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# White Cross Offshore Wind Farm ES Addendum

## Appendix F: Coastal Geomorphology Technical Note

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# Glossary of Acronyms

| Acronym | Definition |
|---|---|
| **BAS** | Burial Assessment Study |
| **BH** | Borehole |
| **CBRA** | Cable Burial Risk Assessment |
| **CEMP** | Construction Environmental Management Plan |
| **EIA** | Environmental Impact Assessment |
| **ES** | Environmental Statement |
| **HDD** | Horizontal Directional Drill |
| **km** | Kilometre |
| **m** | Metre |
| **MHWS** | Mean High Water Springs |
| **MLWS** | Mean Low Water Springs |
| **MMMP** | Marine Mammal Mitigation Plan |
| **MMO** | Marine Management Organisation |
| **OD** | Ordnance Datum |
| **UK** | United Kingdom |
| **WCOWL** | White Cross Offshore Windfarm Limited |

## Glossary of Terminology

| Defined Term | Description |
|---|---|
| **Applicant** | White Cross Offshore Windfarm Limited |
| **Environmental Impact Assessment (EIA)** | Assessment of the potential impact of the proposed Project on the physical, biological and human environment during construction, operation and decommissioning. |
| **Export Cable Corridor** | The area in which the export cables will be laid, either from the Offshore Substation or the inter-array cable junction box (if no offshore substation), to the NG Onshore Substation comprising both the Offshore Export Cable Corridor and Onshore Export Cable Corridor. |
| **Landfall** | Where the offshore export cables come ashore. |
| **Mean high water springs** | The average tidal height throughout the year of two successive high waters during those periods of 24 hours when the range of the tide is at its greatest. |
| **Mean low water springs** | The average tidal height throughout a year of two successive low waters during those periods of 24 hours when the range of the tide is at its greatest. |
| **Mean sea level** | The average tidal height over a long period of time. |
| **Mitigation** | Mitigation measures have been proposed where the assessment identifies that an aspect of the development is likely to give rise to significant environmental impacts, and discussed with the relevant authorities and stakeholders in order to avoid, prevent or reduce impacts to acceptable levels.<br>For the purposes of the EIA, two types of mitigation are defined:<br>Embedded mitigation: consisting of mitigation measures that are identified and adopted as part of the evolution of the project design, and form part of the project design that is assessed in the EIA.<br>Additional mitigation: consisting of mitigation measures that are identified during the EIA process specifically to reduce or eliminate any predicted significant impacts. Additional mitigation is therefore subsequently adopted by WCOWL as the EIA process progresses. |
| **Offshore Export Cables** | The cables which bring electricity from the Offshore Substation Platform or the inter-array cables junction box to the Landfall. |
| **Offshore Export Cable Corridor** | The proposed offshore area in which the export cables will be laid, from Offshore Substation Platform or the inter-array cable junction box to the Landfall. |
| **the Project** | the Project is a proposed floating offshore windfarm called White Cross located in the Celtic Sea with a capacity of up to 100MW. It encompasses the project as a whole, i.e. all onshore and offshore infrastructure and activities associated with the Project. |
| **White Cross Offshore Windfarm Limited** | White Cross Offshore Windfarm Ltd (WCOWL) is a joint venture between Cobra Instalaciones Servicios, S.A., and Flotation Energy Ltd. |

# 1. Coastal Geomorphology Technical Note

## 1.1 Cable Installation and Potential Cable Exposure at the Landfall

1. As indicated in **Chapter 8: Marine Geology, Oceanography and Physical Processes, Section 8.5.1** of the **Onshore ES**, as part of the export cable installation process at Landfall, the worst-case scenario is open trenching to bury two cables across the entire width of Saunton Sands. The results of surveys and site investigations that were completed after the submission of the applications for the Project have resulted in the design evolution of the installation process at Landfall. A cable plough will now be used to create a trench up to 0.5m wide, with a burial depth of between be 0.5m at a depth of 3m resulting in 3,000m$^3$ of excavated sediment. This excavated sediment would be backfilled into the trench to re-instate the intertidal beach to its original morphology.

2. One of the main uncertainties in the landfall construction methodology is the depth to which the cables should be buried across the beach. At the landfall (landward of MLWS), the beach sand overlies bedrock. It is important to define the depth of burial, so that over the design lifetime of the cables (50 years), the risk of exposure is reduced if beach levels lower (potentially because of sea-level rise) into the future. The specifics of the depth, and volumes, are awaiting completion of the final CBRA. However, a draft CBRA is provided as **Appendix U: Updated Cable Burial Risk Assessment** (WHX001-FLO-CON-ENG-RSA-0001) of the **ES Addendum**.

3. The following sections of this technical define the geological sequence of the nearshore and coast, the thicknesses of the units, and the potential for morphological change of the beach, to support the assessment of potential cable exposure, and includes references to the **Offshore ES** and **Onshore ES** where these elements have already been identified.

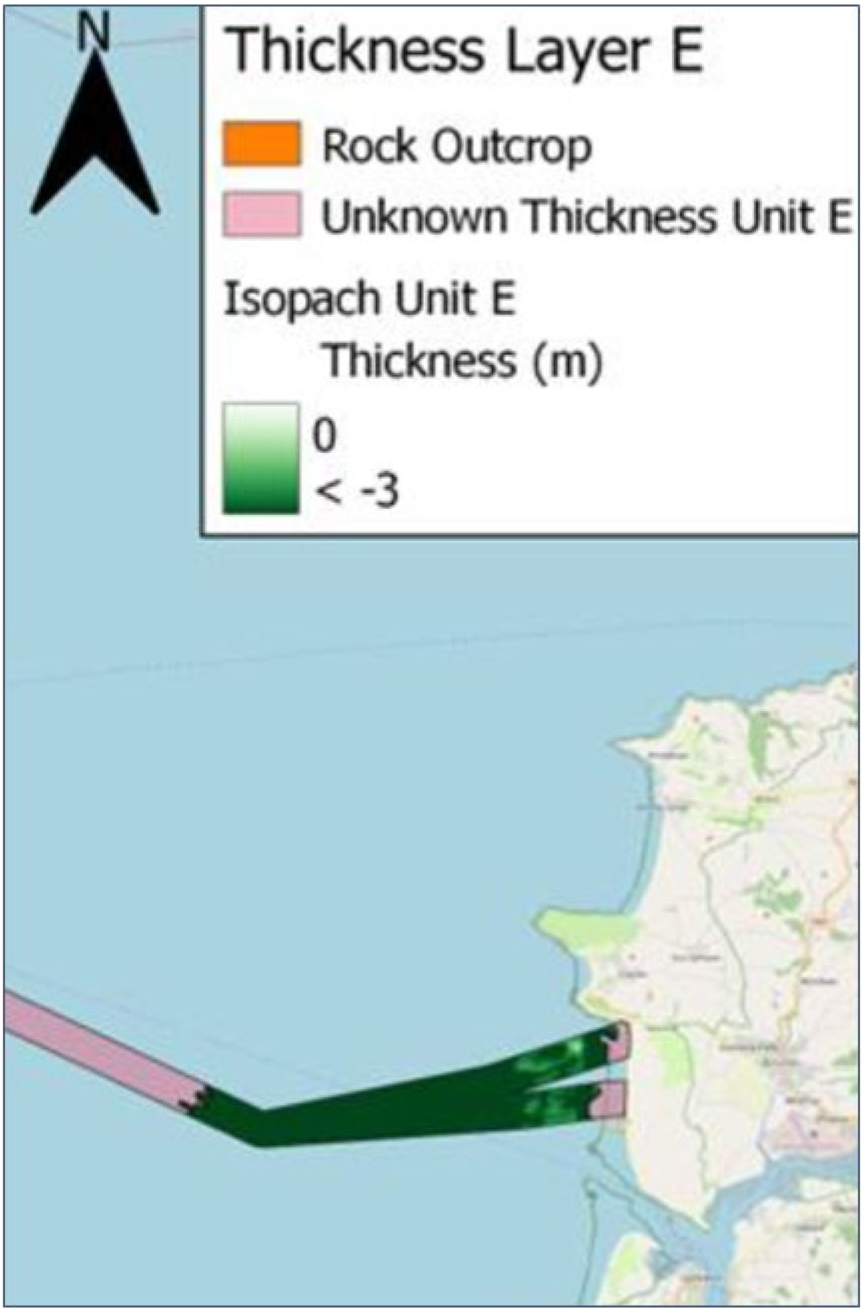
### 1.1.1 Nearshore Geology

4. To map the shallow geology of the nearshore zone, Wood (2022) deployed a sub-bottom profiler between June and August 2022. For interpretation purposes, the nearshore zone along the Offshore Export Cable Corridor was defined as between water depths of +3.7m LAT and -25.1m LAT (from the coast to about 10km offshore, Figure 8.2 of the Offshore ES). Here, the seabed is flat and featureless and composed of sand. In the nearshore zone, Wood (2022) identified a two-part geological sequence interpreted from the geophysical survey (**Chapter 8: Marine Geology, Oceanography and Physical Processes, Section 8.4.1.2, paragraph 45** of the **Offshore ES**). These are

Unit B (bedrock defined as sub-horizontal deposits by Wood, 2022) overlain by Holocene fine sand of Unit E. The base of Unit E is marked by reflector R1.

5. The thickness of Unit E is presented in **Figure 1.1** (part of *Figure 5.59* in the Wood, 2022 report) and described in **Section 5.5.2** of **Appendix 8.B: Geophysical Survey Results Report** of the **Offshore ES**. Wood (2022) state: 'Unit E has a thickness of around 7m at the landfall approach (this isn't obvious on the figure as it is difficult to decipher based on the colours and the scale that is used). Then, approximately 1km away from the shoreline, the Unit thickness decreases rapidly to 2m to 3m. From there, the seismic signature gets more erratic and an unconformity with the seabed and underlying reflector R1 is recognisable. During the following four kilometres (i.e. from 1km offshore to 5km offshore), the isopach values range from 2m to 5m, occasionally less, as two small outcrops were detected.

*Figure 1.1 Thickness of the Holocene sand along the nearshore part of the Offshore Export Cable Corridor (Wood, 2022)*



6. In summary, approaching the landfall, the Holocene sand is around 7m thick (but could be thinner or thicker going landward as the vessel could not get into the shallow water). Further offshore (out to 5km) the sand is between 2m and 5m thick (**Appendix 8.B: Geophysical Survey Results Report, Section 5.5.2** of the **Offshore ES**).

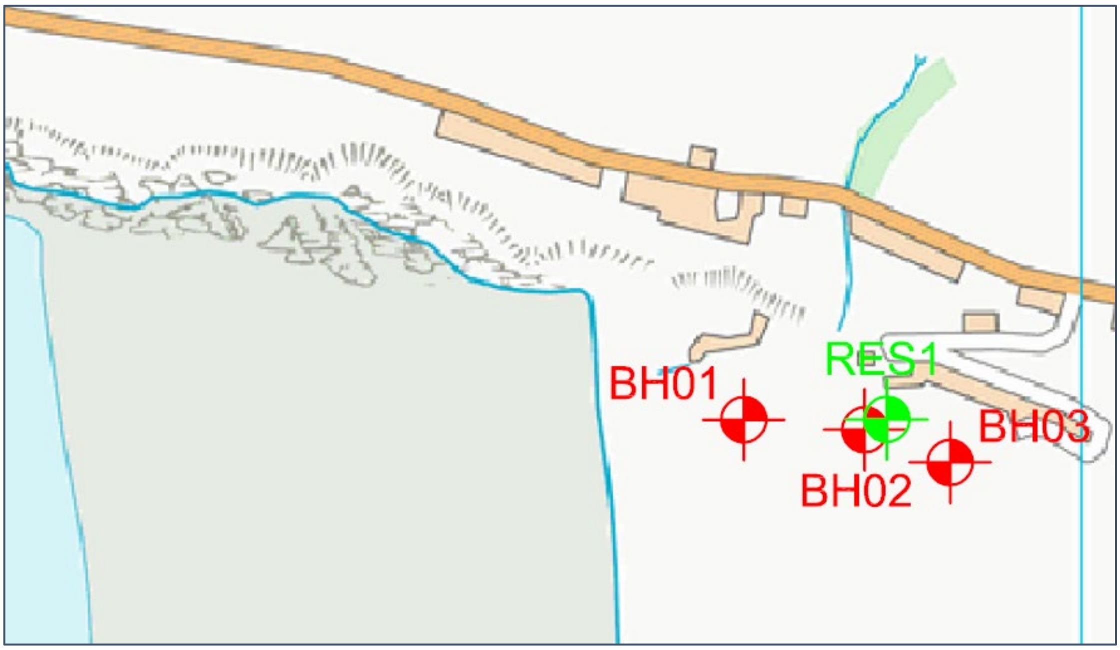
### 1.1.2 Coastal Geology

7. The Offshore Export Cable Corridor will make Landfall at the northern end of Saunton Sands fronting Saunton Sands Car Park where the coast is dominated

by a wide sand beach and the extensive dune system of Braunton Burrows. The beach-dune system extends southwards approximately 5km from the resistant cliff headland of Saunton Down (immediately north of Landfall) into the mouth of the Taw-Torridge Estuaries.

8. The geological sequence along the Onshore Cable Route is described in **Appendix T: Onshore Ground Investigation Interpretative Report** of the **ES Addendum** (Raeburn Drilling & Geotechnical (2023)) through a suite of 18 boreholes and 17 trial pits recovered from Saunton Sands Car Park as part of the Onshore Ground Investigations undertaken for the Project in September to October 2023, south to a new or existing substation at East Yelland on the south bank of the Taw Estuary. Three boreholes (BH01-BH03) are in Saunton Sands Car Park and are used here to describe the geology (**Figure 1.2**). None of the boreholes are located on the beach. However, a geophysical survey (seismic refraction) was completed across Saunton Sands beach to map the depths to bedrock (TerraDat, 2023).

*Figure 1.2 Location of three boreholes in the car park at the Landfall (Raeburn Drilling & Geotechnical, 2023)*



9. The boreholes BH01 and BH03 describe a three-part geological sequence (**Table 1.1**), comprising siltstone/mudstone bedrock (Pilton Mudstone Formation), overlain by fine to medium (coarse towards top) sand (dune sand), overlain by made ground to the car park surface. BH02 did not penetrate bedrock. The dune sand is 6.6m to 11.50m thick overlain by 0.6m to 1.0m of made ground. The top of the bedrock is at +0.69mOD in BH01 and +1.67mOD in borehole BH02.

*Table 1.1 Stratigraphy of boreholes BH01-BH03 recovered in the car park at the Landfall (Raeburn Drilling & Geotechnical, 2023)*

| Geology | Elevation of the Top (mOD) | | |
|---|---|---|---|
| | **BH01** | **BH02** | **BH03** |
| **Made Ground** | 13.19 | 13.06 | 8.87 |
| **Dune Sand** | 12.19 | 12.36 | 8.27 |
| **Bedrock** | 0.69 | Unknown | 1.67 |

10. The seismic refraction survey **Annex 1: Onshore Ground Investigation Factual Report** to **Appendix T: Onshore Ground Investigation Interpretative Report** of the **ES Addendum** (TerraDat, 2023) comprised two lines forming a cross, approximately central to the proposed Landfall corridor traversing the beach (**Figure 1.3**). Borehole BH01 is located approximately 330m east of the centre point of the cross (pink dot on **Figure 1.3**). The cross is in the zone defined as 'Unknown Thickness Unit E' on **Figure 1.1**, seaward of which the thickness of sand has been mapped using sub-bottom profiling.

*Figure 1.3 Location of the seismic refraction lines on Saunton Sands beach at the Landfall (TerraDat, 2023)*

11. The survey recorded a two-part sequence of marine deposits overlying the Pilton Formation bedrock at a depth of approximately -4.5m to -7m OD (**Figure 1.4** and **Figure 1.5**). The top of the bedrock shallows from west to east and from north to south within the confines of the cross. The thickness of the marine deposits increased from 5.5m to 6.5m in an east to west direction and from 5.5m to 7.5m in a north to south direction within the confines of the cross.

*Figure 1.4 Cross-section along the west (left) to east (right) seismic refraction survey line showing the two-part geological sequence (above and below the white dashed line) (TerraDat, 2023). Location of the line is shown on Figure 1.3*

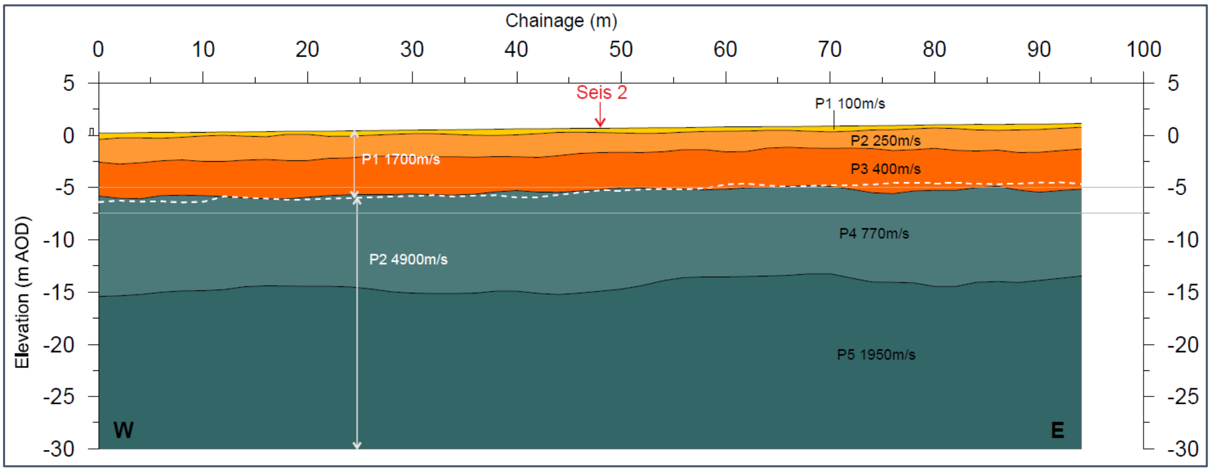
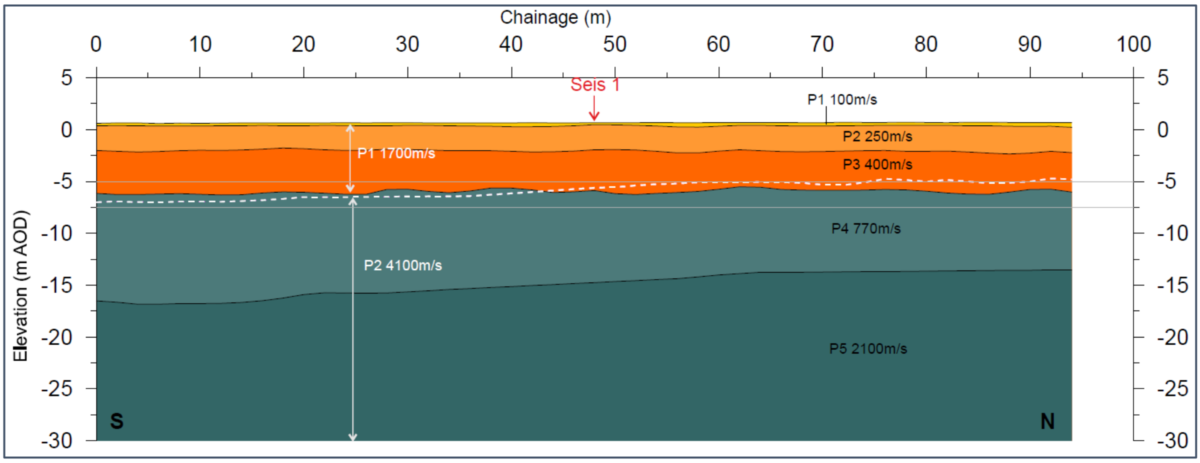


*Figure 1.5 Cross-section along the north (left) to south (right) seismic refraction survey line showing the two-part geological sequence (above and below the white dashed line) (TerraDat, 2023). Location of the line is shown on Figure 1.3*



12. The closest borehole BH01 recovered bedrock at a depth of 0.69mOD (with 11.5m of dune sand on top) implying that the rockhead becomes shallower under the top of the beach between the refraction profile and the borehole. However, a full-length seismic refraction survey would need to be undertaken to support this interpretation of a gradual rise.

### 1.1.3 Medium-term Beach Elevation Change

13. Lidar elevation data captured in 2006/07, 2011/12, 2016/17 and 2020/21 provides a time series that is analysed here for historic medium-term (decadal) changes to Saunton Sands over the past 14 years (**Chapter 8: Marine Geology, Oceanography and Physical Processes, Section 8.4.1.2** of the **Onshore ES**). Comparisons of the 2006/07 and 2011/12 data, 2011/12 and 2016/17 data, 2016/17 and 2020/21 data, and 2006/07 and 2020/21 data are presented in **Figure 1.6** Historic changes to Saunton Sands between 2006/07, 2011/12, 2016/17 and 2020/217. Comparisons of the same data at the Landfall (landward of MLWS) are presented in Figure 1.8.

14. Between 2006/07 and 2011/12, Saunton Sands has varied between erosion (up to 0.25m over the five-year period) and accretion (up to 0.25m over the five-year period), with a higher rate of erosion (up to 0.5m) at the top of the beach at the Landfall (up to MHWS). Similarly, between 2011/12 and 2016/17, the beach was both erosional and accretional, up to 0.25m (with up to 0.5m of accretion at the top of the beach at the Landfall). A mix of accretion and erosion also took place between 2016/17 and 2020/21 (**Chapter 8: Marine Geology, Oceanography and Physical Processes, Section 8.4.1.2, paragraph 57, Figure 8.2** and **Figure 8.3** of the **Onshore ES**).

15. Overall, between 2006/07 and 2020/21, Saunton Sands, including most of the Landfall (up to MHWS) has eroded by up to 0.25m over the 14-year period (0-18mm/year). The top of the beach at the landfall has accreted by up to 0.25m over the 2006/07 to 2020/21 period (0-18mm/year). Hence, the medium-term (decadal) envelope of change is up to about +/-0.2m every ten years.

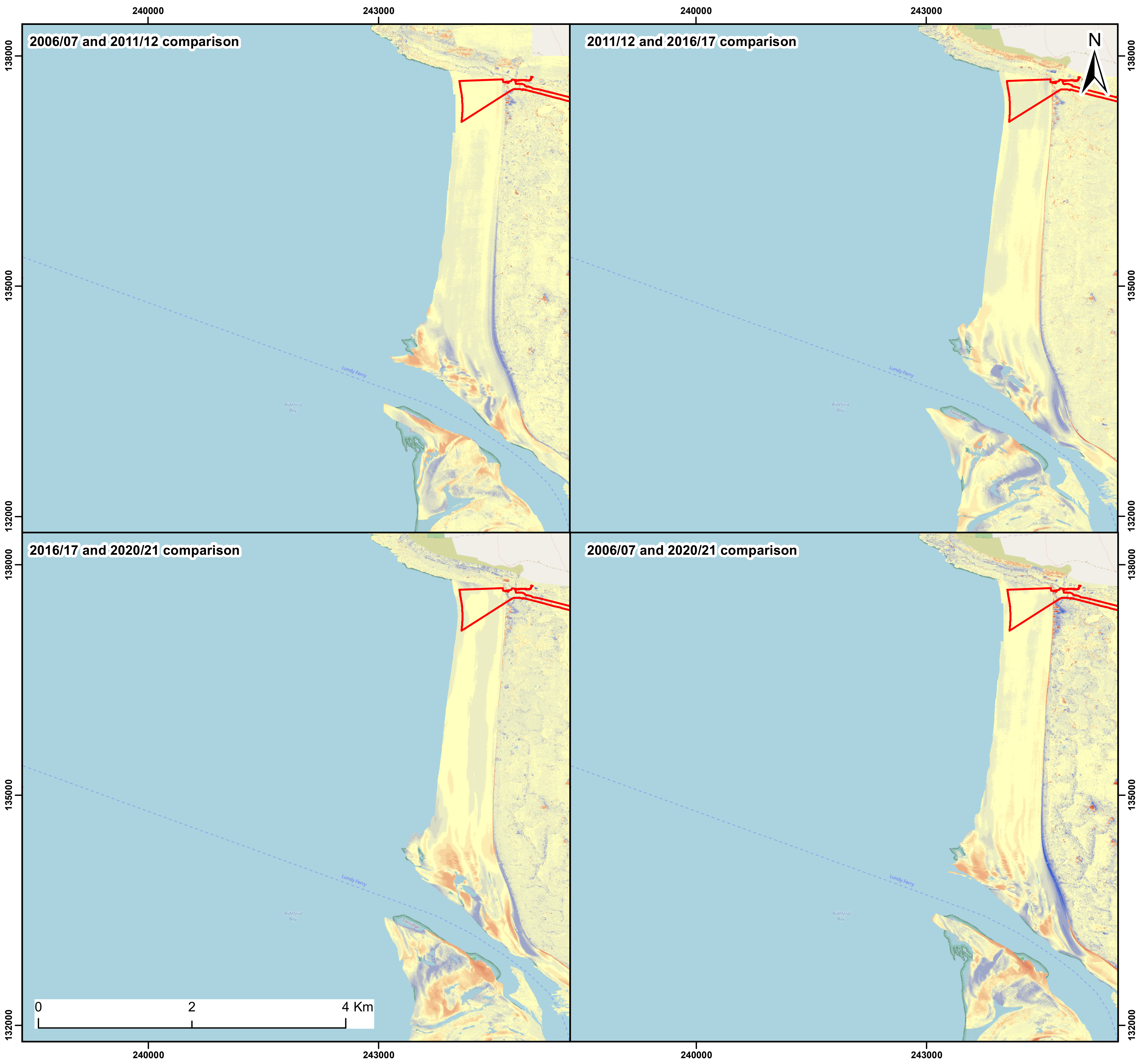
### 1.1.1 Summary

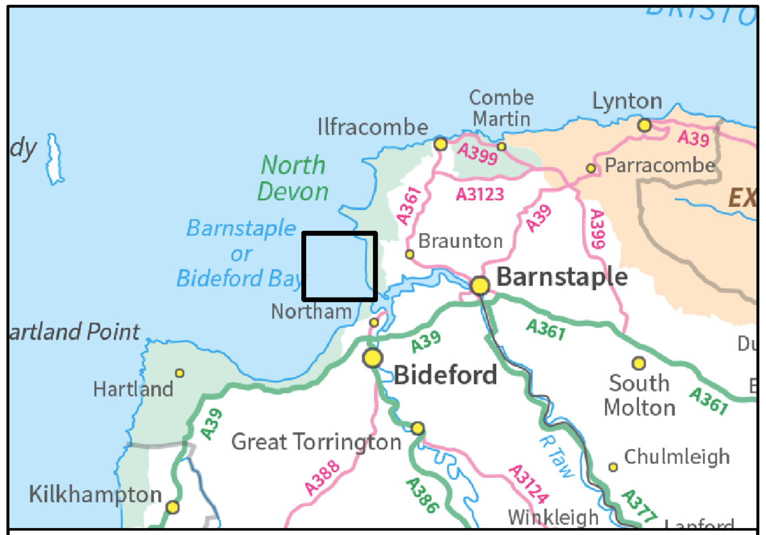
16. The sub-bottom profiler and seismic refraction data indicate that across the nearshore subtidal and lower intertidal beach, there is between 5m and 7m of sand overlying bedrock. The thickness beneath the upper intertidal beach is unknown. Data from the seismic refraction survey and a borehole (BH01) in the car park suggests that the bedrock surface rises from about -6m OD under the lower intertidal beach to about +0.5m OD under the car park. The difficulty remains determining the thickness of sand beneath the upper intertidal beach because there is a gap in the data.

17. Although it is not possible to extrapolate the sequence and depths between the lower intertidal beach and the car park, it is likely that the bedrock surface rises approximately linearly between the two. This is because anecdotal evidence suggests that bedrock has never been exposed along the beach (for example, as a result of winter storms) and large-scale fluctuations in top of the bedrock are

unlikely due to long-term weathering and erosion of its upper surface prior to beach and dune deposition.

18. The data confirms the assumptions used to inform the **Onshore ES** as submitted and no changes to the construction methods are needed. However, in line with the recommendation of TerraDat (2023), a full-length seismic refraction survey across the lower and upper intertidal beach to the toe of the dunes would be useful to fully define sand thicknesses for the purposes of the final Cable Burial Risk Assessment (CBRA).





Legend:

🟥 Onshore Development Area

**LiDAR comparison - Change in elevation (m)**

Gain

- 🟦 > 6
- 🟦 5.01 - 6
- 🟦 4.01 - 5
- 🟦 3.01 - 4
- 🟦 2.01 - 3
- 🟦 1.01 - 2
- ⬜ 0.76 - 1
- ⬜ 0.51 - 0.75
- ⬜ 0.26 - 0.5
- 🟨 0.01 - 0.25

Loss

- 🟨 -0.24 - 0
- 🟧 -0.49 - -0.25
- 🟧 -0.74 - -0.5
- 🟧 -0.99 - -0.75
- 🟧 -1.99 - -1
- 🟥 -2.99 - -2
- 🟥 -3.99 - -3
- 🟥 -4.99 - -4
- 🟥 -5.99 - -5
- 🟥 -6.99 - -6
- 🟥 < -7

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Client: Offshore Wind Ltd.

Project: White Cross Offshore Windfarm

Title:

Historic changes to Saunton Sands between 2006/07, 2011/12, 2016/17 and 2020/21

Figure: 1.6

Drawing No: PC2978-RHD-ZZ-XX-DR-Z-0695

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Co-ordinate system: British National Grid

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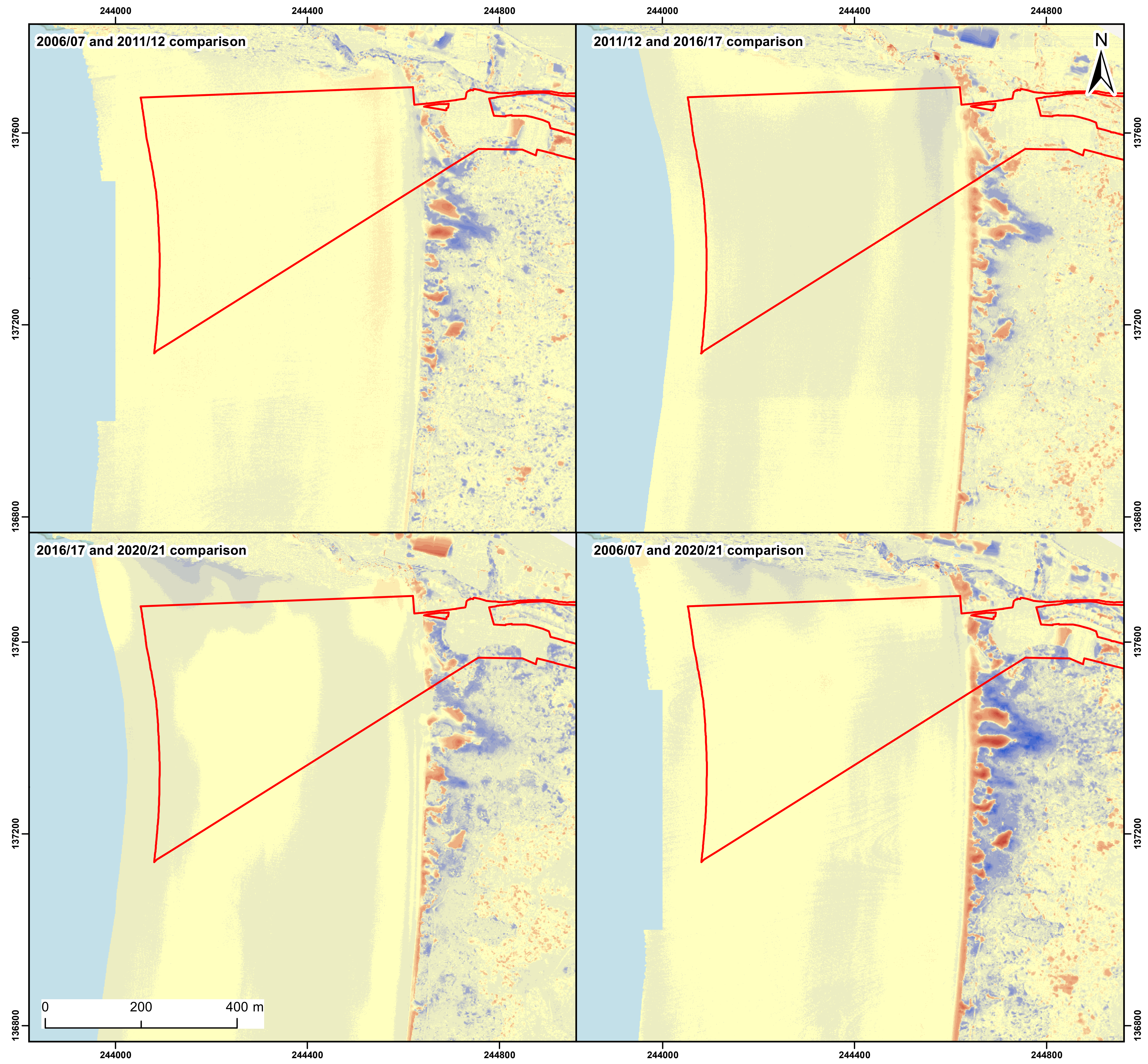

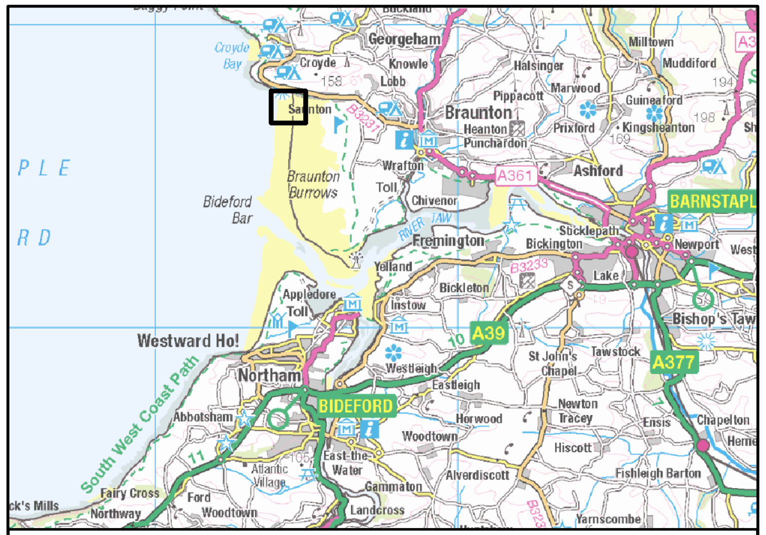

Legend:

▭ Onshore Development Area

**LiDAR comparison - Change in elevation (m)**

Gain
- ▨ > 6
- ▨ 5.01 - 6
- ▨ 4.01 - 5
- ▨ 3.01 - 4
- ▨ 2.01 - 3
- ▨ 1.01 - 2
- ▨ 0.76 - 1
- ▨ 0.51 - 0.75
- ▨ 0.26 - 0.5
- ▨ 0.01 - 0.25

Loss
- ▨ -0.24 - 0
- ▨ -0.49 - -0.25
- ▨ -0.74 - -0.5
- ▨ -0.99 - -0.75
- ▨ -1.99 - -1
- ▨ -2.99 - -2
- ▨ -3.99 - -3
- ▨ -4.99 - -4
- ▨ -5.99 - -5
- ▨ -6.99 - -6
- ▨ < -7

Source: © Haskoning DHV UK Ltd, 2023.

Client: Offshore Wind Ltd.

Project: White Cross Offshore Windfarm

Title:

# Historic changes of the beach at the Landfall between 2006/07, 2011/12, 2016/17 and 2020/21

Figure: 1.7

Drawing No: PC2978-RHD-ZZ-XX-DR-Z-0696

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Co-ordinate system: British National Grid

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19. A linear extrapolation of the beach change rates established through the Lidar comparisons would mean that over the 25-year lifetime of the project the average elevation of the beach could lower by about 0.5m in places. However, there could be anomalously high reductions in beach level (driven by storms) followed by recovery, and there would need to be a buffer of extra burial depth to accommodate these unforeseen 'catastrophic' events.

20. Also, the future evolution of Saunton Sands beach is unlikely to be linear and will largely depend on the position of future water (sea) levels. Accelerated sea-level rise will tend to increase the potential for beach erosion if a constant sediment supply is assumed. This may not be an issue at the top of Saunton Sands beach where it has accreted over the medium term and is backed by dunes without hard defences. It is likely that given this accretionary regime, the sediment supply at the top of the beach will keep pace with sea-level rise and there will be little change in accretion rates into the future, and the top of the beach would remain stable. However, further down the beach, the average rates of historic erosion may increase into the future with sea-level rise. Hence, the cable should be buried to a depth greater than 0.5m (including some contingency for sea-level rise) so that it doesn't become exposed during the 25 years it is in situ, particularly across the lower intertidal beach.

## 1.2 Saunton Sands – Taw-Torridge Estuaries System

### 1.2.1 Conceptual Model

21. Pethick (2007) developed a conceptual geomorphological model of the linked coastal system of Saunton Sands, the Taw-Torridge Estuaries and the coast to Westward Ho! to the south. The intention of the study was to develop a conceptual model of the geomorphology of the system that could be used to assess changes in geomorphology that might arise because of changes in such external factors as sea level rise and estuary management. One of the main issues under review was the relationship between the estuaries and the open coast of Bideford Bay, including Saunton Sands and Braunton Burrows.

22. The intertidal beach of Saunton Sands is oriented just east of north-south and merges south into the ebb-tidal delta (Bideford Bar) of the Taw-Torridge Estuaries. The dominant wave direction is from the west with minimum refraction in the nearshore zone, so there is likely to be a weak longshore sand transport to the north along Saunton Sands.

23. Pethick (2007) argued for the presence of a single anticlockwise tidal current gyre in Bideford Bay driving sand transport alongside the high energy waves. Sand is re-circulated north along the nearshore and coast with a southerly return in the offshore zone. This gyre drives transport of sand north along the Northam

Burrows shore, from where it bypasses the Taw-Torridge channel and arrives on Saunton Sands at Airy Point. From here it is transported north (by waves and tidal residual currents) towards Baggy Point and then returns south and east towards Westward Ho! where it resumes its northward transport towards the Taw-Torridge delta. These attributes of the coastal system demonstrate an intimate link between the estuaries and the open coast based upon the circulation of sand along the coast and into the outer estuary. It is likely that this sediment circulation drives some accumulation at the north end of Saunton Sands in the lee of Saunton Down.

24. This re-circulatory system explains the continued northerly transport of sediment along the coast despite the lack of any sediment inputs to Bideford Bay or erosion of the coast (rather the Saunton Sands coast has slowly accreted over the past century. Pethick (2007) compared an 1832 chart with the 1997 Ordnance Survey map and showed an advance of the high-water mark of spring tides by approximately 150m over a 2km stretch of Saunton Sands. Halcrow (1998) estimated that this advance was about 20m to 60m over the past 100 years.

25. Bypassing of sand north across the Taw-Torridge Estuaries is accomplished through the complex morphological development of the ebb-tidal delta and Bideford Bar. According to Pethick (2007), sand waves migrate along this Bar from south to north during storms. These sand waves eventually merge with the upper shore at the south end of Saunton Sands, forming the headland at Airy Point. From here, some of the sand is transported, by wave action, further north into the tidal gyre, while the rest is transported by flood tide currents into the outer Taw-Torridge Estuaries via Crow Point. Here the sand is temporarily deposited in a flood-tide delta along the Instow shore, before moving seaward again on ebb-tide currents to re-join the ebb-tide delta. The ebb-tidal delta allows longshore sediment transport to bypass the estuary mouth while maintaining an open channel to the sea.

26. Historic charts of the outer estuary since 1832 show that very little change has occurred in the high-water mark or low-water mark of the intertidal sand bodies despite a rise in sea level over this period of approximately 0.5m (Pethick, 2007). This suggests that the outer estuary is receiving sufficient sand from the open coast to maintain its intertidal morphology relative to tidal levels.

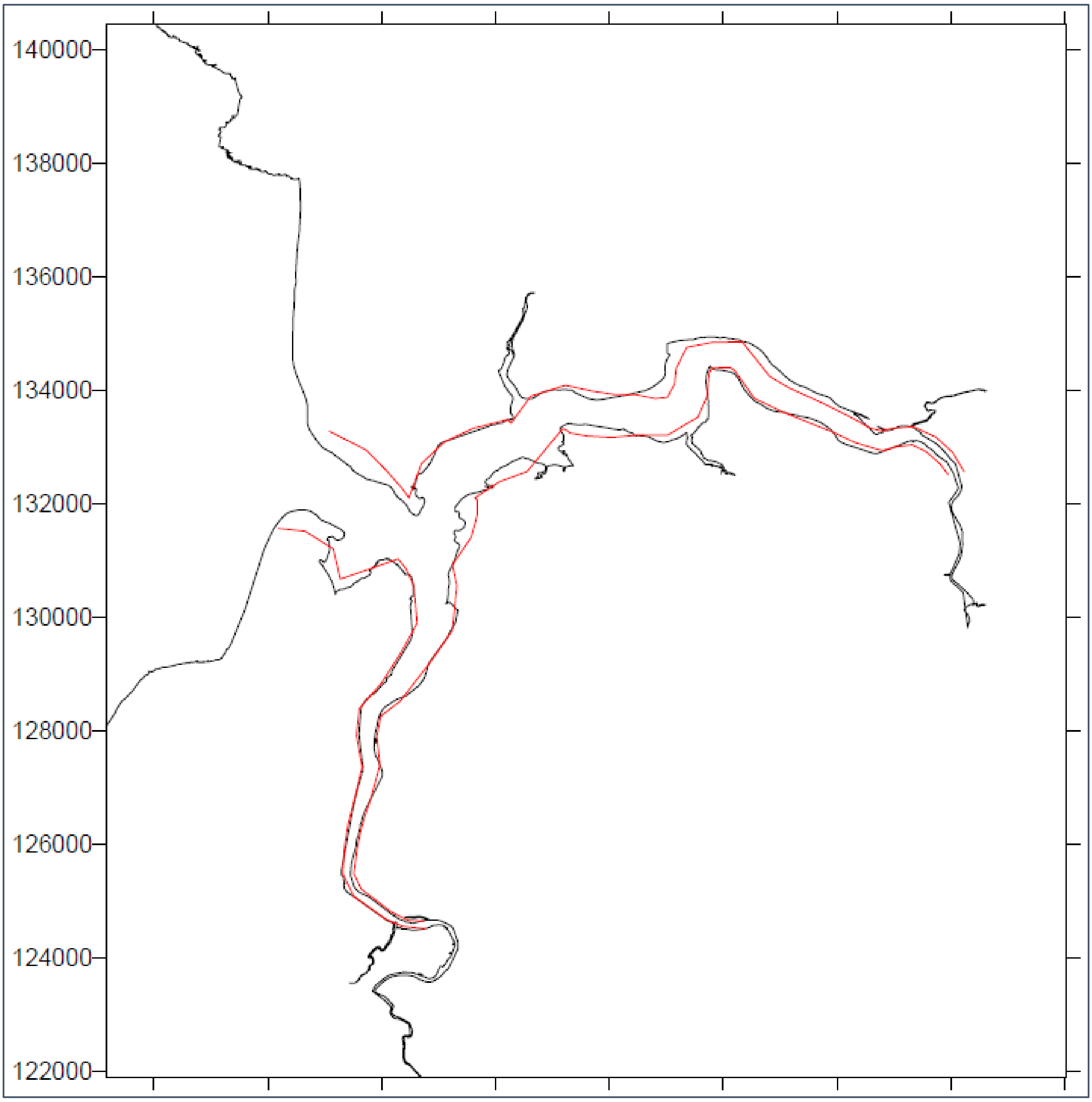
### 1.2.2 Potential Response of the Taw-Torridge Estuaries to Sea-level Rise

27. Pethick (2007) adopted Regime Theory (the relationship between tidal volume and channel size) to quantify the potential form of the mouth of the Taw-Torridge Estuaries with and without future sea-level rise. Without sea-level rise (i.e. existing tidal conditions), the theoretical condition of the estuary mouth would

be 50% wider than the current channel assuming that sufficient time, sediment and space were available (**Figure 1.9**).

28. Sedimentation in the estuary mouth is likely be extremely slow since here the channel bed is over-deepened by the former river channel incised here when sea level was more than 15m below its present level about 8,000 years ago. This means any increase in depth into the future is not possible, and any changes in tidal discharge (for example due to sea level rise) would result in a change in width. With sea-level rise of just under 1m over the next 100 years, the estuary mouth is predicted to increase in width by 360+/-100m) by the year 2100.

*Figure 1.9 Predicted form of the Taw-Torridge Estuaries without sea-level rise (Pethick, 2007). Note that the area between the two lines indicates either a potential for erosion (red line landwards of blue) or saltmarsh development (blue line landwards of red)*



## 1.3 Open Cut Trench and Trenchless Technique as the Worst Case Scenario at the Landfall

29. It is expected that as a worst-case scenario, a combination of an open cut trench across the intertidal zone and beach (assessed in **Chapter 8: Marine Geology, Oceanography and Physical Processes, Section 8.5.1** of the **Onshore ES**), and horizontal directional drilling (trenchless piperam) beneath the dunes and car park will be used to connect the offshore export cable to onshore. This is set within **Appendix Y: Outline Cable Landfall Plan**.

30. For the open cut trench section, two buried export cable (if the final design for the export cable is two 66kV cables) would be trenched, jetted, ploughed, or mechanically cut into the intertidal zone and beach. The width of the intertidal area affected by the installation depends on the type and specification of the cable plough used, but they are typically 4m to 6m wide. The cable trench would be up to 0.5m wide, with a burial depth of between be 0.5m at a depth of 3m resulting in 3,000m$^3$ of excavated sand. The specifics of the depth, and volumes, are awaiting completion of the final CBRA. However, a draft CBRA is provided as **Appendix U: Updated Cable Burial Risk Assessment** (WHX001-FLO-CON-ENG-RSA-0001) of the **ES Addendum**.

31. This worst-case scenario is a small increase on the worst-case scenario presented in the **Onshore and Offshore ES** of 840m$^3$ of sand (for a single cable (1,680m$^3$ for two cables)). However, this does not alter the overall significance of the effect reported in **Section 8.5.1** of the **Onshore ES.** Under the revised worst-case scenario, the effect is deemed negligible adverse. This effect reduces to no significant effect upon cessation of the works and the restoration of the beach to its former profile.

32. The intertidal open cut and upper foreshore cable installation will take approximately 5 days to complete, including all set up, but the installation with the cable plough through the intertidal area would be completed within a single tidal period (approximately 6 hours) from flood tide to ebb tide to take advantage of the high tide. A non-displacement type cable plough will be employed to minimise disturbance. This type of cable plough is particularly suited to installing long continuous lengths of cable in a variety of ground conditions, including fine sand like that encountered at Saunton Sands. As it installs the cable the excavated material falls back into the cable trench so that the topography post-installation will be the same as the topography pre-installation. To confirm this, monitoring prior to cable installation in the intertidal and following backfilling will be undertaken, including remedial action if the levels do not match. Once any remedial backfilling, if required, is undertaken access to the full working area will be restored.

33. Hence, the topography pre-installation will be the same as the topography post-installation, and there will be no effect on wave climate and sediment transport processes during operation, as described in **Chapter 8: Marine Geology, Oceanography and Physical Processes, Section 8.5.1.1, paragraphs 65-67** of the **Onshore ES**.

34. For the trenchless section, the trenchless technique used (likely to be piperam) to install the cable ducting. Ducting will be driven from an east to west direction (i.e., from the drive pit in the Saunton Sands car park into the reception pit on the upper foreshore immediately west of the dune system. The trenchless technique will be of a sufficient depth beneath the dunes and car park that it will not become exposed. Hence, above the ducting, the morphology will continue to be driven by natural processes and will be unaffected by the operation at the landfall.

## 1.4 Do Nothing Scenario

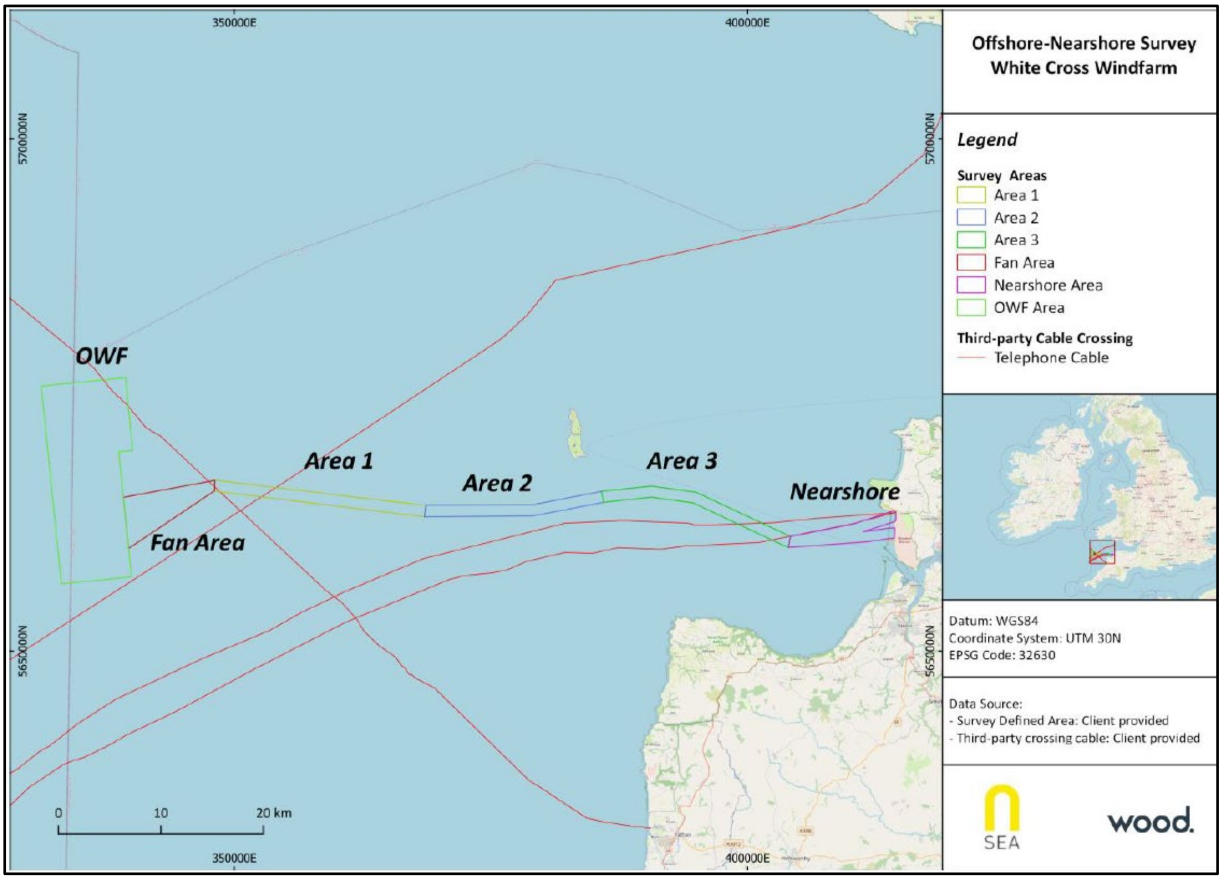
35. The baseline conditions for marine geology, oceanography and physical processes will continue to be controlled by waves and tidal currents driving changes in sediment transport and then seabed, nearshore and coastal morphology. In deeper water, tidal flows will be the dominant force, directed approximately east-northeast and west-southwest with speeds between 0.6m/s and 1.4m/s. Current speeds reduce towards the coast, where wave forces become more prevalent. Waves approach the coast from a predominantly westerly direction.

36. The long-term established performance of these physical drivers may be affected by environmental changes including climate change driven sea-level rise (see Climate Change and Sea-level Rise section). This will have the greatest effect at the coast where more waves will impinge on the beach and dunes, potentially increasing their rate of erosion. At the coast, the anticipated change in beach elevation is expected to be about +/-0.2m every ten years. Climate change will have little impact offshore where landscape-scale changes in water levels (water depths) far outweigh the effect of minor changes due to sea-level rise.

## 1.5 Sediment Transport and Morphological Change along the Offshore Export Cable Corridor

37. Wood (2022) divided the Offshore Development Area into six areas for interpretation purposes (**Figure 1.10**). The primary bedforms as defined by Wood (2022) are in the sand areas and comprise sand ripples (36.7% or 90km$^2$ of the surveyed area) and megaripples (2.7% or 7km$^2$ of the surveyed area).

*Figure 1.10 Division of the Offshore Development Area (Wood, 2022)*



38. Wood (2022) presented the results of a geophysical survey describing the seabed sediments and features in the six defined areas (**Figure 1.10**), along the Offshore Export Cable Corridor and across the Windfarm Site. These were described in **Chapter 8: Marine Geology, Oceanography and Physical Processes, Section 8.4.1.7** of the **Offshore ES**:

- Nearshore. Here the seabed is flat and featureless and composed of sand.
- Area 3. In the eastern part, the seabed continues from the nearshore as flat and featureless and composed of sand. Further west, the sand forms a shallow veneer covering sub-cropping bedrock and can be sculpted into bedforms of various sizes (**Figure 1.11**). Local parts are covered in megaripples with wavelengths of 5m to 12m and crests oriented north-northwest to south-southeast. In places the megaripples are superimposed on larger-scale, similarly oriented, sand waves (wavelengths between 60m

and 120m). Towards the western edge of Area 3, the sand thins to be replaced by exposures of bedrock or bedrock with a thin sand veneer.

- Area 2. The eastern part is a continuation of the western edge of Area 3; bedrock or bedrock with a thin sand veneer. Further west, the bedrock is covered by sand, which is generally flat and featureless, with occasional megaripple patches. The megaripples are generally smaller than in Area 3, with wavelengths between 1m and 3m and crests oriented north-northwest to south-southeast.
- Area 1. Most of Area 1 is covered with sand. In the eastern half, the sand is megarippled and the Offshore Export Cable Corridor contains occasional patches of clay and coarser sediments, while megarippled sand dominates the western half. These megaripples have wavelengths between 4m and 16m, with crests oriented north-northwest to south-southeast and north-south.
- Fan Area. Most of the area is covered with sand with occasional patches of coarse sediment. The seabed is generally flat and featureless except for a section of megaripples that continue from Area 1, at the eastern boundary of this area, with wavelengths 6m and 13m, and crests north-northwest to south-southeast.
- OWF (Windfarm Site). Most of the site is sand with local variations. The northern part is mostly covered with megaripples with wavelengths approximately 15m to 20m and crests oriented north-south. Elsewhere the sand is featureless.

39. The morphology of seabed features can provide information on sediment transport. In the Nearshore part of the Offshore Export Cable Corridor, the seabed is relatively featureless and covered by sand overlying bedrock. The sand can accumulate in the nearshore as the configuration of the coast creates an embayment that is relatively sheltered when compared to the Outer Bristol Channel and Celtic Sea. A bathymetric profile along the Offshore Export Cable Corridor shows that the seabed directly adjacent to beach slopes offshore for around 2.5km and then plateaus forming a terrace for 5km until approximately 7.5km offshore when is begins to slope again (see **Figure 1.12**). This profile is typical of a wave dominated coast and the terrace likely marks the position between the upper shoreface, where average daily breaking waves will dominate sediment transport, and the lower shoreface where storm waves and prevailing tidal currents dominate.

*Figure 1.11 Seabed features of the Offshore Development Area (Wood, 2022) and adjacent designated sites*

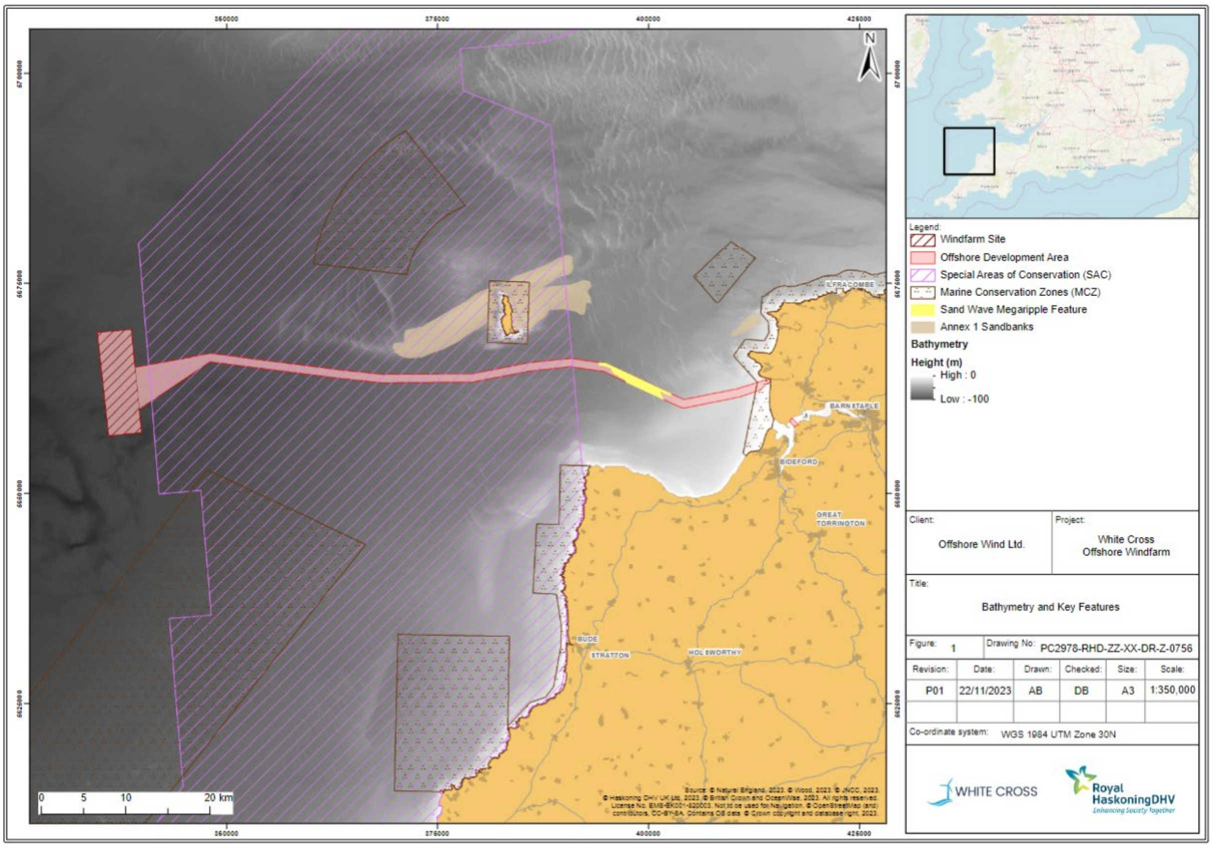
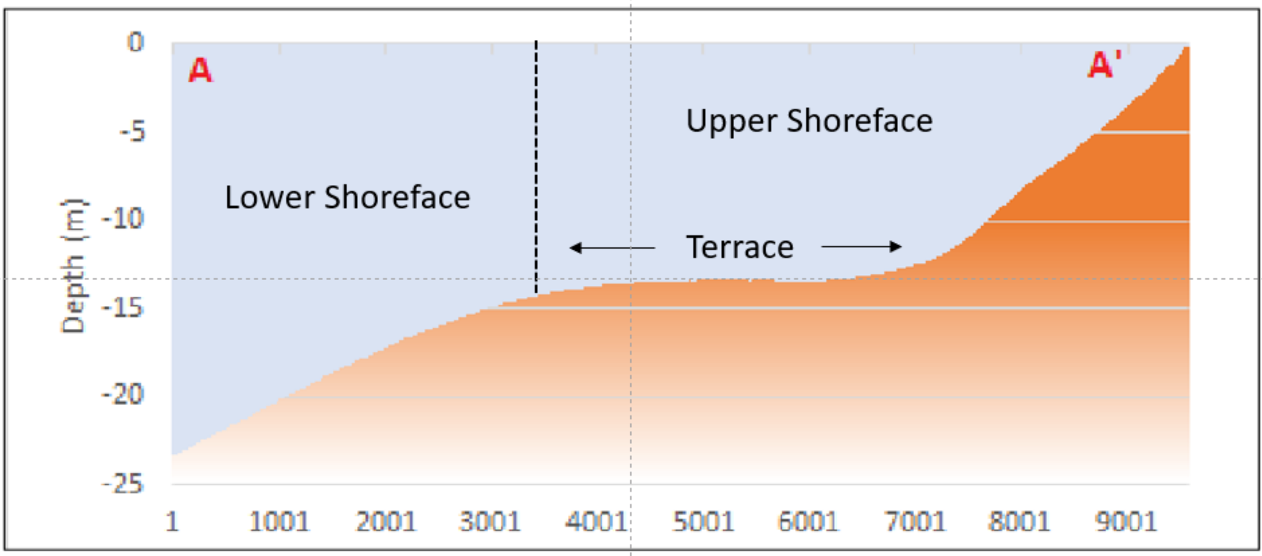


*Figure 1.12 Bathymetric profile across the Nearshore Area (modified from Wood, 2022)*



40. The lower shoreface transitions offshore within Area 3 where megaripples are present. These seabed features are driven by tidal processes and are typically in equilibrium with the prevailing tidal and sediment transport regime. The megaripples in Area 3 have steep sides and broadly symmetrical in cross profile suggesting there isn’t a dominant net sediment transport direction and that sediment transport during a flood tide is broadly equal to transport in the opposite direction during the ebb tide. Sediment transport in Area 3 therefore likely results in no net loss or gain and sediment is recycled over each tidal cycle.

41. There are no mobile bedforms within Area 2 and bedrock is exposed at seabed or present at shallow depths below a thin veneer of sand. Sediment availability in this area is limited and sediment transport rates are expected to be low.

42. The seabed in Area 1 comprises ripples and localised patches of megaripples. The morphology of the seabed features is broadly symmetrical with a slightly steeper slope facing west suggesting a net sediment transport direction towards the west. The features are smaller than the megaripples in Area 3, likely reflecting lower tidal current speeds in deeper water.

43. As stated in **Chapter 8: Marine Geology, Oceanography and Physical Processes, Section 8.6.3.1** of the **Offshore ES**, it is considered that the small areas associated with cable protection would have no significant effect on the sediment transport processes across the seabed.

## 1.6 Seabed Sediment Change along the Offshore Export Cable Corridor

44. The results of a benthic survey characterising seabed sediments across 134 samples in the Offshore Development Area, are outlined in Ocean Ecology (2022). These results were described in full in **Chapter 8: Marine Geology, Oceanography and Physical Processes, Section 8.4.1.7** of the **Offshore ES**.

45. Sand (greater than 0.063mm) is the dominant sediment type in the Offshore Development Area. There is some variability in the Offshore Export Cable Corridor with gravel (greater than 2mm) quantities of greater than 50% at seven locations. Mud (less than 0.063mm) content is highest closer to landfall, exceeding sand as the dominant sediment type at two locations (ST01 and ST38) (**Chapter 8: Marine Geology, Oceanography and Physical Processes, Section 8.4.1.7** of the **Offshore ES**, **Figure 8.7**).

46. On average, about 85% of the sediment fraction in the Offshore Development Area consists of sand, with gravel and mud comprising approximately 9% and 6%, respectively (**Chapter 8: Marine Geology, Oceanography and Physical Processes, Section 8.4.1.7** and **Figure 8.8** of the **Offshore ES**).

Cumulative particle size distributions show that 75% of the sand is fine to medium (0.125-0.5mm) and 23% is coarse (greater than 0.5mm) and only 2% is very fine (0.063-0.125mm) (**Chapter 8: Marine Geology, Oceanography and Physical Processes, Section 8.4.1.7** of the **Offshore ES**, **Figure 8.9**).

47. During construction activities (cable burial and sand wave levelling) less than 7% on average of all sediment will be subject to suspension. This is because the total sediment fraction consists of this percentage of fines (mud) which constitute the suspended sediment load. Due to the localised nature of construction activities, any dispersion of suspended sediment that may occur would have a small spatial scale and would be for a limited time (hours to a few days) before returning to ambient concentrations (5 to 15mg/l, Cefas, 2016).

48. Deposition from these limited sediment plumes would be minimal and the process of continued resuspension on recurring tidal cycles would mean that final deposition on the seabed would be near zero, and effectively immeasurable. Fines are in higher concentrations closer to landfall. Sediment transport within these shallower inshore areas is regularly driven by wave activity causing resuspension and dispersion of fines that may be deposited. Habitats and biotopes within a high energy environment will be used to these natural conditions, contributing to their lower sensitivity in relation to increased suspended sediment pressures. Due to these resuspension effects, it is highly unlikely there will be any measurable changes in deposition due to construction activity. The magnitude of this potential impact is negligible.

49. The sensitivity of identified habitats and biotopes to increased suspended sediment pressures are summarised in **Table 10.17** of **Chapter 10: Benthic and Intertidal Ecology of the Offshore ES** and outlines that there is 'not sensitive' to 'low' sensitivity to each impact pathway for increased suspended sediment concentrations. This includes A5.252/A5.351 *Abra prismatica, Bathyporeia elegans* and polychaetes in circalittoral fine sand (low sensitivity) which are approximately 500m from Landfall (as shown in **Figure 10.3** of **Chapter 10: Benthic and Intertidal Ecology** of the **Offshore ES**). The rating of low sensitivity has been concluded based on the low amount of mud sized particles which could be mobilised. The predicted thickness of sediment resting on the seabed would only amount to a maximum of 1mm (based on expert judgment) over a period of hours to days. Following initial sediment deposition, the sediment will be continually re-suspended to reduce the thickness even further to a point where it will be effectively zero. Overall, this impact would generate the same or less pressure than 'smothering and siltation rate changes (light)' as defined by MarLIN (2022). Therefore, a sensitivity of low has been assigned to A5.252/A5.351 *Abra prismatica, Bathyporeia elegans* and polychaetes in circalittoral fine sand, aligned with MarLIN (2022). Therefore,

given the magnitude of impact is negligible and the sensitivity of receptor is low (at worst), it is considered to be of negligible adverse significance which is not significant in EIA terms. This is in line with the conclusions set out in **Chapter 10: Benthic and Intertidal Ecology, Section 10.5.2** of the **Offshore ES**.

## 1.7 References

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