



**SCOTTISHPOWER
RENEWABLES**



East Anglia ONE North Offshore Windfarm

Outline Landfall Construction Method Statement

Applicant: East Anglia ONE North Limited

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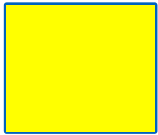
Glossary of Acronyms

ARCMP	Anglian Regional Coastal Monitoring Programme
Cefas	Centre for Environment Fisheries and Aquaculture Science
DCO	Development Consent Order
ES	Environmental Statement
ESC	East Suffolk Council
EU	European Union
HDD	Horizontal Directional Drill
MMO	Marine Management Organisation
OSPAR	Oslo/Paris Convention (for the Protection of the Marine Environment of the North-East Atlantic)
SPA	Special Protected Area
SSSI	Site of Special Scientific Interest



Glossary of Terminology

Applicant	East Anglia ONE North Limited.
Construction consolidation sites	Compounds associated with the onshore works which may include elements such as hard standings, lay down and storage areas for construction materials and equipment, areas for vehicular parking, welfare facilities, wheel washing facilities, workshop facilities and temporary fencing or other means of enclosure.
East Anglia ONE North project	The proposed project consisting of up to 67 wind turbines, up to four offshore electrical platforms, up to one construction, operation and maintenance platform, inter-array cables, platform link cables, up to one operational meteorological mast, up to two offshore export cables, fibre optic cables, landfall infrastructure, onshore cables and ducts, onshore substation, and National Grid infrastructure.
Horizontal directional drilling (HDD)	A method of cable installation where the cable is drilled beneath a feature without the need for trenching.
HDD temporary working area	Temporary compounds which will contain laydown, storage and work areas for HDD drilling works.
Landfall	The area (from Mean Low Water Springs) where the offshore export cables would make contact with land and connect to the onshore cables.
Offshore export cables	The cables which would bring electricity from the offshore electrical platforms to the landfall. These cables will include fibre optic cables.
Offshore cable corridor	This is the area which will contain the offshore export cables between offshore electrical platforms and landfall.
Onshore cables	The cables which would bring electricity from landfall to the onshore substation. The onshore cable is comprised of up to six power cables (which may be laid directly within a trench, or laid in cable ducts or protective covers), up to two fibre optic cables and up to two distributed temperature sensing cables.
Trenchless technique	A method of installation that allows ducts and cables to be installed under an obstruction or area without breaking open the ground and digging a trench (examples of such techniques include horizontal directional drilling, thrust boring, auger boring and pipe ramming).
Transition bay	Underground structures at the landfall that house the joints between the offshore export cables and the onshore cables.



1 Introduction

1.1 Overview

1. This Outline Landfall Construction Method Statement forms part of a set of documents that supports the Development Consent Order (DCO) application (the Application) for the East Anglia ONE North Offshore Windfarm project (the Project) submitted by East Anglia ONE North Limited (the Applicant).
2. Works to be undertaken for the Project includes (amongst other things) the construction of the landfall, where up to two offshore export cables and up to two fibre optic cables are brought ashore by trenchless technique.
3. Requirement 13 of the **draft DCO** (REP5-003) requires the preparation of a Landfall Construction Method Statement, which must be submitted to and approved by the relevant planning authority prior to the commencement of Work Nos. 6 and 8.
4. This Outline Landfall Construction Method Statement presents an overview of the information to be presented within the final Landfall Construction Method Statement, such as construction information, environmental considerations and bentonite mud break-out response planning associated with the landfall construction. It does not include details on the construction of transition bays; onshore cables; temporary construction consolidation sites; haul road; or access, which are also located within Work No. 8. The extent of Works Nos. 6 and 8 are shown in the **Works Plans (Offshore), Sheet 1 of 1** (APP-010), and **Works Plans (Onshore) Sheet 1 of 12** (APP-011), and are shown together in **Figure 1, Appendix 1** of this document.
5. Construction of the landfall will be undertaken using a Horizontal Directional Drill (HDD) method, a commonly used trenchless technique that allows the offshore export cables to be installed under the cliffs, beach and intertidal area without breaking open the ground and digging an open trench through these features. This updated Outline Landfall Construction Method Statement has therefore been prepared on the basis that an HDD installation technique is used.

1.2 Landfall Site Description

6. Up to two offshore export cables will make landfall north of Thorpeness in Suffolk. This site was chosen based on an appraisal of constraints and engineering feasibility from both offshore and onshore perspectives (see **Chapter 4 Site Selection and Assessment of Alternatives** (APP-052) and **Appendix 4.6 Coastal Processes and Landfall Site Selection** (APP-447)).



7. The landfall is characterised by a shingle beach at the wave break point, with a raised terrace of shingle at the base of low-lying cliffs (approximately 10m above ordnance datum) which are partially vegetated by grasses, gorse and other small shrubs. The beach is designated as a Site of Special Scientific Interest (SSSI) for a rich mosaic of habitats including acid grassland, heath, scrub, woodland, fen, open water and vegetated shingle, and is managed by Natural England. There are no formal coastal defences associated with flood prevention or coastal stability at the landfall location. At the landfall the HDD entry pit will be a minimum setback distance of 85m from the cliff top to ensure the integrity of the cliff is not compromised during construction and to allow for natural coastal erosion during operation. The eastern end of the HDD ducts will be buried under the sea bed beyond the intertidal zone.
8. Closest to the coast, the bathymetry of the offshore cable corridor (within Work No. 6) is dominated by an exposed rock outcrop (known as the Coralline Crag) with an irregular surface formed of southwest-northeast oriented ridges between 0.5m and 2m high. The Coralline Crag underpins coastal processes along this section of the coastline which are critical to the coastal processes associated with the water cooling processes and sea defences for the Sizewell B nuclear power station. **Figure 1, Appendix 1** of this document shows the extent of the Coralline Crag as presented in the ES (**Figure 7.7 Offshore Cable Corridor and Landfall** (APP-109)).
9. The length of the HDD will be influenced by the cable design and the HDD drill profile (i.e. the angle of the bore). It is envisaged that the length of the HDD would be approximately 1.7km but would not exceed 2km. This is within the capability of HDD works demonstrated by other HDD projects completed in the UK. The final length of the HDD will be determined during the detail design process based on geology, drill profile and punchout seabed conditions.
10. HDD's, including landfalls, of the lengths proposed for the Project have been drilled on many occasions, with the longest 'single shot' HDDs currently being just over 3km in length. Twenty years ago, a 1km HDD was considered a long HDD, with the first 2km HDD's being completed in 2001. Since then, the frequency of longer HDD's has increased, along with the capability of the HDD rigs, drill pipe, and downhole tooling.

1.3 Rationale for Use of HDD at Landfall

11. The Applicant's commitment to the use of a HDD installation technique at the landfall to avoid potential impacts on the Suffolk coastline as part of the embedded mitigation of the Projects is anticipated to:
 - Avoid direct physical disruption to the nearshore Sizewell Bank;



- Avoid direct physical disruption to the outcrop of Coralline Crag;
- Avoid direct physical disruption to the ness at Thorpeness;
- Avoid interruption of circulatory sediment transport pathways;
- Avoid disturbance to the alongshore sediment transport processes;
- Reduce the risk of suspended sediment (during construction) affecting the Sizewell B Nuclear Power Station's cooling water infrastructure;
- Avoid the need for cable protection measures in the intertidal and shallowest nearshore zones;
- Minimise the need for cable protection measures elsewhere across the sea bed; and
- Avoid interaction with the beach at Thorpeness.

1.4 Consultation

12. The Applicant notes the interests of the Environment Agency, Marine Management Organisation (MMO), Natural England and Sizewell B regarding the construction of the landfall and will consult with these stakeholders in the preparation of the final Landfall Construction Method Statement prior to submission of the final Landfall Construction Method Statement to the relevant planning authority for approval in accordance with Requirement 13 of the ***draft DCO*** (REP5-003).
13. Furthermore, in accordance with requirement 13 of the draft DCO, the MMO and Natural England will also be consulted by the relevant planning authority in the approval of the final Landfall Construction Method Statement.
14. The Applicant will also notify the relevant planning authority of the date when construction of Work No. 6 and Work No. 8 has been completed.

1.5 Interaction with East Anglia TWO

15. Should both the East Anglia ONE North project and the East Anglia TWO project be consented and then built sequentially, when the first project goes into construction, the ducting for the second project will be installed along the whole of the onshore cable route in parallel with the installation of the onshore cables for the first project. This will include the HDD works at the landfall.
16. When the second project then moves into the construction phase, in relation to the landfall works, temporary infrastructure such as haul roads would be installed (where required) to access the works; duct integrity testing and dewatering would be undertaken (where required); transition bays would be constructed and the



offshore export cable brought ashore via the pre-installed ducts and reinstatement would then follow.



2 Geotechnical Investigations

17. Key to ensuring that the design of the trenchless technique is appropriate for the location and can be constructed safely, is understanding ground conditions at the landfall. Detailed onshore and offshore geotechnical investigations will be conducted at the landfall in order to characterise ground conditions, establish the chemical and mechanical properties of the ground and identify the hydrology and hydrogeology of the site and inform the detail design of the HDD solution. Desktop geotechnical studies indicate the ground conditions to be made up of glacial till, crag group and London clay formations. Sufficient flexibility exists in the capacity of HDD drill rigs, range of HDD drill heads available and the design options available (i.e. HDD profile) to ensure a suitable solution can be delivered at the landfall within the bounds of that assessed within the Application.
18. Specifically, onshore investigations at the landfall will include:
 - Boreholes: Drilled to underlying rockhead and providing a profile of soil characteristics through the full depth. There will be a minimum of two boreholes onshore. Boreholes will be securely capped on completion;
 - Hydrological monitoring: At least one of the above-mentioned boreholes will be fitted with hydrological monitoring equipment (i.e. stand pipe and piezometer) to provide ongoing data on groundwater hydrology;
 - Trial Pits: Localised excavations to approximately 3-4m depth in the locations of possible HDD entry pits to identify measures necessary to facilitate construction. Trial pits will be reinstated upon completion;
 - Geotechnical, chemical and environmental laboratory testing: Testing undertaken on samples retrieved during the investigation to provide detailed ground soil profile characteristics and parameter to aid design; and
 - Cliff stability monitoring: Installation of vibration monitoring equipment to establish design parameters and baseline conditions to benchmark against during the HDD drilling works.
19. Onshore geotechnical investigations will be conducted with a small workforce operating from mobile temporary welfare units. Equipment and machinery will be modest in size and likely to be towed by 4x4 vehicles and mid-sized excavators for completion of trial pits. No equipment or machinery associated with the landfall will be operated or stored within the Leiston/Aldeburgh SSSI.
20. Investigations will also be conducted offshore from a vessel, which will provide data to support the HDD design. This will primarily include:



- Boreholes: Drilled in the nearshore area along the potential HDD drill line routes, drilled to rockhead and providing a profile of soil characteristics through the full depth, and associated laboratory testing;
- Bathymetric survey: Providing detailed information for water depths and topography of the seabed; and
- Geophysical survey: Mapping geological features of the seabed, including a focus on confirming the extent of the Coralline Crag within the identified offshore cable corridor.



3 Design

21. The HDD design will be undertaken post consent and will rely on inputs from onshore and offshore pre-construction site investigations as well as information from the detailed cable system design.
22. The design (including tolerances) will be included within the final Landfall Construction Method Statement, and will identify the following:
 - HDD entry pit locations (which (based on coastal erosion studies) will be located a setback distance of 85m from the cliff top to ensure the integrity of the cliff is not compromised and to allow for natural coastal erosion);
 - HDD punch out locations (it is likely that the HDD punch out locations will be to the south of the Coralline Crag outcrop (see **Figure 7.7 Offshore Cable Corridor and Landfall** (APP-109) shown on **Figure 1, Appendix 1** of this document), thereby avoiding direct physical disruption to the nearshore Sizewell Bank, the Coralline Crag outcrop, and the ness at Thorpeness; and avoiding interruption of circulatory sediment transport pathways and disturbance to the alongshore sediment transport processes);
 - HDD drill line routes between the entry pits and the punch out locations, the separation between drill lines being dictated by parameters from the cable design; and
 - HDD drill profiles, dictated by parameters from the cable design.
23. Output from the design phase will also provide recommendations on the drilling methodology to be adopted to best suit the ground conditions and mitigation measures to ensure the stability of the cliffs on the shoreline.



4 Drilling Methodology

4.1 DCO Compliance

24. Prior to commencement of the HDD works, relevant requirements of the **draft DCO** (APP-023) will be complied with, such as Requirement 20 (Archaeology); Requirement 21 (Ecological Management Plan); and Requirement 28 (Traffic).
25. Where conflict arises between archaeological or environmental constraints or obligations, the Applicant will liaise with the relevant stakeholders and seek agreement on the optimal, acceptable solution for the Project.

4.2 Site Set Up

4.2.1 General Set Up

26. Prior to commencement of the HDD works, the general site area will be prepared to a suitable level to facilitate the drilling works and temporary accommodation will be installed to serve the workforce.
27. This will include activities such as:
 - Installation of access to works (i.e. temporary haul road installation along the onshore cable route from Sizewell Gap, if not already constructed for the onshore cable route construction);
 - Preparation of the HDD temporary working area, up to 7,000m² (to accommodate the HDD works) and a temporary construction consolidation site up to 7,040m² in area (to serve the landfall and onshore cable route construction). Typically, this will involve:
 - Stripping and storing (bunding) topsoil in accordance with the approved Soil Management Plan (as part of the Code of Construction Practice secured by Requirement 22 of the **draft DCO** (REP5-003));
 - Installing geotextile to the sub-surface; and
 - Laying and compacting suitable stone material to form a working surface.
 - Installation of welfare facilities for the workforce including connection of services such as water, power, lighting and telecoms services;
 - Installation of security fencing or other means of enclosure in line with the details approved under Requirement 17 of the **draft DCO** (REP5-003). Consideration will be given to the use of appropriately coloured wooden hoarding where views of the fencing and landfall construction area are visible from public rights of way;



- Installation of temporary lighting in line with the approved Artificial Light Emissions Management Plan (as part of the Code of Construction Practice secured by Requirement 22 of the **draft DCO** (REP5-003)); and
- Installation of site surface water and site drainage system in line with the approved Surface Water and Drainage Management Plan (as part of the Code of Construction Practice secured by Requirement 22 of the **draft DCO** (REP5-003)).

4.2.2 Construction Noise Control

28. The Applicant will ensure that acoustic barriers of an appropriate height and specification are erected around the perimeter of the HDD temporary working area or specific items of plant for the duration of the landfall HDD works. This may include the use of surplus spoil arising from the preparatory works to form bunds around the working areas or specific items of plant to attenuate noise associated with landfall construction activities where practicable.
29. Prior to construction, the Applicant will identify the positioning and orientation of plant and equipment involved with the landfall construction in consideration of noise sensitive receptors whilst having regard to the proximity of working areas in relation to the designated sites of nature conservation (i.e. Leiston – Aldeburgh SSSI). The general positions of the plant and equipment will be specified within the final Landfall Construction Method Statement, which must be submitted to and approved by the relevant planning authority prior to commencement of Work Nos. 6 or 8.
30. A Construction Phase Noise and Vibration Management Plan will be prepared post-consent as part of the final Code of Construction Practice secured under Requirement 22 of the **draft DCO** (REP5-003). The Construction Phase Noise and Vibration Management Plan will set out the specific measures in relation to the control of construction phase noise, which will be reflective of the sensitivities of the properties within the vicinity of the landfall, and must be submitted to and approved by the relevant planning authority prior to commencement of the relevant stage of the onshore works.
31. It is noted that physical barriers erected around working areas would provide secondary additional benefits in relation to containing dust which may potentially impact upon sensitive ecological sites, such as the Leiston – Aldeburgh SSSI.

4.3 Excavations

32. HDD entry pits, from where the drilling works will be conducted, will be excavated at each of the designated locations. The Project will require two HDDs to be installed to accommodate each of the offshore export cables. The impact



assessment undertaken by the Applicant provides for up to four HDDs to ensure contingency in the design and delivery of the Project. The Applicants confirm however that should only two HDDs be required and constructed by the Project, no further HDDs will be undertaken.

- 33. Excavations will be benched or shored as necessary to provide a safe working environment with defined access and entry points for the workforce.
- 34. Excavated topsoil will be stored in a designated area and will be kept separate from subsoil to prevent contamination, in line with the approved Soil Management Plan (as part of the Code of Construction Practice secured by Requirement 22 of the **draft DCO** (REP5-003)).

4.4 HDD Drilling

- 35. HDD drill rig(s) and ancillary equipment will be delivered to the site via flatbed heavy goods vehicles and offloaded adjacent to the drill entry locations. An anchor (typically sheet piles) will be installed at each drill location to ensure the rig is securely anchored.

4.4.1 Rig Set-Up

- 36. An indicative layout for the HDD drill rig set up will be presented within the final Landfall Construction Method Statement and will reflect HDD works design and the nature of the equipment to be used.

4.4.2 Pilot Hole

- 37. Following all preparation works, drilling of the pilot hole will commence. A drill bit connected to the gyro steering system and drill pipes will form the 'drill string'. Drilling fluid (bentonite mud) is jetted through the drill string and out through nozzles within the drill bit. The fluid then mixes with arisings from the drilling action and is transported back through the drilled hole to the surface.
- 38. Directional control is achieved via the gyro steering assembly and directional survey of the drill progress are completed at regular intervals (usually at every point the drill advances one 'pipe' length).
- 39. It is common for the pilot hole to stop a short distance from the punch out location on the sea bed (the stop short point). The pilot string will then be retracted through the hole for reaming to commence. On completion of reaming, the hole will be advanced to punch out on the sea bed.

4.4.3 Reaming

- 40. On completion of the pilot hole, the drill string will be retracted, and the first reaming head attached to increase the pilot hole diameter. A bull nose attached



to the front of the reamer and stabilisers behind ensure the assembly is guided through the pilot hole. As with the pilot hole, drilling fluid will transport cuttings back to the onshore site to be recycled. Upon reaching the stop short point, the string will be retracted, and the next sized reamer attached to continue widening the hole. This process will continue until the desired size necessary to accommodate the cable duct assembly is achieved.

41. Upon completion of the reaming process to the stop short point, a final assembly will be installed to the drill string and advanced through the final distance to punch out through the sea bed. The final assembly will be withdrawn from the bore and the pull back assembly will be installed to facilitate the pullback of cable ducts from offshore to onshore.

4.4.4 Pull Back

42. The cable ducts to be installed will be positioned at the HDD punch out locations (offshore). The pull back assembly (attached to the drill string) will be advanced from the HDD punch out locations to an offshore support vessel to allow the attachment each duct.
43. Each duct will be pulled back through each bore by the HDD drill rig positioned onshore (with support from the offshore support vessel), to the HDD entry point.

4.5 Working Hours

44. Use of the HDD technique at the landfall will require 24-hour working at certain times due to the nature of the works, typically during HDD drilling.
45. Continuous periods of construction, such as those associated with trenchless techniques, are permitted within Requirement 23 of the **draft DCO** (REP5-003) subject to the timing and duration of such construction works being approved in advance by the relevant planning authority.



5 Drilling Fluid

5.1 Purpose of Drilling Fluid

46. HDD drilling is undertaken with the help of a viscous drilling fluid (typically bentonite mud), which is usually a mixture of water and bentonite (a non-toxic clay commonly used in farming practices). The bentonite mud is continuously pumped to the cutting head or drill bit to facilitate the removal of cuttings, stabilise the bore, cool the cutting head, and lubricate the passage of the duct.

5.2 Drilling Fluid Management

47. Drilling fluid will be recycled as far as practicable by separating the drill cuttings which the drilling fluid recovers from the cutting head, allowing the cleaned drilling fluid to be reused time and again in a closed drilling fluid cycle. This reduces the use of raw materials (in particular water and bentonite) and reduces the time taken for the drilling progress to be completed.
48. Drilling fluid which is returned to the surface will undergo treatment to separate the drill cuttings through a variety of mechanical methods. The spoil from this process will be collected and disposed of in line with the approved Site Waste Management Plan (as part of the Code of Construction Practice secured by Requirement 22 of the **draft DCO** (REP5-003)).
49. Excess drilling fluid will be stored in tanks to manage the expected volumes and where necessary, removed from site.

5.3 Measures to Prevent Drilling Fluid Break-Out

50. HDD drilling at the landfall carries a potential risk of drilling fluid (or bentonite mud) break-out from the bore due to the bentonite mud being forced through small fractures in the ground at pressure. However, bentonite mud breakouts in these circumstances are rare, as the bentonite is a thixotropic fluid of high viscosity which seals the wall of the drill by the bentonite entering and sealing fissures within the bore.
51. A number of measures will be adopted to prevent or minimise the risk of bentonite breakout and to mitigate its impact in the unlikely event that it occurs, as detailed below and in **Section 5.4**.
52. Ground investigations will be undertaken to establish the ground conditions along the HDD drill profile as described above, allowing a suitable HDD design to be established. Ground investigations will influence such matters as the equipment to be used; HDD entry pit and punch out locations; HDD drill profile; HDD drill depth below ground; bentonite viscosity; the pilot hole diameter; and subsequent



reaming diameter(s), all of which will minimise the risk of bentonite mud break-out during HDD drilling.

53. During HDD drilling, the bentonite mud pressure and fluid levels within the mud tanks will be monitored. Where bentonite mud pressure loss or reductions in returns to the mud tanks is detected, the operator will reduce the bentonite mud pressure within the bore where possible, thereby reducing the risk of bentonite mud break-out.
54. To mitigate the risk of bentonite mud break-out in the location of the HDD entry pit during the pilot hole stage (one of the most sensitive sections of the HDD drill), casing will be installed in the first ca. 100m of the HDD drill. The casing will remain in place for the duration of the pilot hole drilling and will provide physical containment of bentonite mud within the casing. Upon completion of the pilot hole and prior to the first reaming the casing will be extracted by the HDD drill rig.

5.4 Bentonite Mud Break-Out Response Planning

55. In the unlikely event that a bentonite mud break-out is confirmed, drilling works will be reduced or halted, with bentonite mud re-introduced periodically under pressure to plug the break-out channel. Should this prove unsuccessful, additional products known as loss circulation materials will be introduced to plug the point of mud egress. These loss circulation materials will be mixed and pumped into the HDD drill via the drill string. Once the plug has been left to set for the required period, the drilling works will resume with careful observation of the break-out location.
56. Where bentonite mud break-out is confirmed to have occurred, a visual inspection will be undertaken along the HDD drill line route to identify the location and extent of the bentonite mud break-out and sandbags (available on site) will be used to contain the bentonite mud. The Applicant will advise the relevant planning authority and relevant statutory nature conservation body within 24 hours of a bentonite mud break-out being confirmed and discuss how the bentonite mud will be removed.
57. Means to remove the bentonite include collecting with a flexible hose and pump or similar method. The collected material will be transported directly to an approved waste management facility or returned to the works area and reused. The affected area will be flushed with clean water if agreed with the relevant statutory nature conservation body.
58. In the unlikely event that a bentonite mud break-out is confirmed to have occurred, no new HDD bores will commence until the break-out is investigated and a review of the HDD design parameters is undertaken to establish whether



any modifications to the HDD design and construction method statement are necessary to reduce the risk of further break-outs. Such modifications may include changes to the HDD drill profile, bentonite mud mixture or drilling pressures.

59. Contact details for the relevant planning authority and relevant statutory nature conservation body will be provided within the final Landfall Construction Method Statement for ease of reference.



6 Potential Environmental Effects of Bentonite Mud Break-Out

6.1 Leiston-Aldeburgh Site of Special Scientific Interest

60. The Leiston-Aldeburgh SSSI contains a rich mosaic of habitats including acid grassland, heath, scrub, woodland, fen, open water and vegetated shingle. This mix of habitats in close juxtaposition, and the associated transition communities between habitats, is unusual in the Suffolk Coast and Heaths. The variety of habitats support a diverse and abundant community of breeding and overwintering birds, a high number of dragonfly species and many scarce plants.
61. On the vegetated shingle there is a gradual transition between the strandline community and the shingle heath resulting from increasing stability and distance from tidal influence. On the open shingle, sea-kale *Crambe maritima* and yellow horned poppy *Glaucium flavum* are frequent with the irregularly occurring sea spurge *Euphorbia paralias*. The stable shingle areas support many species including early hair-grass *Aira praecox*, the nationally scarce sand catchfly *Silene conica*, dune fescue *Vulpia fasciculata*, bur medick *Medicago minima*, suffocated clover *Trifolium suffocatum* and sea pea *Lathyrus japonicus* (Natural England 2020).
62. It should be noted that HDD avoids any interaction with Leiston-Aldeburgh SSSI. As such, the intertidal features of the Leiston-Aldeburgh SSSI will not be affected directly by the construction of the landfall.

6.2 Consideration of Potential Impacts

63. The Leiston-Aldeburgh SSSI is a nationally designated site which meets the published selection criteria for national designation. The SSSI contains viable areas of coastal vegetated shingle, a habitat type listed in Annex I of the EU Habitats Directive ('perennial vegetation of stony banks'). It supports a unique range of flora and fauna that are adapted to the harsh conditions that are present at such locations.

6.2.1 Breakout at Sea

64. As discussed in **Section 5**, HDD drilling is undertaken with the help of a viscous fluid known as drilling mud. It is typically a mixture of water and bentonite (a non-toxic naturally occurring clay commonly used in farming practices). Bentonite is recognised by the Centre for Environment Fisheries and Aquaculture Science (Cefas) as being fully biodegradable and is on the Oslo/Paris convention (for the Protection of the Marine Environment of the North-East Atlantic) (OSPAR)) 'List



of Substances Used and Discharged Offshore which are considered to Pose Little or No Risk to the Environment¹.

65. Bentonite mud could potentially be lost to sea at the HDD punch out location, either during the punching out, reaming or duct installation. This could cause the bentonite mud to settle on intertidal shingle habitat and have potential smothering effects. However, in marine environments the smothering effect is less problematic because seawater degrades the drilling fluid, causing the bentonite to flocculate and be rapidly dispersed within one tidal cycle (Rigall 2018). Owing to the rapid dispersal and short-term nature of potential bentonite mud release, it is not considered to be of significance. Any risk of bentonite mud break-out will be further minimised by robust HDD design and control measures which will be defined within the final Landfall Construction Method Statement.

6.2.2 Surface Breakout on Land

66. As previously described in **Section 5.3**, given the design measures to be adopted to minimise the risk of surface-breakout of bentonite mud, it is considered that there is no impact pathway for surface-breakout on the Leiston-Aldeburgh SSSI.
67. In the unlikely event that a bentonite mud break-out is confirmed to have occurred, the measures outlined in **Section 5.4, Bentonite Mud Break-Out Response Planning** above will be implemented.

6.2.3 Subsurface Breakout on Land

68. As previously described in **Section 5.3**, given the design measures to be adopted to minimise the risk of surface-breakout of bentonite mud, it is considered that there is no impact pathway for subsurface breakout on the Leiston-Aldeburgh SSSI.
69. The design of the final HDD works will be subject to a hydrogeological risk assessment, to be undertaken pre-construction to consider and assess the risk to groundwater from the works and ensure the protection of existing water abstractions (if any).
70. In the event of a bentonite mud break-out, bentonite mud may be lost to the ground (i.e. subsurface). This exposure pathway could lead to potential degradation to the chemical status and quality of groundwater aquifers. The Leiston-Aldeburgh SSSI is designated due to the acid grassland, heath, scrub, woodland, fen, open water and vegetated shingle habitats that it supports. Given that the underlying ground at the landfall is partly associated with the Leiston-

¹ OSPAR List of Substances available at:
<https://www.cefas.co.uk/data-and-publications/ocns/downloads-and-useful-links/>



Aldeburgh SSSI, due to the interaction between SSSI habitats (wetland such as fen, marsh and swamp and standing open water) and where they are located in proximity to the potential areas for subsurface breakout, it is considered to be a high sensitivity receptor.

71. A sub-surface breakout would however be small and involve a localised release of biodegradable material. Bentonite is a thixotropic fluid of high viscosity which seals the wall of the drill by the bentonite entering and sealing fissures within the bore, minimising the risk of a significant loss of drilling fluid to surrounding ground (subsurface breakout).
72. Given that the bentonite used as the base for the drilling fluid is a naturally occurring, non-toxic clay, any losses into the aquifer will not contaminate the aquifer. There is a range of environmentally inert drilling fluid additives that can be used for modifying the properties of the drilling fluids to suit the ground conditions encountered. Ground investigations (see **Section 2**) will provide further information on the permeability of the ground and allow selection of additives suitable to ground conditions and use in aquifers.
73. The Applicants have undertaken an early hydrogeological risk assessment for the Project's HDD works at the landfall (REP6-021). This concludes that there will be no degradation of the aquifer.
74. Given the proximity of the wells supplying Ness House and associated properties within the vicinity of the landfall, all affected landowners and water supplies will be monitored appropriately during construction works. Standard mitigation, where required, would include pre- and post-construction monitoring surveys of the water supply, development of risk management measures and, subject to voluntary agreements, the preparation of contingency supply arrangements.



7 Cliff Stability

75. The Applicant recognises the importance of ensuring the integrity of cliffs under which the HDD drill lines are routed, during construction and operation of the Project.
76. The HDD entry pit locations onshore will be located a setback distance of 85m from the cliff top to ensure the integrity of the cliff is not compromised and to allow for natural coastal erosion during operation of the Project.
77. The transition bay will be located a setback distance of at least 85m from the current mapped top of the cliff line. The outline design of the HDD is approximately 10m below the beach level of the cliff line even at the maximum predicted 100-year erosion extent. The depth of the HDD will be deeper below the toe of the existing cliffs, potentially between 15m and 20m below the toe level. This is to ensure the integrity of the cliff is not compromised and to account for natural coastal erosion during the operational life of the Projects.
78. The British Geological Survey Geological Map Sheet 191 (solid and drift) 1:50,000 shows a thin strip of Lowestoft Till formation outcropping along the cliff line to the north of Thorpeness. The anticipated thickness (depth) and geometry of the superficial deposits is such that directional drilling is expected to pass through these and be within the underlying bedrock (Crag Group) where the HDD passes under the current cliff line.
79. HDD uses rotary rather than percussive drilling and only minor vibrations are expected. The detailed design will be developed to take into account the anticipated levels of vibration from the proposed drilling equipment to ensure the integrity of the cliff. The HDD drill profile will be established to take into account the capacity/size of the HDD drill rig being utilised and the vibration levels generated by the rig, to ensure the integrity of the cliff is not compromised during HDD drilling. The HDD drill profile will ensure the HDD bores can achieve the maximum possible depth beneath the cliffs in order to minimise the impact of the HDD drilling on the stability of the cliffs.
80. Vibration monitoring will be undertaken in the vicinity of the cliffs as part of the site investigation works to gather background data on vibration levels under normal conditions. This data will be examined to establish a suitable vibration limit which will be maintained during HDD drilling to ensure the integrity of the cliffs are maintained.
81. Vibration monitoring points will then be undertaken in the vicinity of the cliffs for the duration of the HDD drilling. The HDD drill rig operators will monitor vibration



levels, modify the HDD drilling to avoid the maximum vibration limit from being exceeded. Where the maximum vibration limit is exceeded, HDD drilling will be stopped, and the method statement reviewed so as to maintain the maximum vibration limit on recommencement of HDD drilling.

82. The final Landfall Construction Method Statement will include further information on the vibration monitoring to be undertaken to ensure the integrity of the cliffs is not compromised.



8 Monitoring and Remedial Action

83. As per Requirement 13 of the ***draft DCO*** (to be submitted at Deadline 7) the Applicant will undertake monitoring of the landfall for significant changes to coastal processes at this location. An Outline Landfall Monitoring Plan is presented within ***Appendix 2*** of this Outline Construction Method Statement, which sets out the proposed monitoring and reporting procedures to be implemented. The final Landfall Monitoring Plan will be prepared post-consent and must accord within the Outline Landfall Monitoring Plan.
84. Where landfall monitoring identifies a risk that Work Nos. 6 or 8 could become exposed during the operation of the Project, written proposals for remedial works or mitigation measures to protect Work Nos. 6 or 8 from coastal retreat must be submitted to and approved by the relevant planning authority. Any such remedial works must be implemented as approved.

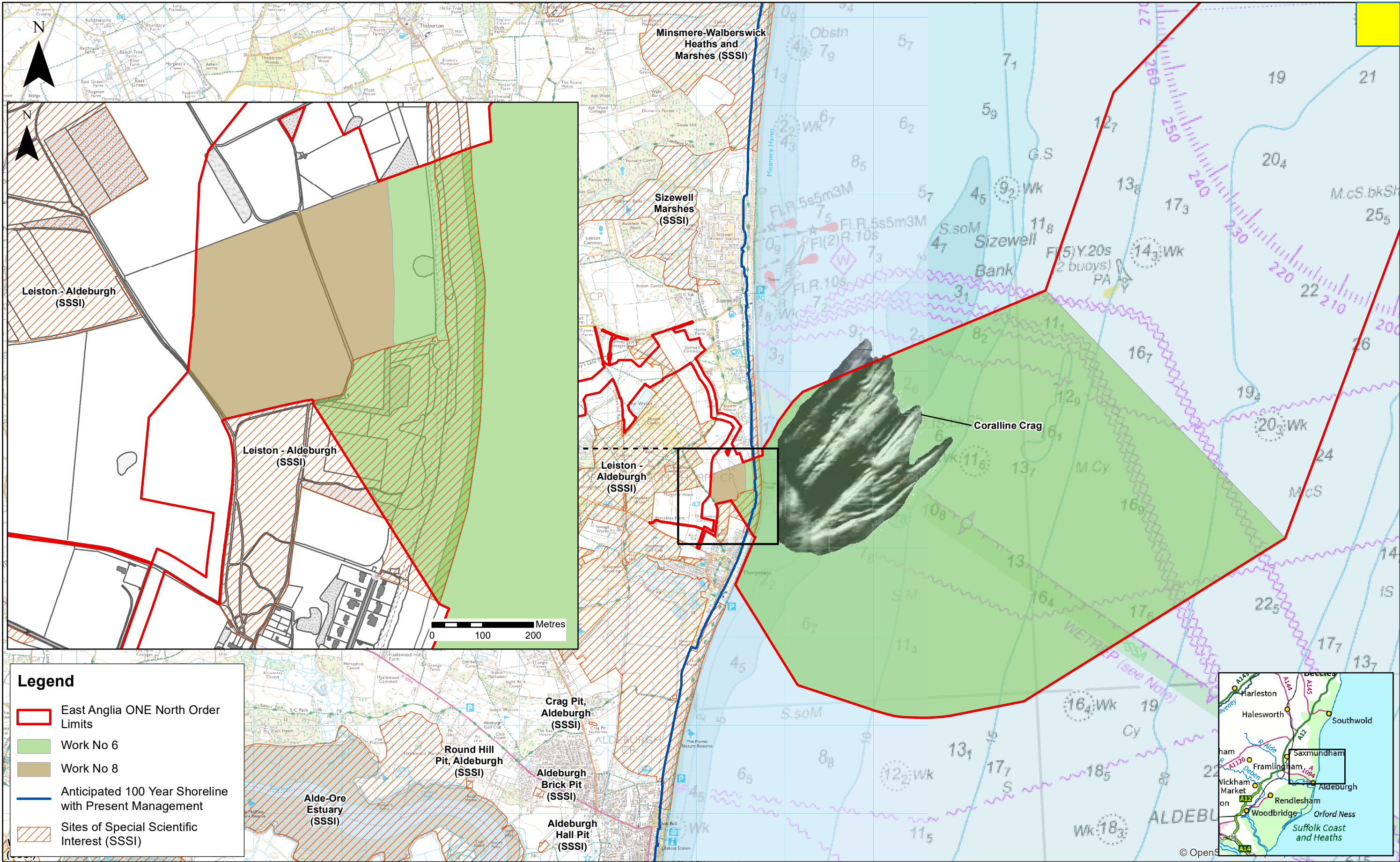


9 References

Rigall, T. (2018). HDD Feasibility Report: Cable Landfall Site at Happisburgh for Vanguard and Boreas Windfarms, U.K. Report No. 20171201RA-FR01



Appendix 1: Figures



2	24/02/2021	AB	Second Issue.
1	26/10/2020	AB	First Issue.
Rev	Date	By	Comment

Prepared: AB

Checked: BD

Approved: PP

1:40,000

Scale @ A3



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East Anglia ONE North

Landfall (including extent of Work No. 6 and 8, and the Coralline Crag)

Drng No	EA1N-DEV-DRG-IBR-001184
Rev	2
Date	24/02/21
Figure	1

Coordinate System: BNG

Datum: OSGB36



Appendix 2 Outline Landfall Monitoring Plan

1 Introduction

1. This Outline Landfall Monitoring Plan has been prepared to outline the monitoring and reporting to be undertaken by East Anglia ONE North Limited (the Applicant) at the landfall of the East Anglia ONE North offshore windfarm project (the Project) to establish the current and future coastal erosion regime where the Project's offshore export cables make landfall north of the village of Thorpeness, Suffolk.
2. Requirement 13 of the ***draft DCO*** requires the submission to and approval of a Landfall Monitoring Plan, which must accord with this Outline Landfall Monitoring Plan. The same Requirement specifies that the Landfall Monitoring Plan must be implemented as approved. As such, the Applicant will undertake monitoring of the landfall for significant changes to coastal processes at this location in line with the approved Landfall Monitoring Plan, which must accord with this Outline Landfall Monitoring Plan.
3. Where landfall monitoring indicates that Work Nos. 6 or 8 could become exposed during the operation of the Project, written proposals for remedial works or mitigation measures to protect Work Nos. 6 or 8 from coastal retreat, together with a timetable for their implementation, must be submitted to and approved by the relevant planning authority as soon as practicable. Any such remedial works must be implemented as approved.
4. This Outline Landfall Monitoring Plan is structured into the following sections:
 - Section 2 Landfall Site Baseline;
 - Section 3 Landfall Monitoring Plan;
 - Section 4 Reporting; and
 - Section 5 Mitigation or Remedial Action.



2 Landfall Site Baseline

2.1 Baseline Description

5. The Project's offshore export cables make landfall within an offshore cable corridor that is located north of the village of Thorpeness, Suffolk.
6. The coastal processes operating along the coastline between Dunwich and Thorpeness and the reasons for selecting the landfall location are described in **Appendix 4.6 Coastal Processes and Landfall Site Selection** of the Environmental Statement (ES) (APP-447).
7. The cliffs at the landfall are represented by the Pleistocene rocks and sediments (mainly sands and gravelly sands) of the (undifferentiated) Crag Group.
8. In the nearshore sea bed, underneath and outcropping just seaward of a ness feature called 'Thorpe Ness' (not to be confused with references to the village of Thorpeness) is an area of older rock from the Pliocene, formed from the Coralline Crag formation. This relatively erosion-resistant marine deposit is characterised by sometimes silty, medium to coarse shelly sands strongly influenced by debris from marine invertebrate species. This bank-like feature exerts an important geological control on the geomorphological evolution of the wider coastline.
9. The Crag Group and the Coralline Crag are unconformably underlain by the Tertiary age Thames Group London Clay Formation comprising sandstones and mudstones.
10. The beaches are generally characterised by more recently deposited (Holocene) sand with a superficial covering of gravel, but specifically at Thorpe Ness there is a substantial accumulation of gravel within a ness feature which appears to be controlled by the outcrop of Coralline Crag and in turn strongly influences sediment transport and coastal processes along the shore and nearshore.

2.2 Natural Erosion

11. Erosion of the beaches and cliffs to the south of Thorpe Ness has prompted various coastal protection works over past years and decades to the village of Thorpeness, whereas the beaches and cliffs at the ness and to the immediate north (at the landfall location) are generally more stable. This is reflected in analysis of the beach profiles along this frontage captured as part of the Anglian Regional Coastal Monitoring Programme and is due to these frontages being afforded protected by the sheltering and stabilising effects of the Coralline Crag outcrop, the accumulation of gravel within the ness itself and, just north of the ness, the southern end of the nearshore Sizewell Bank (sandbank).



12. Based on analysis of erosion rates along the coast between Dunwich and Thorpeness, using survey data of changes over time, it is known that the stretch of coastline where the landfall is located is relatively stable with rates of cliff recession generally being less than 0.1m/year. The relative stability is due largely to the sheltering presence of the Dunwich and Sizewell sand banks and the sheltering presence of Thorpe Ness.
13. A fuller account of the existing erosion regime is presented within **Appendix 4.6 Coastal Processes and Landfall Site Selection** (APP-447).



3 Landfall Monitoring Plan

3.1 Objectives

14. The objectives of the Landfall Monitoring Plan are to quantify the beach profile and cliff top changes along, or in the close vicinity of, the alignment of the HDD bores following construction of the landfall and during the operational life of the Project.
15. This will enable both landward cliff recession and beach profile lowering to be monitored, if these processes are occurring, in order to:
 - Corroborate the projections of future coastal change along the landfall frontage that were made in **Appendix 4.6 Coastal Processes and Landfall Site Selection** (APP-447);
 - Establish the coverage between the 'as built' HDD profiles and the cliff and beach profiles.

3.2 Monitoring

16. Due to the availability of high quality data collected by the Environment Agency as part of the Anglian Regional Coastal Monitoring Programme (ARCMP), it is agreed with East Suffolk Council (ESC) to utilise this ongoing data collection to fulfil the stated objectives (whilst the ARCMP remains ongoing²).
17. The ARCMP began in 1987 and was the first regional-scale programme in the UK. It has run uninterrupted until 2021 and funding its continuation over the next 6-year phase is committed by central Government until 2027.
18. The aims of the ARCMP have been to provide essential coastal data to inform sea flooding and coastal erosion risk management decisions between the Humber and Thames estuaries, which includes the low-lying and potentially vulnerable East Anglian coastal frontage.
19. The coastal frontage at the landfall is well covered by beach profile data from the existing ARCMP, with beach profile transect surveys typically undertaken twice a year.

² Should surveys collected by others cease, the Applicant will undertake a beach profile transect survey along the alignment of the HDD bores, annually or every 5 years depending on reporting cycle, from 10m inland from clifftop to Mean Low Water Springs (MLWS).



20. The precise locations of the HDD bores within the landfall area is yet to be finalised, but it is likely that existing ARCMP profiles between TN006 and TN012 will be sufficient to representatively cover the locations of HDD bores.
21. The ARCMP occasionally undertake photographic or Light Detection and Ranging (LiDAR) surveys, enabling changes in cliff top position to be mapped and three-dimension changes in beach morphology to be established. Such data will be reviewed as and when it is available as part of the Landfall Monitoring Plan as appropriate.



4 Reporting

22. Landfall Monitoring reports shall be prepared presenting the analysis and interpretation of the coastal changes (cliff top and beach level) at the landfall, as derived from the available beach profile survey data, as follows:
- The first Landfall Monitoring report (Year 1) will utilise profile data from the first available ARCMP survey that is undertaken following completion of the HDD bores. This report will also include a historic review, covering the previous 5 years of profile data available from the ARCMP.
 - The second and third Landfall Monitoring reports (Years 2 and 3) will be produced one year and two years, respectively, after the first report. Again, these reports will utilise the profile data from the latest available ARCMP surveys that have been undertaken at the time of writing.
 - On the assumption that the first three years of annual Landfall Monitoring reports (Years 1 – 3) corroborate that no significant unpredicted changes to the coastline have occurred since completion of the landfall construction, the frequency of reporting will reduce to every five years thereafter (i.e. Years 8, 13, 18, 23, etc.) until the Project is decommissioned. Where a five-yearly report identifies a significant change from the predicted changes to the coastline, the Applicant will consult the relevant planning authority and agree a more frequent reporting frequency for an agreed period of time.
23. Each Landfall Monitoring report will present beach profile data from the ARCMP surveys undertaken along, or in close vicinity to, the alignment of the HDD bores as well as the predicted profile based on the 'worst case' conservative assumptions used to inform the Project's EIA and the 'as build' profile of the HDD bores.
24. When supplementary survey records, such as aerial photography or LiDAR surveys become available from the ARCMP (or similar other programmes), their analysis and interpretation will be incorporated within the relevant Landfall Monitoring report to further contextualise the findings.
25. Each Landfall Monitoring report will be submitted to ESC and Natural England.



5 Mitigation or Remedial Action

26. In the event that inspections carried out in accordance with the landfall monitoring plan indicate that (as a result of the rate and extent of landfall erosion) Work Nos. 6 or 8 could become exposed during the operation of the Project, the Applicant must, as soon as practicable, submit to the relevant planning authority written proposals for remedial works or mitigation measures to protect Work Nos. 6 or 8 from coastal retreat, together with a timetable for their implementation, for approval. Any such remedial works or mitigation measures must be implemented as approved.