within which dredging and disposal activities relating to Work Nos. [3A/3B] and [4A/4B] were carried out under this licence within 12 months of the completion of the dredging and disposal activities to determine the extent of suitable herring spawning ground habitat within those areas.</p> <p>The post construction survey will follow the same techniques and sampling locations as</p>	The survey will establish whether there has been a significant change in the extent of suitable herring spawning ground habitat identified during pre-construction monitoring surveys, within the areas in which dredging and disposal activities were carried out.	Agreed	Schedules I & K Part 2, 17(2)(d)	Marine process monitoring (geophysical surveys) (Table 1)



Potential effect	Receptor(s)	Monitoring approach	Monitoring objectives	Agreed	DCO ref.	Links to other monitoring
		the pre-construction survey.				

4.5 Marine mammals


- 4.5.1 Table 4 provides information on the in-principle monitoring for marine mammals during the pre-construction, construction and post-construction phases.
- 4.5.2 As per Schedule H, I, J & K Part 2, Condition 10(2)(e), a MMMP will be submitted to the MMO for approval in advance of works commencing and the approved MMMP will be implemented during construction. The MMMP will detail mitigation measures which may include soft-start to piling, identification of a Marine Mammal Mitigation Zone (MMMZ) and/or detailed methods to be employed within the MMMZ.
- 4.5.3 In accordance with Schedule H & J Part 2, Condition 10(2)(h) the undertaker will submit a plan for marine mammal monitoring which will set out the circumstances in which marine mammal monitoring will be required and the monitoring to be carried out in such circumstances.

Table 4 In-principle monitoring – Marine mammals

Potential effect	Receptor(s)	Monitoring approach	Monitoring objectives	Agreed	DCO ref.	Links to other monitoring
<i>Pre-construction monitoring</i>						
Underwater noise as a result of foundation installation (i.e., percussive piling)	Marine mammals	Monitoring as required under the plan for marine mammal monitoring. It is anticipated that this monitoring will be achieved through ongoing strategic studies into the consequence of behavioural disturbance, such as DEPONS. The need for any site specific monitoring will be determined based on the outputs from such strategic studies and a consideration	The objectives of marine mammal monitoring if required will be defined within the plan for marine mammal monitoring. Under the primary monitoring scenario (i.e., through the use of DEPONS) the objective will be to better understand the	Agreed	Schedules H & J Part 2, 10(2)(h) Schedules H & J Part 2, 15(2)(d)	

Potential effect	Receptor(s)	Monitoring approach	Monitoring objectives	Agreed	DCO ref.	Links to other monitoring
		as to whether any site specific work could provide any meaningful outputs (with regard to the consequence of disturbance question).	consequence of disturbance from piling activity at a North Sea population level.			
<i>Construction monitoring</i>						
Underwater noise as a result of foundation installation (i.e., percussive piling)	Marine mammals	<p>Marine mammal monitoring to inform mitigation as per the MMMP, which may <i>inter alia</i>:</p> <ul style="list-style-type: none"> Identify a marine mammal mitigation zone (MMMZ), Appoint an appropriate number of suitably qualified marine mammal observers, Define methods for detection of marine mammals, e.g. visual observation or acoustic monitoring. 	<p>In the circumstance that current standard methods (i.e., visual or passive acoustic techniques) are used, the objectives will be to survey for the presence of marine mammals, ensure they are not within the relevant impact zone during construction and inform the implementation of appropriate mitigation actions.</p> <p>Note that if alternative options are adopted (such as through the use of ADDs) then this monitoring would not be undertaken.</p>	Agreed	Schedules H, I, J & K Part 2, 16(2)(b)	

Potential effect	Receptor(s)	Monitoring approach	Monitoring objectives	Agreed	DCO ref.	Links to other monitoring
Underwater noise as a result of foundation installation (i.e., percussive piling)	Marine mammals	<p>Unless the MMO agrees otherwise in writing, measurements of noise generated by the installation of the first four foundations of each discrete foundation type to be constructed under this licence where driven or part-driven pile foundations are used.</p> <p>The transects monitored in the survey will be informed by the predictions for noise propagation within the ES.</p>	To validate the noise propagation and source level attenuation predictions made in the ES.	Agreed	Schedules H, I, J & K Part 2, 16(2)(a)	
<i>Post-construction monitoring</i>						
Underwater noise as a result of foundation installation (i.e., percussive piling)	Marine mammals	<p>Monitoring as required under the plan for marine mammal monitoring.</p> <p>It is anticipated that this monitoring will be achieved through ongoing strategic studies into the consequence of behavioural disturbance, such as DEPONS. The need for any site specific monitoring will be determined based on the outputs from such strategic studies and a consideration as to whether any site specific work could provide any meaningful outputs (with regard to the</p>	The need for, and approach to, any marine mammal monitoring will be defined within the plan for marine mammal monitoring.	Agreed	<p>Schedules H & J Part 2, 10(2)(h)</p> <p>Schedules H & J Part 2, 17(2)(e)</p>	



Potential effect	Receptor(s)	Monitoring approach	Monitoring objectives	Agreed	DCO ref.	Links to other monitoring
		consequence of disturbance question).				

4.6 Offshore ornithology

4.6.1 Table 5 provides information on the in-principle monitoring for offshore ornithology during the pre- and post-construction phases.

Table 5 In-principle monitoring – Offshore ornithology

Potential effect	Receptor(s)	Monitoring approach	Monitoring objectives	Agreed	DCO ref.	Links to other monitoring
<i>Pre-construction monitoring</i>						
<p>The impact of displacement from an area around turbines and other ancillary structures during the operational phase of the development may result in effective habitat loss and reduction in survival or fitness rates.</p> <p>The impact of collisions with rotating turbine blades may result in</p>	<p>Birds (principle species of concern being kittiwake (collision risk), gannet (collision risk and displacement), guillemot (displacement), puffin (displacement) and razorbill (displacement)).</p> <p>The principle SPA feature of</p>	<p>The current wording of the DML commits the developer to monitoring in accordance with the detail of the Ornithological Monitoring Plan (OMP). The condition has been purposefully kept flexible at this stage in recognition that the monitoring that is undertaken should not be specified at this stage. The options that are likely to be considered during the drafting of the OMP (post consent) will include site specific studies (including standardised pre and post construction surveys), colony specific studies and or contributions to more industry wide strategic work.</p> <p>The form and nature of the monitoring that is recommended within the OMP will be based on the final form the consent, the</p>	<p>To establish a baseline to test key predictions or address specific areas of uncertainty relating to key receptors as identified in the ES and HRA (and summarised within this IPMP).</p>	<p>Approach to OMP is agreed, but wider ornithological discussions on-going</p>	<p>Schedules H & J Part 2, 10(2)(k) and 15(2)(b)</p>	

Potential effect	Receptor(s)	Monitoring approach	Monitoring objectives	Agreed	DCO ref.	Links to other monitoring
direct mortality of individuals.	concern (linked to the above species) is the Flamborough and Filey Coast pSPA.	<p>final project design, the current industry knowledge/knowledge gaps relevant to those effects predicted for Hornsea Project Two (and the key receptors / risks as identified within this IPMP) at the time of drafting the OMP. The OMP will be approved by the MMO in consultation with Natural England.</p> <p>Strategic work may represent options such as a contribution to an industry wide study (i.e., via ORJIP), or a contribution towards (for example) colony specific work being carried out by another party (i.e., not directly related to the Project) the results of which will enhance the knowledge base for future development etc.</p> <p>Any site specific monitoring will focus on key species and seasons identified from a desk based review of the ES and HRA.</p>				
<i>Construction monitoring</i>						
N/A						
<i>Post-construction monitoring</i>						

Potential effect	Receptor(s)	Monitoring approach	Monitoring objectives	Agreed	DCO ref.	Links to other monitoring
Direct disturbance to birds including displacement from important foraging and habitat	Birds (principle species of concern being kittiwake, gannet, guillemot, puffin and razorbill). The principle SPA feature of concern (linked to the above species) is the Flamborough and Filey Coast pSPA.	As per pre-construction.	To establish any significant change from baseline conditions to test key predictions or address specific areas of uncertainty relating to key receptors in the ES and HRA.	Approach to OMP is agreed, but wider ornithological discussions on-going	Schedules H & J Part 2, 10(2)(k) and 17(2)(a)	



4.7 Offshore Historic Environment

- 4.7.1 The need for and scope of monitoring associated with the historic environment is set out within the WSI. A draft WSI has been submitted as part of the Applicant's application and the content of which has been agreed with Heritage England. The WSI will be a live document that is updated as the project progresses. A number of other monitoring surveys (such as the high resolution swath bathymetric pre-construction surveys) will feed into the WSI.

4.8 Shipping and navigation

4.8.1 Table 7 provides information on the in-principle monitoring for shipping and navigation during the pre-construction, construction- and post-construction phases.

Table 7 In-principle monitoring – shipping and navigation

Potential effect	Receptor(s)	Monitoring approach	Monitoring objectives	Agreed	DCO ref.	Links to other monitoring
<i>Pre-construction monitoring</i>						
Navigational risk	All marine traffic	High resolution bathymetric surveys as identified in Table 1.	<p>To provide a baseline on bathymetry of areas within which construction activity will take place.</p> <p>Results from the survey will be used to inform the cable specification and installation plan, which will in turn give due consideration to the identification of any cable protection which exceeds 5% of navigable depth referenced to Chart Datum and, in the event that any area of cable protection exceeding 5% of navigable depth is identified,</p>	Agreed	<p>Schedules H, I, J & K Part 2, 10(2)(c)(iii)</p> <p>Schedules H, I, J & K Part 2, 10(2)(f)(ii)</p> <p>Schedules H & J Part 2, 15(2)(a)</p> <p>Schedules I & K Part 2,</p>	Marine process monitoring (geophysical surveys) (Table 1)

Potential effect	Receptor(s)	Monitoring approach	Monitoring objectives	Agreed	DCO ref.	Links to other monitoring
			details of any steps (to be determined following consultation with the MCA) to be taken to ensure existing and future safe navigation is not compromised.		15(2)(c)	
<i>Construction monitoring</i>						
Displacement caused by physical presence of infrastructure	All marine traffic	Vessel traffic monitoring by Automatic Identification System for the duration of the construction period. A report will be submitted to the MMO and the MCA at the end of each year of the construction period.	To monitor any changes in vessel routes and validate associated predictions (including use of mitigations) in the NRA and the ES.	Agreed	Schedules H, I, J & K Part 2 Condition 16(5)	
<i>Post-construction monitoring</i>						
Displacement caused by physical presence of infrastructure	All marine traffic	Vessel traffic monitoring by Automatic Identification system with a for 28 days taking account seasonal variations in traffic patterns for a maximum duration of one year post construction. A report will be submitted to the MMO and the MCA at the end of the first year after construction is completed.	To monitor any changes in vessel routes and validate associated predictions (including use of mitigations) in the NRA and the ES.	Agreed	Schedules H & J Part 2 Condition 17(2)(f) Schedules I & K Part 2 Condition 17(2)(e)	



5 REFERENCES

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