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VATTENFALL

Norfolk Boreas Offshore Wind Farm

Clarification Note Landfall Method

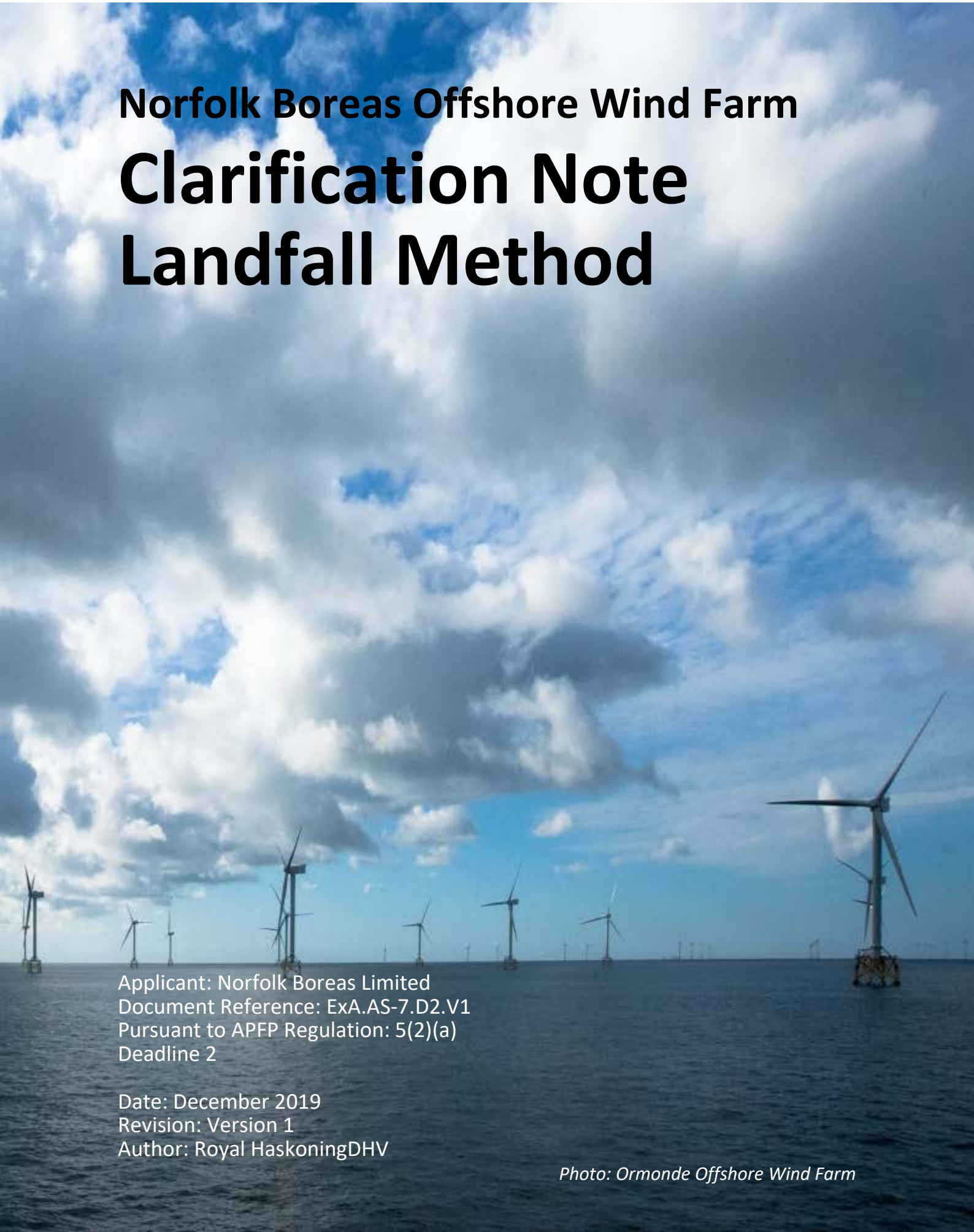

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Table of Contents

Plates

Glossary of Acronyms

AP	Action Point
DCO	Development Consent Order
EIA	Environmental Impact Assessment
ES	Environmental Statement
HDD	Horizontal Directional Drill
HVDC	High Voltage Direct Current
GI	Ground Investigation
ISH	Issue Specific Hearing
LAT	Lowest Astronomical Tide
RR	Relevant Representation
MCZ	Marine Conservation Zone
m	Metre
mm	Millimetre
MTBM	Micro Tunnel Boring Machine
NNDC	North Norfolk District Council
SoCG	Statement of Common Ground
UK	United Kingdom

1 LANDFALL METHOD CLARIFICATION NOTE

1.1 Introduction

1. This clarification note has been produced in response to the relevant representation made by Happisburgh Parish Council (RR-048), further representations made during the open floor hearing on 13th November 2019, as well as comments made by the Examining Authority during ISH2 on the 14th November 2019, and to respond to AP6 from ISH2.

2. The Applicant responded to the relevant representation by Happisburgh Parish Council in the document 'Comments on Relevant Representations' (document ExA.RR.D0.V1, AS-024).

3. In summary, the landfall design will mitigate against impacts to the cliffs. The use of long HDD method prevents the requirement for surface excavations on the beach or at the existing cliff face. Landfall processes and construction methodology is summarised in the Vattenfall Landfall information sheet (document ExA.RR.D0.V1, AS-025) and detailed in section 5.6.1 of ES Chapter 5 Project Description (document 6.1.5, APP-218).

4. The term "Horizontal Directional Drilling (HDD)" is used within the Norfolk Boreas DCO, and associated documents, however it remains the case that other methods of achieving landfall are not precluded so long as they comply with the principle of surface to surface drilling methods without sinking of shafts. This could include methods which are a variation of HDD such as Direct Pipe®.

5. Detailed design and tendering for the landfall works will take place following a positive consent decision. Ensuring compliance with the terms of the consent will be a key objective in this process. All drilling techniques will be considered, so long as their application is consistent with this objective.

6. This clarification note provides further details to expand on the response to the relevant representation and respond to the further queries raised, including AP6 from ISH2 with respect to ground investigations, see Section 1.5.

1.2 Horizontal Directional Drilling (HDD)

7. HDD is a proven technique, first deployed in the 1970's, and has been successfully utilised on numerous landfalls for offshore wind farms throughout the UK, including Dudgeon, Sheringham Shoal, East Anglia ONE, Greater Gabbard, Galloper, Westermost Rough, Triton Knoll and Hornsea Project One. The technique is used in both hard and soft ground and can be used for excavation diameters from 200mm up to 2m and for drill lengths of up to 4000m.

8. The method for HDD installation is detailed within section 5.6.1.2 of Chapter 5 Project Description (document 6.1.5, APP-218) and is summarised here for ease:

- A pilot hole would be drilled from the entry pit and advanced in stages until the required length is reached and the boring head emerges at the exit point (beyond -5.5m Lowest Astronomical Tide (LAT)). The drill head would be guided by sensors, potentially tracking a wire placed above ground.
- Drilling fluid (a combination of water and natural clays such as bentonite) would be employed to lubricate the drilling process and cool the drill head. The fluid is kept under pressure to support the borehole. Fluid pressures would be monitored throughout the process to minimise the potential for breakout of the drilling fluid. An action plan would be developed and procedures adopted during the drilling activity to respond to any drilling fluid breakout. Further details with respect to mitigation by design and on site mitigation measures for HDD design to minimise the risk and impact of bentonite breakout is provided in the Clarification Note: Trenchless Crossings and Potential Effects of Breakout on the River Wensum (document ExA.AS-3.D1.V1, REP1-039).
- Once the pilot hole is completed, it would be enlarged through several passes with reamers until the necessary diameter for duct installation is achieved.
- The HDD would exit at an offshore location (beyond -5.5m LAT), classified as a 'long HDD'. The long HDD option does not require any restrictions or closures to the beach for public access.
- The ducts would be typically floated into position at the offshore exit point via barges. The duct would then be flooded with water and pulled into the reamed drill hole from the entry pit. Alternatively, the ducts could be welded in sections onshore and pulled from the offshore side.

9. Upon completion of the duct installation, the drilling rigs would be removed, and drilling fluids/other wastes cleared from the site with the land reinstated.

10. An example of a HDD drilling rig is provided in Plate 1.

Plate 1 Example HDD rig (Source: Vattenfall Wind Power Ltd)

11. The Applicant has conducted a HDD Feasibility Report (document 4.6, APP-542) for the landfall site which concludes in section 14 and section 15 that the landfall site is suitable for 'long HDD' methods, recognising that further information is required to subsequently derive the detailed design of the landfall. For clarity, the HDD Feasibility Report was produced during site selection and the final Norfolk Boreas landfall location is identified as 'site 3a'. Furthermore, following stakeholder consultation, the Applicant has committed to a 'long HDD' to beyond the -5.5m LAT, therefore references to 'short HDD' are not applicable.

1.3 Direct Pipe®

12. The Direct Pipe® method is an emerging technique (since 2007) which is a hybrid of traditional HDD and microtunnelling methods, developed by drilling company Herrenknecht. The method has been developed to allow pipelines/ducts to be installed in a single phase i.e. no reaming and no separate duct pull through. Direct Pipe® can be used in a wide range of ground conditions including heterogeneous/mixed ground conditions and can be used for excavation diameters from 750mm up to 1.5m and for drill lengths up to 2000m.

13. It should however be noted that at this time, for an 800m length installation, as notionally required for the Norfolk Boreas landfall it is recommended by the supplier to utilise a 48" (1,219mm) Direct Pipe® diameter excavation due to the power of the

machinery required to achieve this distance. This is greater than the maximum diameter excavation assessed and required of 750mm, as described in Table 5.33 of Chapter 5 Project Description (document 6.1.5, APP-218). The supplier has however noted that further developments of the technology are ongoing which may allow for smaller diameters at the required length, prior to the proposed Norfolk Boreas landfall construction.

14. Direct Pipe® use is not as extensive as HDD and its first use as a sea outfall was in the UK on the Beatrice Offshore wind farm in 2017. This landfall was for two 440m long 48" (1,129mm) ducts, which is notably shorter and larger than required and assessed for Norfolk Boreas.

15. The method for Direct Pipe® installation would include:

- The Micro Tunnel Boring Machine (MTBM) is launched from a shallow launch pit (approximately 3m deep); the duct is directly attached to the rear of the MTBM.
- The Pipe Thruster operates as a thrust unit from the launch pit, clamping the duct on the outside and pushing the machine as well as the duct into the ground.
- Drilling fluid (such as bentonite) is utilised to support the excavated face in a variety of ground conditions and provide lubrication for the cutting head. A drilling fluid circuit located inside the duct is utilised to transport the excavated material to a separation plant located above ground.
- The MTBM exits at the exit point offshore and is required to be recovered offshore as it cannot be retrieved from land (duct has been installed).

16. An example of a Direct Pipe® MTBM with Pipe Thruster is provided in Plate 2 with an example of a typical onshore arrangement presented in Plate 3.

Plate 2: Direct Pipe® MTBM with Pipe Thruster (Source: Herrenknecht AG)

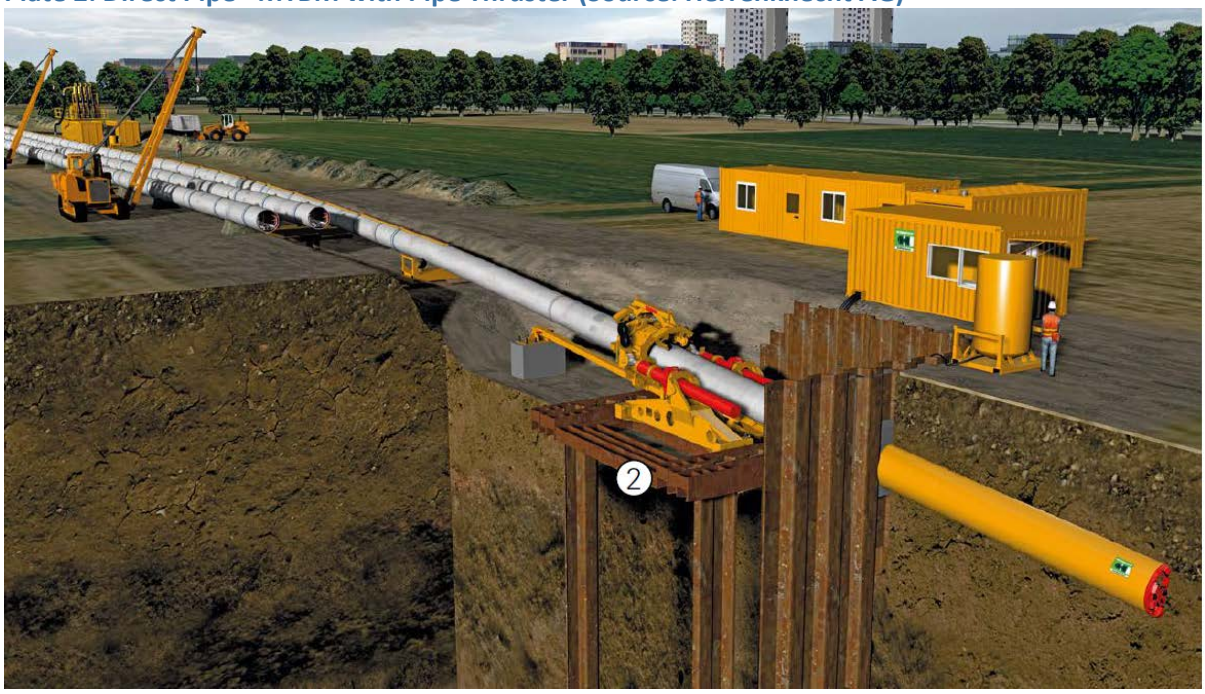

Plate 3: Typical Direct Pipe® onshore arrangement

1.4 DCO and ES Controls

17. The Applicant has reviewed the Direct Pipe® method and determined that such a method could be achieved within the as assessed design envelope, assuming that the suppliers ongoing development allows for a 750mm diameter at the length required for the Norfolk Boreas landfall. This includes aspects such as, but not exclusively:

- Landfall compound requirement of 50m x 60m
- Material deliveries, including traffic and transport requirements
- Excavated material quantities
- Maximum noise sources
- Programme length
- Duct installation method following drilling (from onshore or offshore)

18. The maximum number of individual drills/ducts is common irrespective of landfall method as this is dictated by the electrical arrangement (number of circuits), with each offshore cable circuit requiring its own landfall duct.

19. With regard to the dDCO the definition of 'Horizontal Directional Drilling' is set out at Article 2 and states: *"means a trenchless technique for installing an underground duct between two points without the need to excavate vertical shafts"*.

20. Therefore, although the term Horizontal Directional Drilling is used within the Norfolk Boreas application with respect to the landfall, it remains the case that innovative variations on the HDD method which utilise the principle of HDD (surface to surface drilling without the requirement to sink shafts), such as Direct Pipe®, are not precluded from consideration during detailed design.

1.5 Detailed Design and Further Investigative Works

21. The Applicant has conducted initial ground investigation works at the landfall to confirm the feasibility of HDD at the landfall location and identify geoarchaeological sensitive features such as the Cromer Forest Bed (not identified). The results of the four boreholes are provided in Appendix 28.3 Geoarchaeological Watching Brief Report: Onshore Engineering Ground Investigations (GI) Works (Phase 1) (document 6.3.28.3, APP-671). The geology is summarised as firm to stiff CLAY with some dense SAND. The deeper stratigraphy of the ground investigation indicates the presence of CRAG. The investigations supported the initial British Geological Society data as detailed in Section 3 of the HDD Feasibility Report (document 4.6 – APP-542) which concluded that HDD is feasible with a low risk.

22. Further site investigation works, both onshore and offshore, are required to inform the detailed design of the landfall method with respect to the existing ground conditions and geology. However, this is only part of the information required and the detailed design of the landfall will be dictated by the final offshore cable size (outside diameter) and number to be installed, which will subsequently determine the necessary duct size, associated bore size and method to achieve this. The final offshore cable size and number to be installed will not be known until post consent, following detailed electrical design and engagement with the supply chain, but will be within the design envelope assessed.

23. There is flexibility but sufficient control in the dDCO definition and Rochdale Envelope such that there is no necessity to make a decision on the specific construction method at this point in time. There may be other, newer landfall construction technologies that can be employed within the dDCO definition and Rochdale Envelope when detailed design is conducted following cable size and electrical arrangement determination and once site investigation works are completed which should not be precluded.

1.6 Landfall Method Statement

24. The applicant has committed to producing a landfall method statement, secured under Requirement 17 of the dDCO, which will fully detail the methods and design to be employed, as informed by further investigative works and subsequent detailed design. The landfall method statement is subject to approval by North Norfolk District Council (NNDC) in consultation with Natural England.

1.7 Statutory Stakeholders

25. NE, through the Statement of Common Ground (SoCG) (document ExA.SoCG-17.D0.V1, AS-028), is agreed that landfall at Happisburgh South is a viable option, the design of the landfall works will adopt a suitably conservative approach to ensure cables do not become exposed as a result of erosion and that the landfall avoids impacts on the Cromer Shoal Chalk Beds Marine Conservation Zone (MCZ).

26. NNDC, through the SoCG (Norfolk Boreas North Norfolk District Council Statement of Common Ground, ExA.SoCG-20.D2.V1), is supportive in the use of the HDD long drill to bring cables onshore and notes that any impact on coastal processes would be considered negligible by NNDC.

2 SUMMARY

27. The following provides a summary of this clarification note and the Applicants position:

- HDD is a mature and proven technique, used on numerous offshore wind farm landfalls in the UK. The applicant has conducted a HDD feasibility report and initial ground investigations for the Norfolk Boreas landfall location which support the position that HDD is a suitable landfall method at this location.
- The applicant is aware of new and innovative techniques which could be considered for landfall. Methods such as Direct Pipe® could provide benefits through a single drill/duct installation process over traditional HDD methods, however there are limitations such as the maturity of the technology and untested nature at the scale required by the project at this time. The benefits and drawbacks of each method, and any others which satisfy the dDCO definition and ES assessment, will be considered during detailed design.
- The Applicant has confirmed that techniques which are a variation on the principle of HDD (surface to surface drilling method without the requirement to sink shafts) such as Direct Pipe® are within the assessed design envelope (on the assumption that smaller diameters of Direct Pipe will be achievable for the length required prior to construction) and the definition of horizontal directional drilling as given in the dDCO.
- Further ground investigations are to be conducted onshore and offshore, to inform the detailed design of the landfall with respect to ground conditions. However, the landfall detailed design will be dictated by the final offshore cable designs which will in turn define the size and number of ducts required, which will not be known until post consent following detailed electrical design and engagement with the supply chain.
- The production of a landfall method statement is secured in Requirement 17 of the dDCO, which is to be approved by NNDC in consultation with Natural England.
- NNDC and Natural England are satisfied with the current approach to construction at the landfall, as noted in the relevant SoCGs.