East Anglia ONE North Offshore Windfarm

Appendix 4.6

Coastal Processes and Landfall Site Selection

Environmental Statement
Volume 3

Applicant: East Anglia ONE North Limited
Document Reference: 6.3.4.6
SPR Reference: EA1N-DWF-ENV-REP-IBR-000341_006 Rev 01
Pursuant to APFP Regulation: 5(2)(a)

Author: Royal HaskoningDHV
Date: October 2019
Revision: Version 1

Revision Summary				
Rev	**Date**	**Prepared by**	**Checked by**	**Approved by**
01	08/10/2019	Paolo Pizzolla	Ian Mackay	Helen Walker

Description of Revisions			
Rev	**Page**	**Section**	**Description**
01	n/a	n/a	Final for Submission

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Glossary of Acronyms

AIS	Air Insulated Substation
AONB	Area of Outstanding Natural Beauty
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CD	Chart Datum
CION	Connection and Infrastructure Options Note
DBA	Desk Based Assessment
EAOW	East Anglia Offshore Wind
EIA	Environmental Impact Assessment
EPP	Evidence Plan Process
ETG	Expert topic Group
GIS	Geographical Information System
GWFL	Galloper Wind Farm Limited
HAT	Highest Astronomical Tide
HDD	Horizontal Directional Drilling
IMO	International Maritime Organisation
LAT	Lowest Astronomical Tide
LPA	Local Planning Authority
MaRS	Marine Resources System,
MCA	Martine and Coastguard Agency
MCZ	Marine Conservation Zone
MHWN	Mean High Water Neaps
MHWS	Mean High Water Springs
MLWN	Mean Low Water Neaps
MLWS	Mean Low Water Springs
MMO	Marine Management Organisation
NE	Natural England
NPPF	National Planning Policy Framework
OD	Ordnance Datum
OESEA	Offshore Energy Strategic Environmental Assessment
PDZ	Policy Development Zone
PEIR	Preliminary Environmental Information Report
PROW	Public Rights of Way
RAG	Red Amber Green
REC	Regional Environmental Characterisation
RSPB	Royal Society for the Protection of Birds
SAC	Special Area of Conservation
SMP	Shoreline Management Plan
SPA	Special Protection Area
SPR	ScottishPower Renewables
SSSI	Site of Special Scientific Interest
TWT	The Wildlife Trust
ZAP	Zone Appraisal Planning
ZDA	Zonal Development Agreement
ZEA	Zone Environmental Assessment

Glossary of Terminology

Applicant	East Anglia ONE North Limited.
Cable sealing end compound	A compound which allows the safe transition of cables between the overhead lines and underground cables which connect to the National Grid substation.
Cable sealing end (with circuit breaker) compound	A compound (which includes a circuit breaker) which allows the safe transition of cables between the overhead lines and underground cables which connect to the National Grid substation.
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.
Construction operation and maintenance platform	A fixed offshore structure required for construction, operation, and maintenance personnel and activities.
Development area	The area comprising the onshore development area and the offshore development area (described as the 'order limits' within the Development Consent Order).
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.
East Anglia ONE North windfarm site	The offshore area within which wind turbines and offshore platforms will be located.
European site	Sites designated for nature conservation under the Habitats Directive and Birds Directive, as defined in regulation 8 of the Conservation of Habitats and Species Regulations 2017 and regulation 18 of the Conservation of Offshore Marine Habitats and Species Regulations 2017. These include candidate Special Areas of Conservation, Sites of Community Importance, Special Areas of Conservation and Special Protection Areas.
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.
Inter-array cables	Offshore cables which link the wind turbines to each other and the offshore electrical platforms, these cables will include fibre optic cables.
Jointing bay	Underground structures constructed at intervals along the onshore cable route to join sections of cable and facilitate installation of the cables into the buried ducts.
Landfall	The area (from Mean Low Water Springs) where the offshore export cables would make contact with land, and connect to the onshore cables.
Link boxes	Underground chambers within the onshore cable route housing electrical earthing links.

Meteorological mast	An offshore structure which contains metrological instruments used for wind data acquisition.
Mitigation areas	Areas captured within the onshore development area specifically for mitigating expected or anticipated impacts.
Marking buoys	Buoys to delineate spatial features / restrictions within the offshore development area.
Monitoring buoys	Buoys to monitor *in situ* condition within the windfarm, for example wave and metocean conditions.
National electricity grid	The high voltage electricity transmission network in England and Wales owned and maintained by National Grid Electricity Transmission
National Grid infrastructure	A National Grid substation, cable sealing end compounds, cable sealing end (with circuit breaker) compound, underground cabling and National Grid overhead line realignment works to facilitate connection to the national electricity grid, all of which will be consented as part of the proposed ONE North project Development Consent Order but will be National Grid owned assets.
National Grid overhead line realignment works	Works required to upgrade the existing electricity pylons and overhead lines (including cable sealing end compounds and cable sealing end (with circuit breaker) compound) to transport electricity from the National Grid substation to the national electricity grid.
National Grid overhead line realignment works area	The proposed area for National Grid overhead line realignment works.
National Grid substation	The substation (including all of the electrical equipment within it) necessary to connect the electricity generated by the proposed East Anglia ONE North project to the national electricity grid which will be owned by National Grid but is being consented as part of the proposed East Anglia ONE North project Development Consent Order.
National Grid substation location	The proposed location of the National Grid substation.
Natura 2000 site	A site forming part of the network of sites made up of Special Areas of Conservation and Special Protection Areas designated respectively under the Habitats Directive and Birds Directive.
Offshore cable corridor	This is the area which will contain the offshore export cables between offshore electrical platforms and landfall.
Offshore development area	The East Anglia ONE North windfarm site and offshore cable corridor (up to Mean High Water Springs).
Offshore electrical infrastructure	The transmission assets required to export generated electricity to shore. This includes inter-array cables from the wind turbines to the offshore electrical platforms, offshore electrical platforms, platform link cables and export cables from the offshore electrical platforms to the landfall.
Offshore electrical platform	A fixed structure located within the windfarm area, containing electrical equipment to aggregate the power from the wind turbines and convert it into a more suitable form for export to shore.
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 infrastructure	All of the offshore infrastructure including wind turbines, platforms, and cables.
Offshore platform	A collective term for the construction, operation and maintenance platform and the offshore electrical platforms.

Onshore cable corridor	The corridor within which the onshore cable route will be located.
Onshore cable route	This is the construction swathe within the onshore cable corridor which would contain onshore cables as well as temporary ground required for construction which includes cable trenches, haul road and spoil storage areas.
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.
Onshore development area	The area in which the landfall, onshore cable corridor, onshore substation, landscaping and ecological mitigation areas, temporary construction facilities (such as access roads and construction consolidation sites), and the National Grid Infrastructure will be located.
Onshore infrastructure	The combined name for all of the onshore infrastructure associated with the proposed East Anglia ONE North project from landfall to the connection to the national electricity grid.
Onshore preparation works	Activities to be undertaken prior to formal commencement of onshore construction such as pre–planting of landscaping works, archaeological investigations, environmental and engineering surveys, diversion and laying of services, and highway alterations.
Onshore substation	The East Anglia ONE North substation and all of the electrical equipment within the onshore substation and connecting to the National Grid infrastructure.
Onshore substation location	The proposed location of the onshore substation for the proposed East Anglia ONE North project.
Platform link cable	Electrical cable which links one or more offshore platforms. These cables will include fibre optic cables.
Safety zones	A marine area declared for the purposes of safety around a renewable energy installation or works / construction area under the Energy Act 2004.
Scour protection	Protective materials to avoid sediment being eroded away from the base of the foundations as a result of the flow of water.
Transition bay	Underground structures at the landfall that house the joints between the offshore export cables and the onshore cables.

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1 Background

1. In April 2018, a desk based assessment (DBA) was prepared for the proposed East Anglia ONE North and East Anglia TWO projects considering various construction and operational issues relating to physical processes for the proposed offshore cable corridor, which makes landfall between Sizewell and Thorpeness, in Suffolk.

2. The DBA was not included in the Preliminary Environmental Information Report (PEIR) as its original purpose was to inform the design process and scope of the formal Environmental Impact Assessment (EIA).

3. The DBA has now been included as an appendix to Environmental Statement (ES) ***Chapter 4 Site Selection and Assessment of Alternatives*** in response to key comments raised during section 42 consultation (please refer to stakeholder comments regarding coastal processes in ES ***Appendix 7.3 Consultation Responses***).

4. This document provides additional context to the site selection for the offshore cable corridor for East Anglia ONE North, specifically regarding the landfall siting and coralline crag outcrop feature. It is important to note that this DBA was originally authored in April 2018, and that the potential impacts outlined in this assessment have since been formally assessed as part of the ES. The final offshore cable corridor was determined by this work and the figures within this report demonstrate the evolution of the final offshore development area submitted with this DCO application.

5. The full evolution of the final offshore development area is described in detail in ES ***Chapter 4 Site Selection and Assessment of Alternatives***.

6. The principal matters considered within this DBA relate to the following principal issues:

- The influence of coastal management and coastal change in relation to the proposed landfall site, specifically in relation to potential future erosion;
- The construction-related effect of cable burial within the Sizewell-Thorpeness cable corridor on turbidity and erosion/sedimentation at the cooling water intake and outfall of the Sizewell B nuclear power station; and
- The effect of export cable burial (or protection) within the Sizewell-Thorpeness cable corridor on the baseline sea bed and shoreline morphology and physical processes.

2 Baseline Understanding

2.1 Principal Information Sources

7. Prior to undertaking an assessment of the principal matters, it is necessary to understand the baseline physical processes along the shoreline and nearshore sea bed of this section of the Suffolk coast. This has been achieved through review of the following key sources:

- HR Wallingford, CEFAS/UEA, Posford Haskoning and D'Olier, B., 2002. *Southern North Sea Sediment Transport Study*, Phase 2. Anglian Coastal Authorities Group.
- Black and Veatch, 2005. Minsmere frontage: *Dunwich Cliffs to Sizewell Power Stations Coastal Processes Report*. Environment Agency.
- Kenneth Pye and Simon J. Blott, Coastal Processes and Morphological Change in the Dunwich-Sizewell Area, Suffolk, UK. Journal of Coastal Research, Vol. 22, No. 3, 2006.
- Royal HaskoningDHV, 2010. *Suffolk Shoreline Management Plan 2 (SMP2)*. Suffolk Coastal District Council, Waveney District Council/ and Environment Agency.
- Brooks, S.M., 2010. *Coastal change in historic times – linking offshore bathymetric changes and cliff recession in Suffolk*. The Crown Estate.
- Burningham, H. and French, J., 2016. *Shoreline–Shoreface Dynamics on the Suffolk Coast*. The Crown Estate.

8. It is acknowledged that there is a large quantity of further research into this section of the Suffolk coast, much of which is academic in nature. The above documents are considered to synthesise much of this and present it within practical context and thus are deemed the most useful of the available information sources.

2.2 General Overview

9. The SMP2 (Royal HaskoningDHV 2010) splits the Suffolk coastline, between Lowestoft Ness and Felixstowe Landguard Point, into a number of Policy Development Zones (PDZs). Of most relevance to the East Anglia ONE North and East Anglia TWO cable corridor assessment is PDZ4, the coastline between Dunwich and Thorpeness (***Figure 2.1***).

10. This frontage extends from just south of Dunwich village to the B1353 road at the centre of Thorpeness village. Key findings from the SMP2 (Royal HaskoningDHV 2010) in relation to the frontage and the nearshore zone are as follows (with key features identified in ***Figure 2.2***):

- The whole frontage is dominated by the two areas of high ground, the Dunwich and Minsmere cliffs to the north and the Sizewell cliffs and Thorpeness headland to the south.
- The main control features on evolution of the coastline are the cliffs to north and south, with the harder Coralline Crag of Thorpeness acting as the principal anchor in the south. The coast in-between is cut by the extensive valley of the Minsmere River, which includes a smaller side-valley behind Sizewell.
- In the nearshore area there are two sandbanks running parallel to the shore, the Dunwich bank to the north and the Sizewell bank to the south, with a deeper channel (10m Chart Datum (CD)) running between the shore and the banks.
- The nearshore sandbanks clearly influence shoreline behaviour. These features are considered to be banner banks associated with Thorpeness. However, the indication of north northeast/south southwest orientated features further offshore, such as the Aldeburgh Napes, suggest a possible geological base to some of these banks, in particular possibly to the Sizewell bank leading from Thorpeness, although there is no geological evidence of this.

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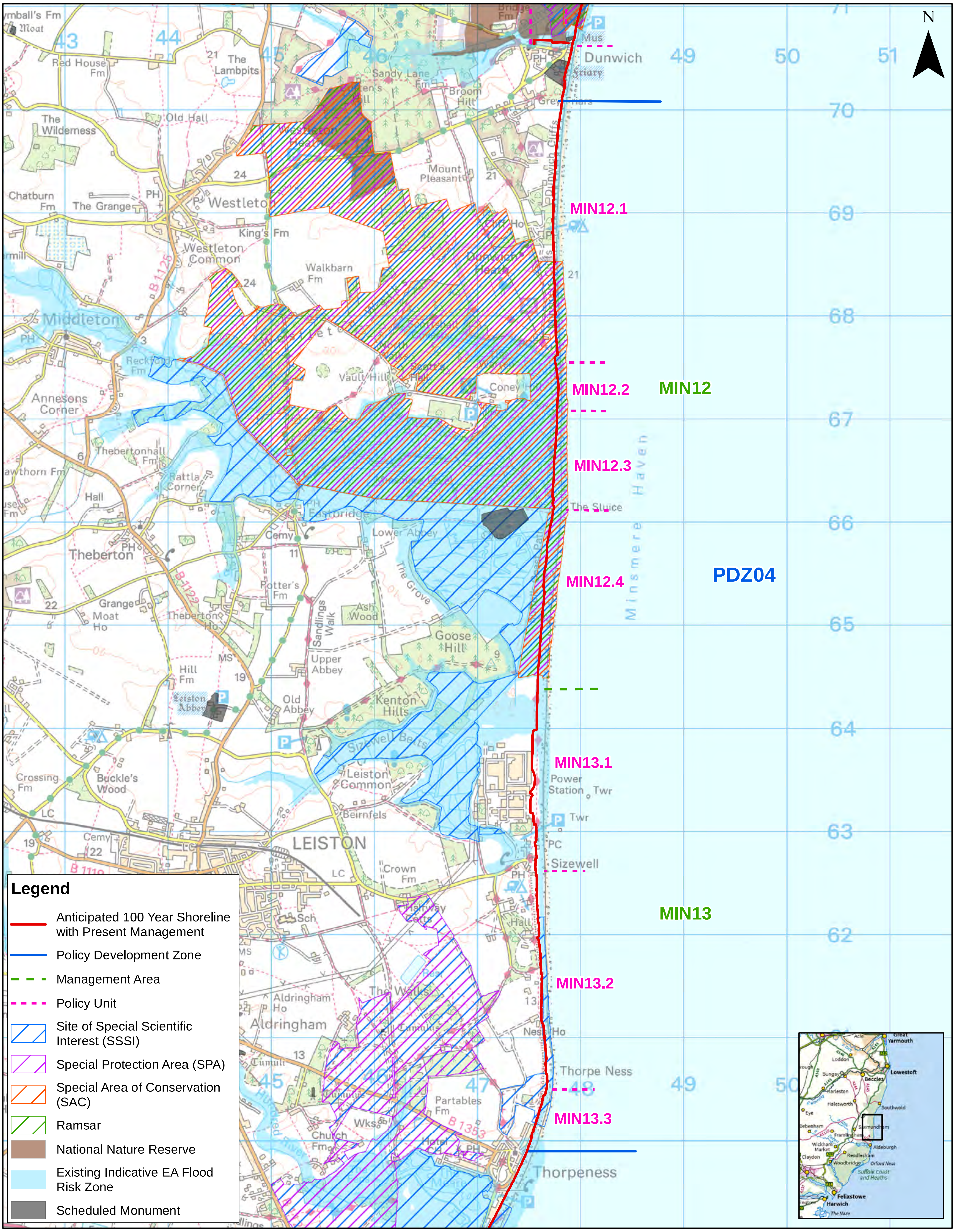

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East Anglia ONE North

Suffolk SMP2 - Policy Development Zone 4: Dunwich to Thorpeness

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1	18/07/19	AB	First Issue.	Checked:	PM
				Approved:	PP

Figure	Date	Dwg No.	
2.1	18/07/19	EA1N-DEV-DRG-IBR-000965	Coordinate System: BNG Datum: OSGB36

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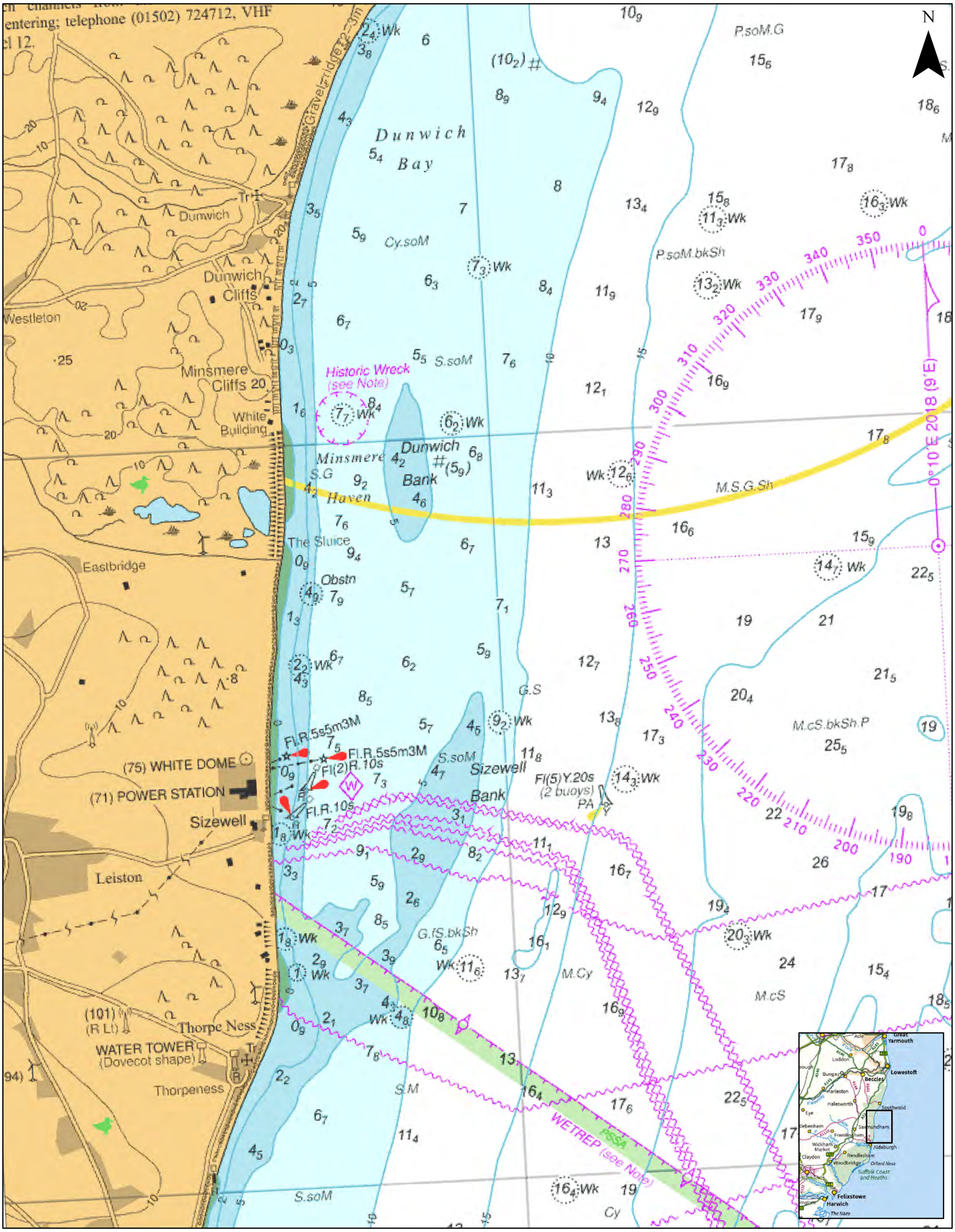

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East Anglia ONE North

Sea Bed Bathymetry between Dunwich and Thorpeness

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1	18/07/19	AB	First Issue.	Checked:	PM
				Approved:	PP

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2.3 Characteristics and Behaviour of the Shoreline

11. The following is summarised from the Suffolk SMP2 (Royal HaskoningDHV 2010):

12. The shore over this frontage is typically that of a relatively sandy lower beach with coarser shingle above, although this varies to a degree along the shoreline. In general, the coast appears quite linear. However, on the ground there is significant, though quite slight, variation in the alignment. Most noticeable is the tendency for the coast at Minsmere to be held forward of the general alignment, with the apex of this tending to be at the position of the sluice. This also coincides with the lower section in the offshore banks and is potentially associated with the centre of the Minsmere River valley.

13. The backshore also varies in position and character. To the northern end are the steep Dunwich cliffs, with a narrow upper beach berm which presently is relatively well vegetated. Further south there are areas of the more gently sloped cliff with a reasonable width of beach berm between the toe of the slope and the crest of the beach. Set back some 60m from the crest of the Minsmere cliffs are the National Trust properties and visitor centre.

14. At the southern end of the Minsmere cliffs, the cliffs decrease in height to the Minsmere valley. The cliffs are again relatively steep and tend to curve in line with the alignment of the shore through to the sluice. The backshore across Minsmere comprises a system of natural and remodelled systems of sand and shingle. To the north of the sluice is a man-made channel and earth bank acting as a secondary line of defence. To the south of the sluice the shingle ridge and dune is the main defence to the low lying land behind. This continues through to the slightly higher ridge of land to the north of the Sizewell B Power Station.

15. The Power Station is set back some 100m behind the beach with a width of dune and shingle fronting a higher earth embankment. The embankment comprises two banks, one at 5m Ordnance Datum (OD) and the other at 10m OD. The Sizewell village frontage is similarly set back with a lower lying area of dune and shingle between it and the beach. Behind the village is the main access road to the Power Station, with a road and car park to the front of the village. Along this frontage the beach is pulled forward, apparently associated with the position of the water outlets of the Power Station.

16. South from Sizewell, the coastline again rises and there tends to be an increasing width of back beach berm of accumulated material between the cliff face and the active beach slope. This berm continues all the way through to the nominal shoreline position of Thorpe Ness (although the actual ness feature extends within the nearshore area over a significantly greater extent). Beyond the

shoreline position of the ness, the backshore berm decreases rapidly in width and the cliff is steep and slowly eroding.

17. There is a slight increase in beach width as the cliff line decreases to the centre of Thorpeness village and the shingle beach tends to widen slightly as the cliff curves towards the southwest. To the back of the beach at Thorpeness is a low shallow slope earth bank with property set back only 20m to 30m behind this bank. These properties are typically some 70m behind the active face of the beach. These properties are in two sections. A single line of properties runs to the seaward side of North End Avenue. A larger cluster of properties is located behind Old Homes Road and the B1353. There are rock gabions in front of North End Avenue.

2.4 Characteristics and Behaviour of the Sizewell-Dunwich Bank System

18. The following is summarised from the Suffolk SMP2 (Royal HaskoningDHV 2010), the Southern North Sea Sediment Transport Study (HR Wallingford 2002) and the Minsmere Frontage Coastal Processes Report (Black and Veatch 2005):

19. The Sizewell and Dunwich banks are between 1.5 km and 2.0 km from the shore and provide shelter for the coastline between its attachment point at Thorpeness and a point just north of Dunwich. Between the banks and the shore runs a deeper channel (10m CD). At the southern end of the banks this channel virtually disappears with a connection between the nearshore area of Thorpeness and the southern end of the Sizewell bank (***Plate 2.1***).

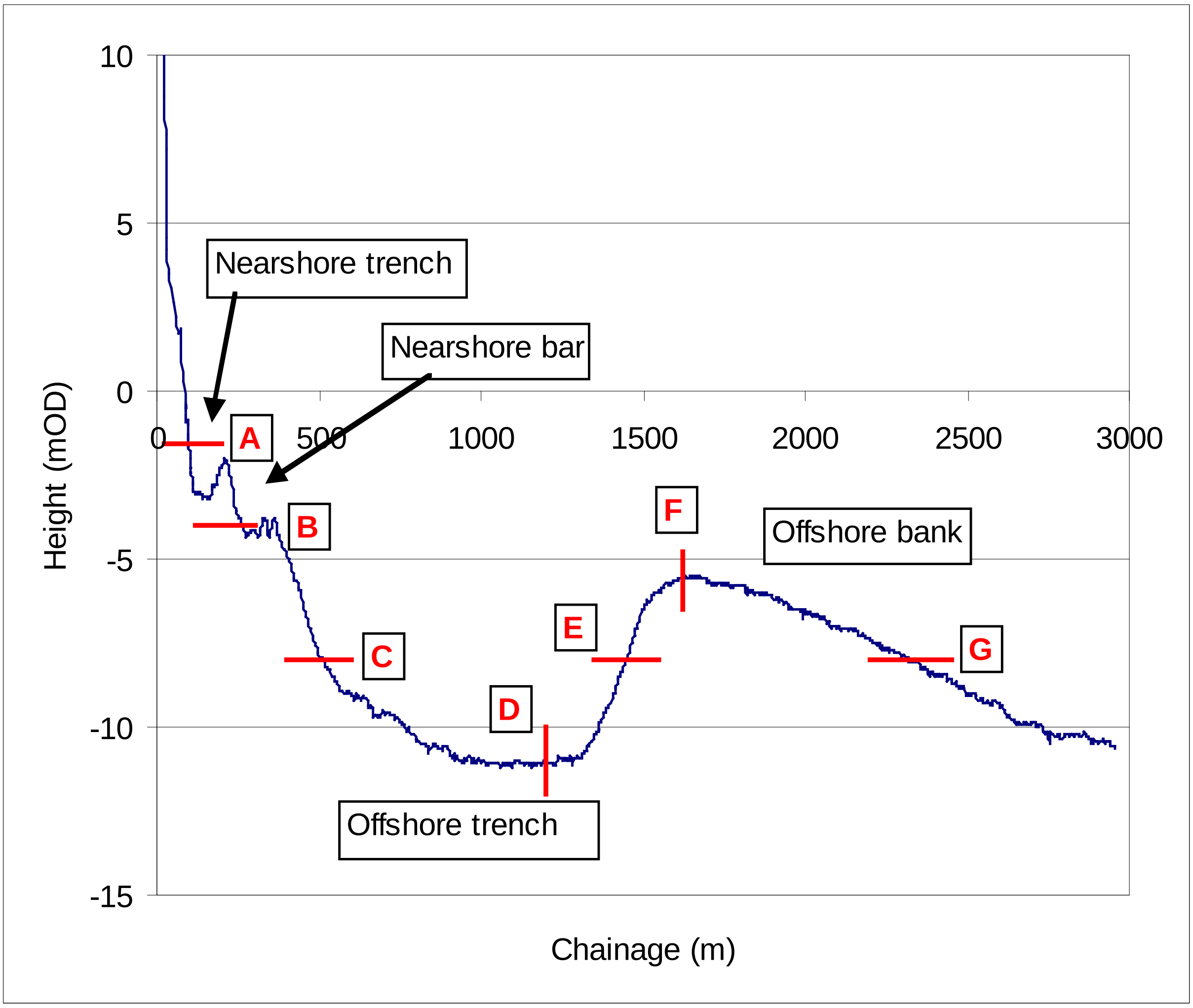


Plate 2.1 Typical offshore profile showing nearshore and offshore bar and trench systems (Black and Veatch 2005)

20. The banks are made up of fine to medium sands with a proportion of carbonate shell material especially on the seaward face (Cefas 2001). The mean grain diameter was found to vary between 0.096mm to 0.291mm in the boxcore samples collected by Lees and Heathershaw (1981).

21. The two banks (both rising to about 3m CD) are separated from each other in front of Minsmere by a deeper area, typically down to 5m CD (***Plate 2.1***). This deeper area changes in level such that the banks are at times nearly continuous and at other times relatively separate.

22. Black and Veatch (2005) examined historical data comprising Admiralty Charts and Environment Agency beach profile and bathymetric survey information to analyse historical change of the nearshore and offshore areas along the Dunwich cliff to Sizewell frontage. There has been a general trend for the Dunwich and Sizewell banks to amalgamate since the mid-1800s and to grow northward while

also moving inshore and flatten. As the banks have moved landward the offshore trench has also been noted to have shown some slight shallowing.

23. It was also noted from the Admiralty charts that the gap between Sizewell and Dunwich banks has widened and deepened during the latter half of the century. Separation of the banks will have reduced the wave protection provided to the frontage behind the separated area during these periods.

24. Burningham and French (2016) have also examined the historic changes in the Sizewell-Dunwich bank system. They identified the following:

25. In the early 19th century, these banks were separate features that were semi-connected at their southerly extent, Sizewell Bank at Thorpeness and to a lesser extent, Dunwich Bank just south of Dunwich (***Plate 2.2***). At that time, the Minsmere-Dunwich cliffs were protected from waves to the northeast by the Dunwich Bank, but exposed to the southeast.

26. By the late 1800s, the banks had partly coalesced, a process that has continued since. Throughout the history considered here, the southern extent of Sizewell Bank has maintained a connection to Thorpeness. In addition to coalescing with Sizewell Bank, Dunwich Bank has moved shoreward.

27. During this historical timeframe, shoreline behaviour along the Minsmere-Dunwich cliffs changed from recessional to stabilised, reaching the latter condition in the first half of the 20th century. Bank movement thus appears to have been a key factor influencing the observed changes in shoreline behaviour. Given that the earlier, more north easterly, location of Dunwich Bank was associated with a period of retreat for the Dunwich-Minsmere shoreline, and that its more recent southerly location is concurrent with stability at Dunwich/Minsmere, it follows that south easterlies were more responsible for shoreline change than north easterlies.

28. Shoreline change at Sizewell has been comparatively limited, with significant temporal and spatial variability. The wave dissipation effects of Sizewell Bank are unlikely to have changed as significantly as for Dunwich Bank due to the persistence in its alongshore position (noting that this continues to move onshore, however). The Sizewell shoreline might therefore be more responsive to changes in alongshore sediment flux than to direct wave forcing.

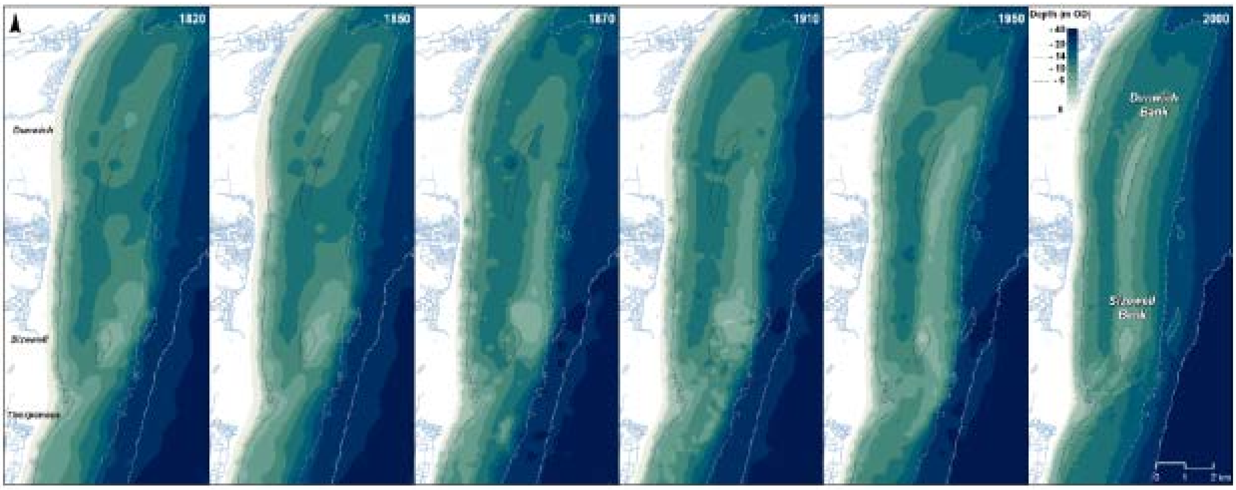


Plate 2.2 Historic Bathymetric Change around the Sizewell and Dunwich Banks (Burningham and French 2016)

2.5 Characteristics and Behaviour of the Coralline Crag outcrop

29. The Coralline Crag Formation is a geological formation found near the North Sea coast of Suffolk. It comprises a series of marine deposits and characterised by bryozoan and mollusc debris. The deposit, whose onshore occurrence is mainly restricted to the area around Aldeburgh and Orford, is a series of bioclastic calcarenites and silty sands with shell debris, deposited during a short-lived warm period at the start of the Pliocene Epoch of the Neogene Period. Small areas of the rock formation are found in locations such as Boyton and Tattingstone to the south of Orford as well as offshore at Thorpeness.

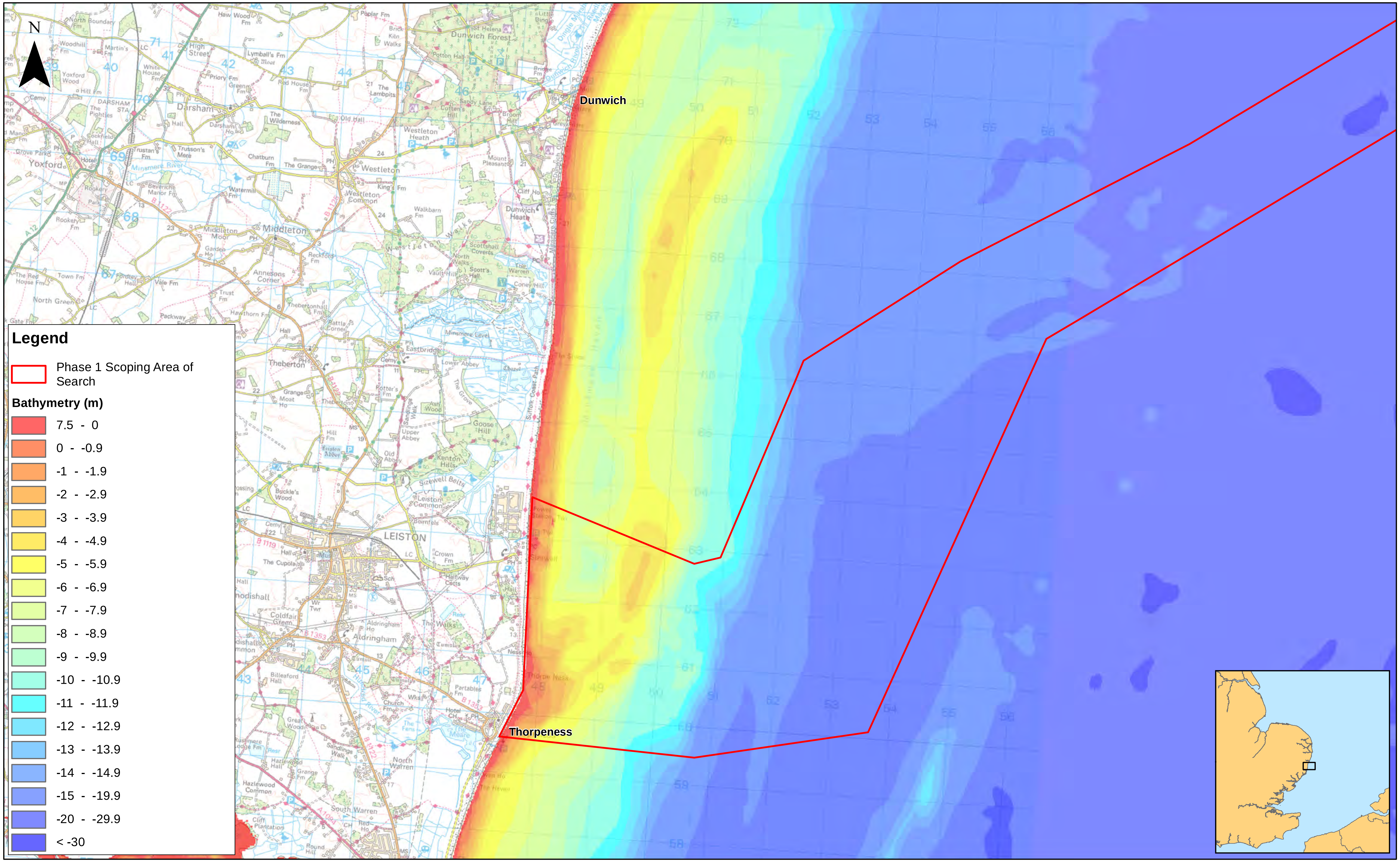
30. It is the outcrop of the Coralline Crag Formation offshore from Thorpeness that is of relevance to the offshore export cable landfall. This is one of the principal control features on evolution of the section of coast between Dunwich and Thorpeness, effectively providing an anchoring effect in the south. Whilst this outcrop of rock is discernible through the sea bed contours shown on the Admiralty Chart of the area, detailed definition of its fuller extent became possible through shaded depth plots of data arising from a detailed bathymetry survey and a composite plot of radar imagery, provided by EDF Energy.

31. ***Figure 2.3*** shows the nearshore sea bed bathymetry offshore of the coast between Dunwich and Thorpeness. The crests of the Sizewell Bank and the Dunwich bank are both clearly discernible as shallower areas of sea bed, with the channel which separates them from the shore running to their landward side. The extent of the Coralline Crag outcrop on the sea bed off Thorpeness is also a major feature discernible from the data.

32. Definition of the extent of the Coralline Crag outcrop, i.e. where exposed at the sea bed, is shown in the radar imagery presented in ***Figure 2.4***, it can be seen that the ridges of Coralline Crag run in a southwest to northeast alignment. The

geomorphological interpretation and mapping undertaken by EDF Energy suggests that the Coralline Crag may likely extend further seaward, but becomes covered by the southern end of the Sizewell Bank and, further offshore still, by sandwaves or megaripples.

33. ***Figures 2.3 and 2.4*** show that within around 2.5km of shore, the inter-tidal and nearshore area within the proposed offshore export cable corridor for the East Anglia ONE North and East Anglia TWO wind farms is occupied across its width by either the Coralline Crag outcrop or the southern end of the Sizewell Bank. Disturbance of either feature due to cable laying would cause potential adverse effects on baseline physical processes and morphology that need to be considered further.



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1	18/07/2019	AB	First Issue.	Checked:	PM
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East Anglia ONE North

Bathymetry around Proposed Export Cable Corridor

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Figure	2.3	

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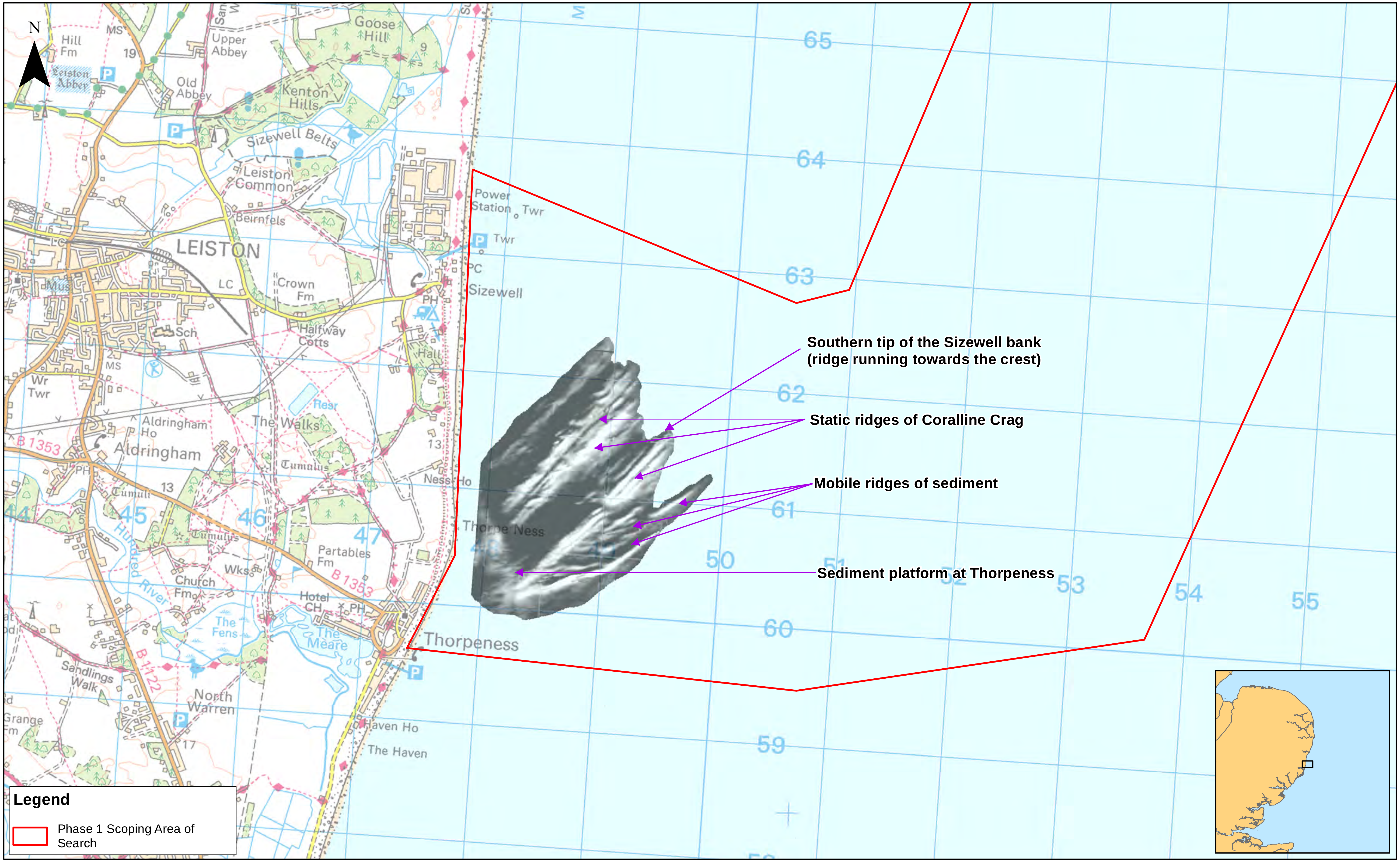

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Approved: PP

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East Anglia ONE North

Radar Imagery (Courtesy of EDF Energy)

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Rev	1
Date	18/07/19
Figure	2.4

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Projection: Zone 31N

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2.6 Controls and Interactions

34. The Coralline Crag outcrop helps maintain a ness feature at Thorpeness and helps provide stability to the southern end of Sizewell Bank. In turn, the ness and the sandbank both have important positive feedback interactions on the relative long term stability of the Sizewell shore (notwithstanding the short-term storm-related dynamics which form part of the baseline response to predominantly north-easterly and south-easterly wave events and associated gross sediment transport).

35. There is interconnectivity within the natural coastal system thus:

- The Coralline Crag outcrops directly help provide stability to the ness at Thorpeness.
- The ness helps provides stability to the Sizewell shore by slowing net alongshore drift rates from north to south.
- The Coralline Crag outcrops directly help provide stability to the sandbank at Sizewell Bank.
- The Sizewell Bank helps provide stability to the Sizewell shore through sheltering against direct wave effects.
- The ness helps provide stability to the Sizewell Bank by means of an offshore directed sediment transport link between the ness and the bank.
- The Sizewell Bank helps provide stability to the ness through sheltering against direct wave effects.
- The Sizewell Bank helps provide stability to the Dunwich Bank by means of a northerly-directed nearshore sediment transport link along the banks.
- The Dunwich Bank helps provides stability to the Dunwich shore through re-circulation of sediment from the bank back to the shore.
- The Sizewell Bank and Dunwich Bank both help provide stability to the Dunwich – Sizewell – Thorp ness shore by influencing the tidal circulation patterns (localised clockwise around the banks).
- The Sizewell Bank and Dunwich Bank both help provide stability to the Dunwich – Sizewell – Thorp ness shore by dissipating wave energy, resulting in relatively low net sediment transport rates.

36. It is understandable, therefore, that there would be concern, from a physical process perspective, if any activity adversely affected the exposures of Coralline Crag in the vicinity of Thorpeness since there could be not only potential local effects at Thorpeness but also longer term geomorphological implications on a wider scale system extending as far north as Dunwich and encompassing the

Sizewell shore. It is therefore necessary to ensure that the East Anglia ONE North project has no impact on the Coralline Crag.

2.7 Tidal Regime

37. Astronomical water level statistics for Southwold (to the north of Dunwich), Sizewell and Aldeburgh (top the south of Thorpeness) are shown in ***Table A4.1***. Due to meteorological effects, these astronomical tidal levels can be affected by surges and wind set-up. A series of extreme water levels for the same locations (plus Dunwich) are shown in ***Table A4.2***.

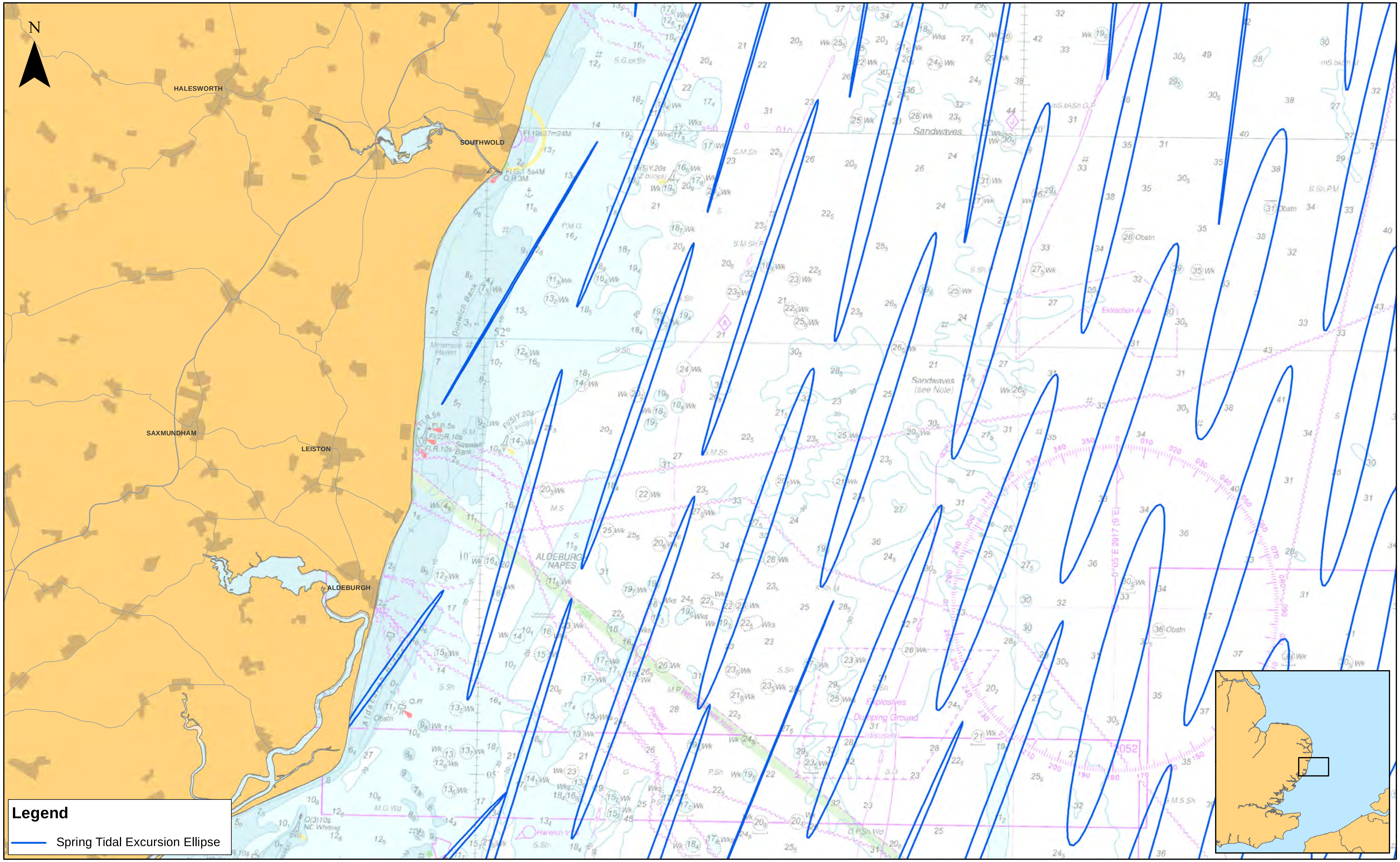
Table A4.1 Astronomical Tidal Levels (Royal Haskoning 2010)

Location	LAT	MLWS	MLWN	MHWN	MHWS	HAT	Neap range	Spring range	Correction CD/OD
Southwold	-	-1.15	-0.50	0.80	1.10	-	1.10	1.25	-1.3
Sizewell	-	-1.45	-0.50	0.70	1.10	-	1.20	2.55	-1.3
Aldeburgh	-	-1.55	-0.60	0.7	1.20	-	1.30	2.75	-1.6

Table A4.2 Extreme Water Levels (Royal Haskoning 2010)

Location	1:1	1:10	1:25	1:50	1:100	1:250	1:500	1:1000
Southwold	2.05	2.58	2.79	2.94	3.1	3.31	3.47	3.63
Dunwich	2.05	2.57	2.78	2.93	3.09	3.3	3.45	3.61
Sizewell	2.05	2.57	2.78	2.93	3.09	3.29	3.45	3.61
Aldeburgh	2.05	2.57	2.77	2.93	3.08	3.29	3.45	3.6

38. The tidal currents off this part of the Suffolk coast are directed to the south on the flooding tide and to the north on the ebbing tide, with current speeds typically of the order of 0.7m/s on spring tides and 0.4m/s on neap tides. The tidal ellipses offshore from this part of the Suffolk coast are shown in ***Figure 2.5***.



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1:150,000 Scale @ A3

0 2 4 8 Km

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East Anglia ONE North

Tidal Ellipses off the Suffolk Coast

Drg No	EA1N-DEV-DRG-IBR-000969
Rev	1
Date	18/07/19
Figure	2.5

Datum: WGS 1984
Projection: Zone 31N

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39. The mean spring and mean neap astronomical tidal current velocities across an area of the sea bed close to part of the cable corridor (offshore section) are provided as a Tidal Diamond on the UK Hydrographic Office Admiralty Chart #1610-0: Saint Govan.

40. ***Table A4.3*** presents the current direction (°) and speeds (converted from knots to m/s) from relevant Tidal Diamonds close to the PDZ. The location of the Tidal Diamond is shown in ***Figure 2.6***. The times are relative to high water at Dover.

Table A4.3 Tidal Current Parameters from a Tidal Diamond Near to the Cable Corridor (UK Hydrographic Office Admiralty Chart 1610)

Time relative to high water (hrs)	Current direction (o)	Spring current speed (m/s)	Neap current speed (m/s)
-6	115	0.3	0.2
-5	104	0.5	0.3
-4	100	1.1	0.8
-3	99	1.4	0.9
-2	97	1.2	0.8
-1	92	0.8	0.6
0	334	0.4	0.3
1	288	0.5	0.3
2	282	1.1	0.7
3	279	1.3	0.9
4	276	1.2	0.8
5	270	0.9	0.6
6	159	0.5	0.3

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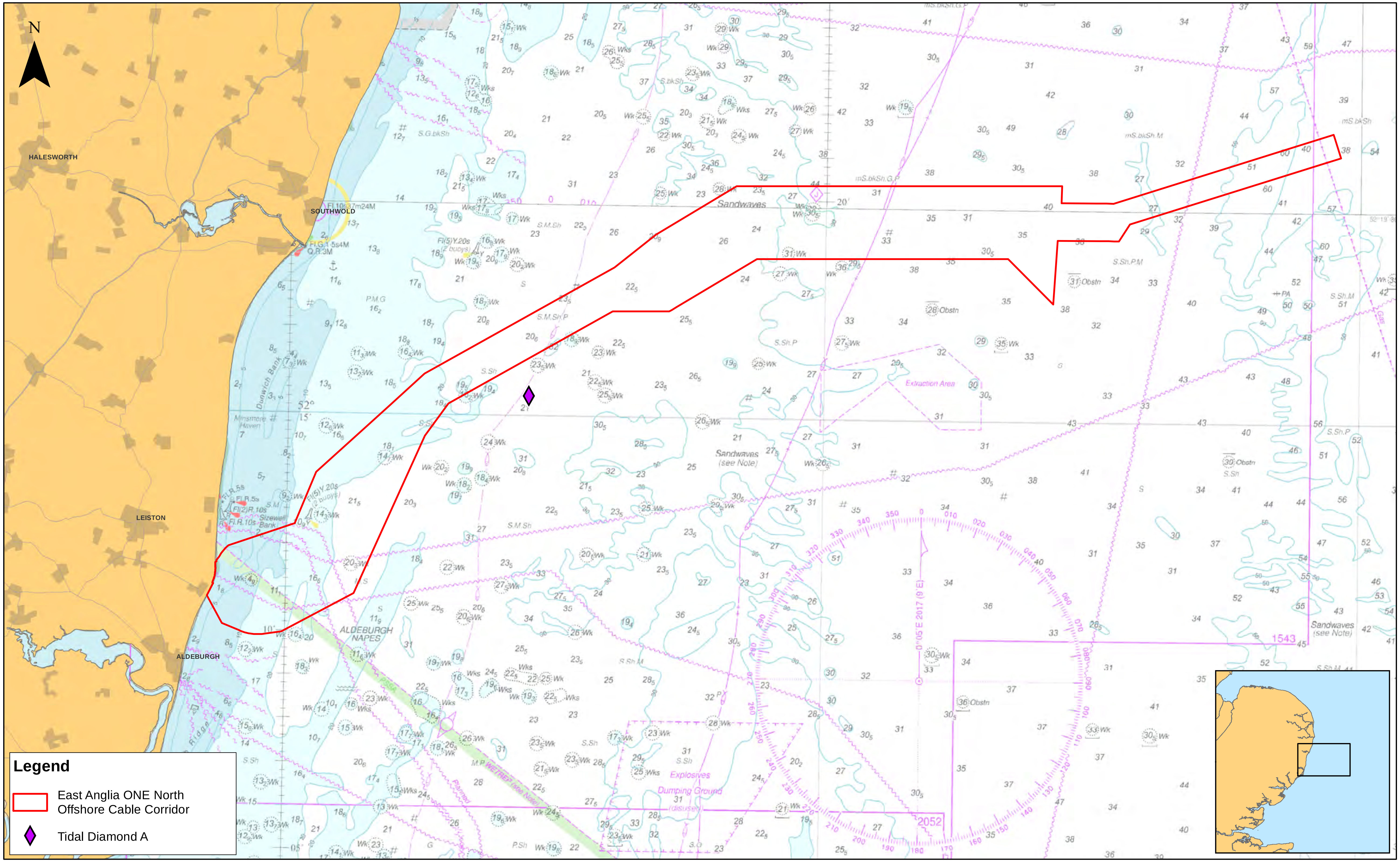

East Anglia ONE North

Location of Admiralty Tidal Diamond A

SCOTTISHPOWER RENEWABLES

Rev	Date	By	Comment		
				Prepared:	AB
1	18/07/2019	AB	First Issue.	Checked:	PM
				Approved:	PP

1:150,000 Scale @ A3

0 2.5 5 Km

Drg No	EA1N-DEV-DRG-IBR-000970
Rev	1
Date	18/07/19
Figure	2.6

Datum: WGS 1984
Projection: Zone 31N

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41. The nearshore banks influence flows locally, with sediment tracer studies and sea bed current meter moorings indicating a (proposed) local clockwise tidal circulation around the Sizewell and Dunwich banks (HR Wallingford 2002).

2.8 Wave Regime

42. Black and Veatch (2005) states that dominant offshore (deep water) wave directions off the Sizewell coast are from the north northeast and south southwest (***Plate 2.3***). There can also be significant wave action directly from the east and, although less frequent, there can be periods of high southeasterly wave energy.

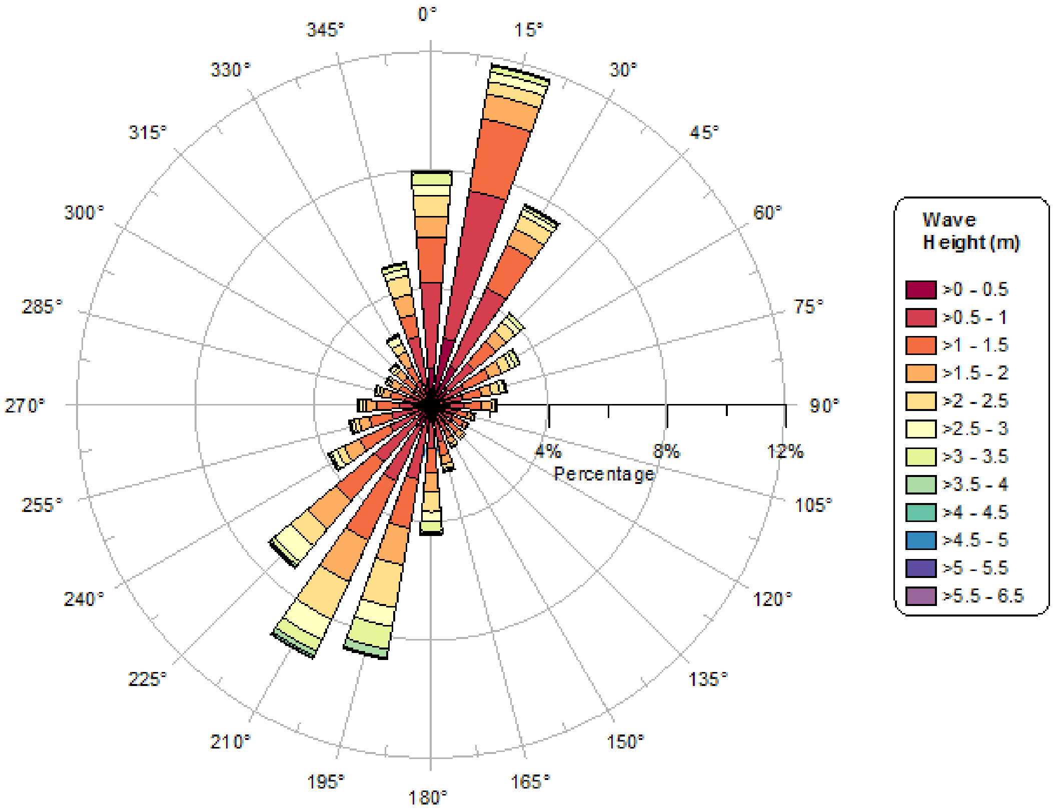


Plate 2.3 Offshore Wave Rose (source Black and Veatch 2005)

43. Black and Veatch (2005) inshore wave modelling shows dominant wave directions in the Sizewell nearshore from northeast and east northeast and from southeast and east southeast, with the latter directions being the south southwest offshore waves refracted around Thorpe Ness (***Plate 2.4***).

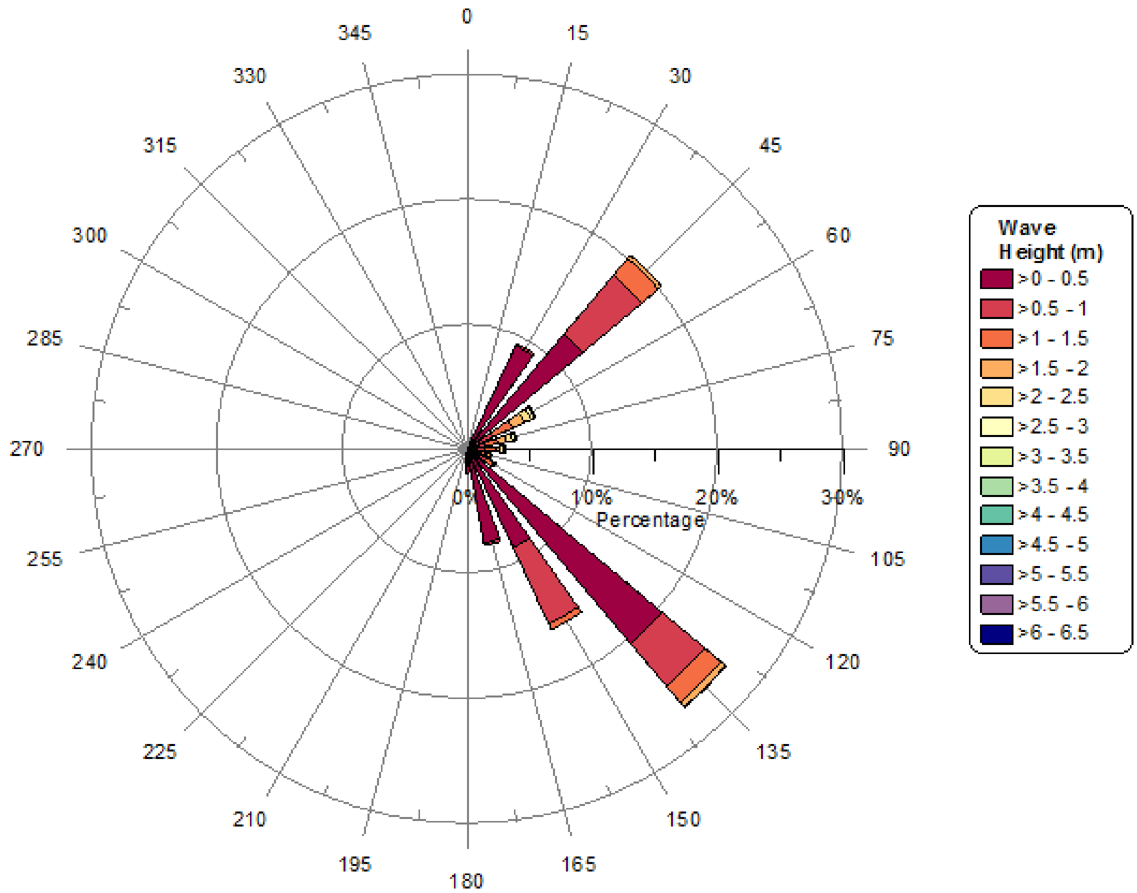


Plate 2.4 Nearshore Wave Rose off Sizewell (Black and Veatch 2005)

44. Cefas' WaveNet website lists a directional waverider buoy being located offshore from Sizewell (4.18km from Mean High Water Springs (MHWS)) in 18m water depth. Data collection from this buoy commenced in February 2008 and (presently) is due to end on 1st January 2021. Historic data from this buoy are not available to download from the WaveNet website but are provided for display purposes on behalf of the data owner, EDF Energy. Plots are possible to create and timeseries are presented of significant wave height (***Plate 2.5***), peak wave period (***Plate 2.6***), zero mean crossing wave period (***Plate 2.7)*** and wave direction (***Plate 2.8***). It is also possible to view on WaveNet tabulated and graphical representation of the wave data, including wave spectra and wave roses.

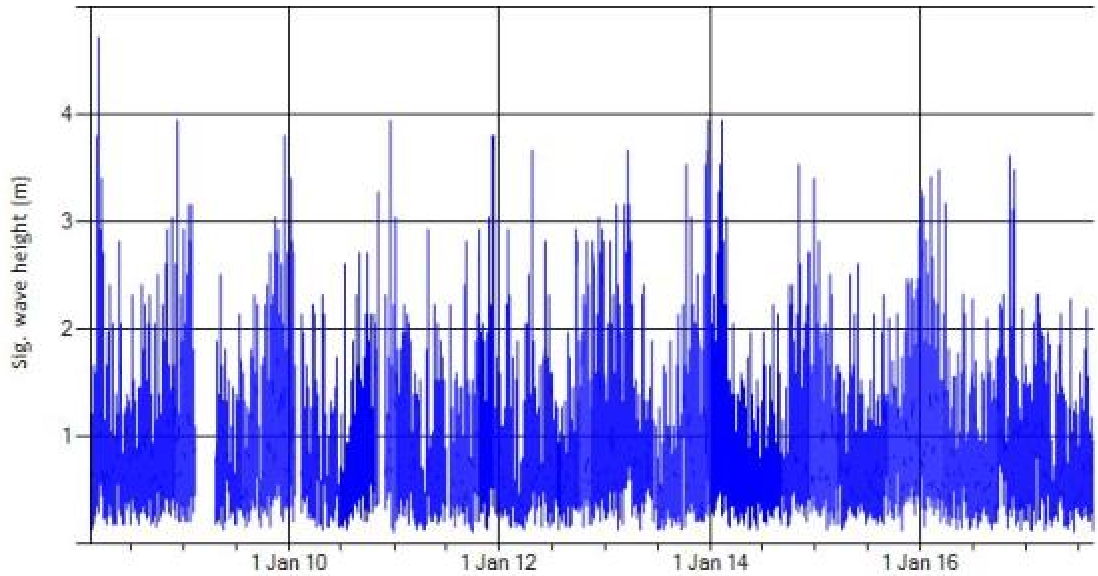


Plate 2.5 Timeseries of Significant Wave Height Recorded at Sizewell Wave Buoy (2008 – 2017)

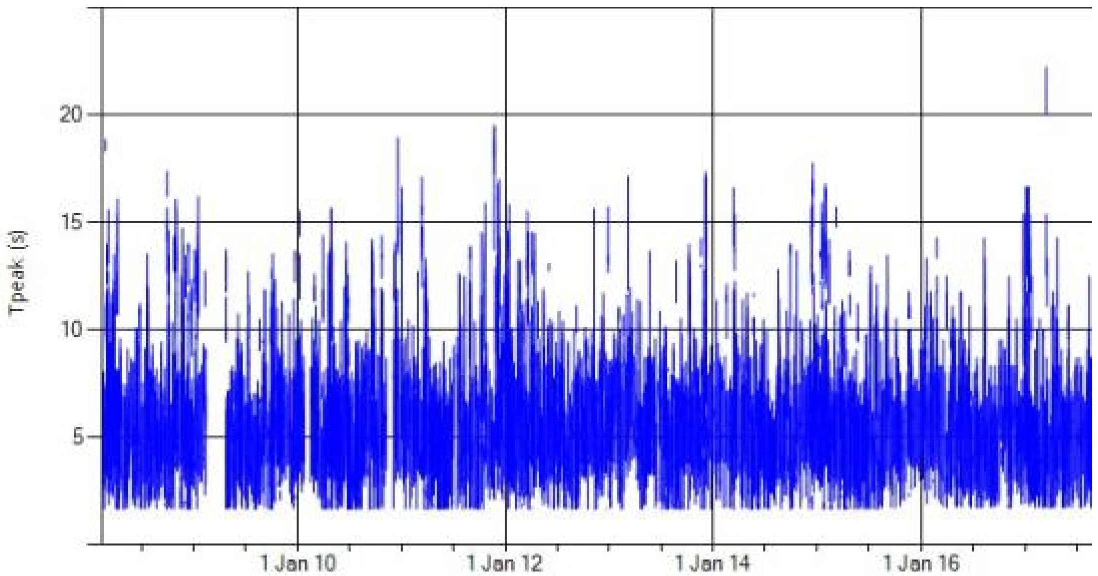


Plate 2.6 Timeseries of Peak Wave Period Recorded at Sizewell Wave Buoy (2008 – 2017)

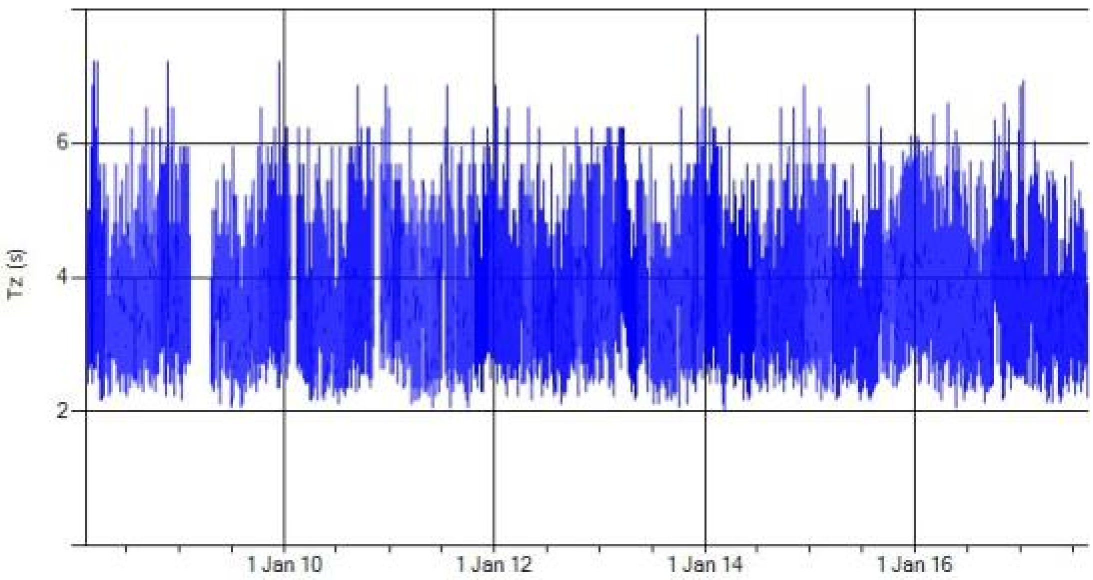


Plate 2.7 Timeseries of Zero Mean Crossing Period Recorded at Sizewell Wave Buoy (2008 – 2017)

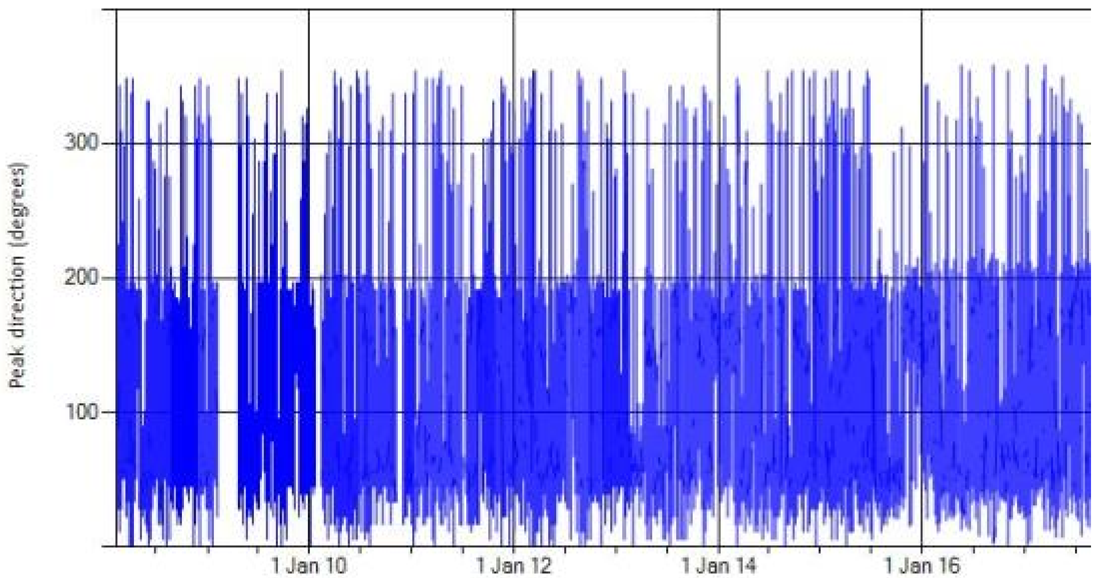


Plate 2.8 Timeseries of Wave Direction Recorded at Sizewell Wave Buoy (2008 – 2017)

45. However, wave conditions recorded at the Sizewell buoy will be affected by the Sizewell-Dunwich bank system before it reaches the shoreline. Any natural changes to the formation of the banks over the longer term will alter their impact on incoming waves. A reduction in crest height will increase the breaking depth on the banks and therefore allow larger waves to move across the banks without breaking therefore exposing the frontage behind to greater wave exposure. A reduction in crest height may also alter the way in which waves are refracted over the banks so that the location of concentrated wave impact may shift if the banks continue to change in size or migrate landwards.

2.9 Sediment Transport

46. This is summarised from the Suffolk SMP2, the Southern North Sea Sediment Transport Study and the Minsmere Frontage Coastal Processes Report:

47. The whole frontage is considered in all studies to be strongly in line with net wave energy such that there is only limited net drift of sediment along the shore. There is a slight net southerly movement modelled and a very weak net drift to the south past Thorpe Ness. To the south of Thorpe Ness the indication is for a slight net northerly drift tending to hold material under the cliffs at Thorpeness Village. However, within this system there is significant recorded gross drift of sediment along the shoreline, both to the north and the south, tending to balance overall, due to prevailing wave climate.

48. With the larger variation in gross drift rates, however, there can be significant local change in the condition of the beaches and this can, in more extreme events, result in exposure and erosion of the cliffs. This is seen as providing important sediment supply to the system, helping to maintain a net balance along the coast.

49. In the past, there have been occasions when the shingle ridge over the Minsmere valley has breached. Although after many events this required intervention to maintain the defence, following the breach of 1857 the natural defence healed itself without assistance. This does reinforce the concept that this frontage is dynamic but quite resilient. It has to be noted that there may have been greater input of sediment to the frontage at this time, with erosion of the cliffs to the north and possibly greater input from the shoreline further north. It also highlights, therefore, the importance of maintaining sediment drift to the area to maintain a competent natural defence line.

50. There is considerable discussion over the impact of the sluice at Minsmere. This structure quite evidently does influence movement of sediment along the shore, although not consistently acting as a full barrier. The structure is believed to act to strengthen the coast at this location, tending to limit more excessive movement away from the area and tending to encourage the overall retention of material towards the centre of the valley. There is an issue, however, of whether this accumulative behaviour of the shore at this point is totally as a result of the sluice. Potentially, it is the location of the sluice at the centre of the valley which provides the underlying geomorphological control. This may also be associated with the lower division between the banks offshore. The presence of the sluice reinforces this behaviour. Regardless of these uncertainties in the underlying structure of the coast, the sluice is considered to be an important structure.

51. The Dunwich and Sizewell banks (and the Aldeburgh Ridge bank) are banner banks being actively fed with finer material from various headlands. Based on

previous studies there may also be some re-circulation from the Sizewell and Dunwich banks back to the shore at Dunwich (HR Wallingford 2002).

52. Various studies have examined the past and present erosion rates of the area. These all conclude that to the south of Minsmere, there tends to be far less variation than further north under the cliffs at Minsmere and Dunwich. Certainly, in the southern section of the coast south of Sizewell B Power Station there is greater protection offered by the shingle beach to the backshore ridge and cliffs. This additional width of beach, coupled to the stronger nature of Thorpeness and the nearshore influence of the ness itself, provides the shore with a greater ability to respond to specific storm events without resulting in a net landward retreat of the overall shoreline.

53. A report (Pye and Blott 2005) highlights the variation in longer term erosion of the frontage. This demonstrates the development of the cliffs to the north of Minsmere and the accretion occurring south of the valley. It is noted that this accretion occurs before the facilities and outfalls at the Power Station.

54. To the northern end of the system at the Dunwich and Minsmere cliffs, periods of erosion of the beaches have exposed the cliff line more regularly, causing a net retreat of the shore. With the distribution of sediment along the shore, the input locally of sediment is never able to build sufficiently to resist further erosion of the cliffs. The process is seen as being similar to the manner in which Dunwich cliffs control the shingle bay over the Walberswick marshes. It is probably part of a larger system of behaviour.

55. The shore sediments are relatively mobile and are supported cross-shore by the cliffs backing the shore, or in the case of the Minsmere valley section, by the limiting effect of the cliff line to the north. During more severe conditions the cliff is exposed and erodes so material is able to infill behind, creating the variation in width of beach berm. Such areas locally have a greater resilience to erosion of the back cliff and, therefore, there is preferential erosion elsewhere. The net effect is that the shoreline acts as a unit, slowly eroding inland. Underlying this is the variation in wave climate and the behaviour of the nearshore banks such that there is also the creation of very shallow bays. Each separate section still, however, acts within the overall behaviour as a continuous unit.

56. Long term average erosion trends suggest that the coast is still attempting to adjust in shape such that the frontage to the north is eroding at a slightly faster rate than to the south, in effect hinging on Thorpe Ness. Locally, particularly at the interface between the cliffs and the low lying area of Minsmere, there can be discontinuity along the coast. This is seen most significantly to the northern end of Minsmere where there has been an area particularly vulnerable to setting back. Overall, this is seen as a local problem rather than a breakdown of the larger

system, although attempting hold the line forward artificially in this area would detract from the overall resilience of the area.

57. Several previous studies have provided estimates of net alongshore drift rates for the frontage. Black and Veatch (2005) summarised these in their work, with their summary reproduced in ***Table A4.4***, it can be seen that there is considerable variability in the results.

Table A4.4 Alongshore Sediment Transport Potential Calculated by Various Authors (Black and Veatch 2005). Note that (S) denotes net sediment transport direction to the south.-

Author	Site	Potential Net Transport Rate (m^3 per year)
Vincent (1979)	Dunwich	70,000 (S)
Onyett and Simmonds (1983)	Southwold	200,000 (S)
	Walberswick	210,000 (S)
	Dunwich	130,000 (S)
	Thorpeness North	200,000 (S)
	Thorpeness South	55,000 (S)
Halcrow (2001)	Southwold	3,100 (S)
	Corporation Marsh	9,900 (S)
	Dunwich	12,100 (S)
	Minsmere Sluice	3,200 (S)
	Sizewell Power Station	3,700 (S)
	Thorpeness	300 (S)

58. Further modelling by Black and Veatch (2005) together with Historic Trends Analysis of Admiralty Chart and beach/bathymetric survey data is illustrated in ***Plate 2.9.***

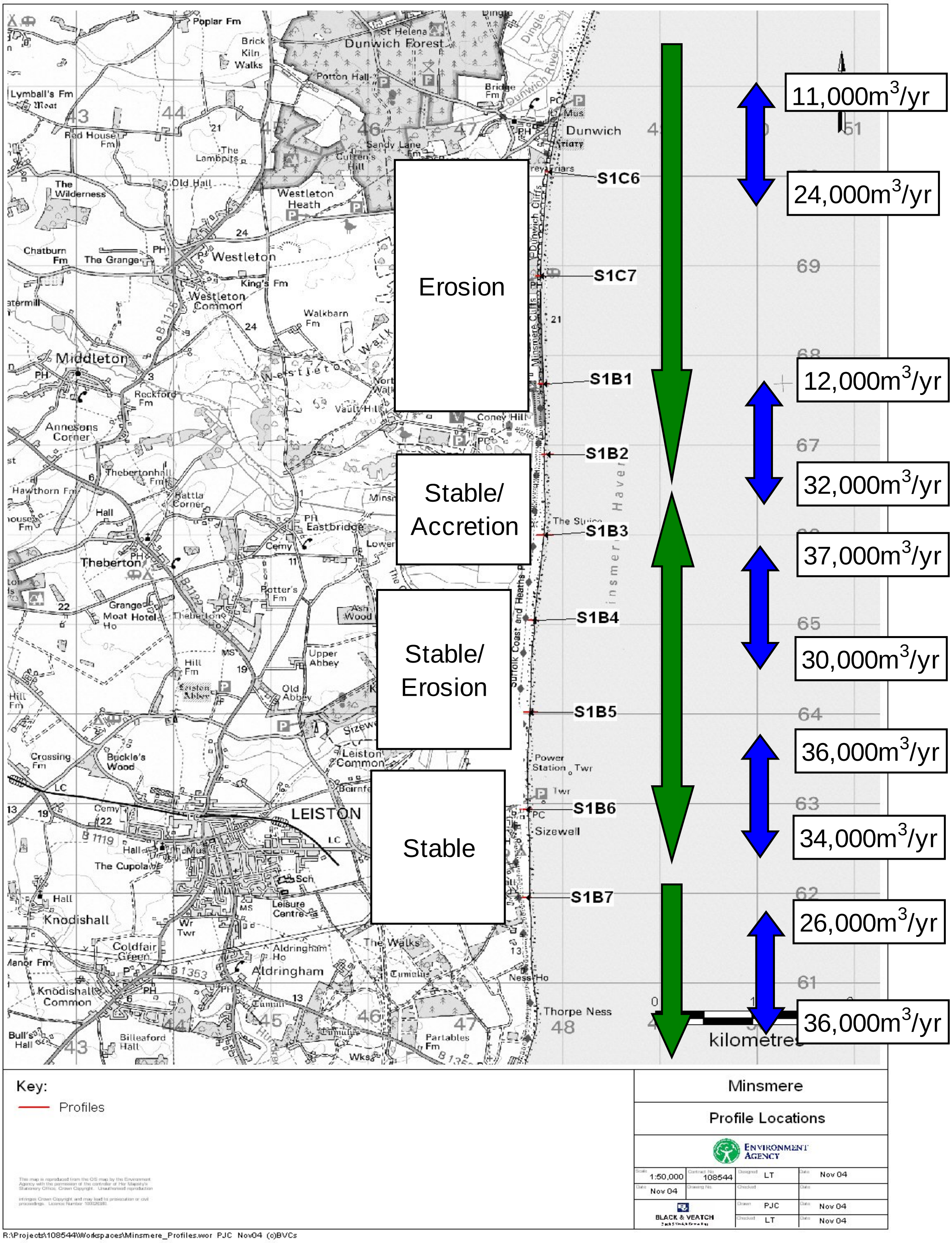


Plate 2.9 Conceptual Diagram of Potential Gross Sediment Transport Rates (Black and Veatch 2005)

2.10 Coastal Defences

59. There are limited sections of man-made defences along the frontage, with defences tending to be set back behind the active shingle beach. The Minsmere Sluice does however cut through the shore as a hard structure.

60. Behind the natural shoreline there is the embankment to the northern end of the Minsmere valley and a more substantial bank and a maintained dune system set back in front of Sizewell B Power Station.

61. There are also various low banks within the Minsmere valley acting to channel the river and contain the various areas of open water.

2.11 Conceptual Understanding of Relevance to the Cable Corridor

62. Combining key information from the relevant information sources, the following key points are of relevance for consideration when assessing the potential effects of the alternative cable corridor on physical processes:

- Net transport of sediment along the shore is limited, but gross transport can be higher and its direction is dependent on prevailing wave conditions.
- The alongshore transport of shingle is restricted to the surf zone under predominantly storm conditions.
- Under normal conditions sand moves alongshore in the intertidal zone; under storm conditions, sand transport predominantly takes place along the nearshore bar.
- The nearshore area is characterised predominantly by shelly fine to medium sands, with only minimal shingle present.
- Sediments greater than 2mm in size are not mobilised in offshore regions; therefore, it is unlikely for shingle sized material to be transported onshore.
- Thorpe Ness, while limiting supply to the south plays a major role in holding material to the north. The majority of the fine sediment transported south each year is therefore likely to be recirculated north into the Sizewell and Dunwich banks. Indeed, sand has been noted to move offshore at Thorpe Ness from the shore onto the Sizewell bank system.
- The Sizewell and Dunwich banks are sinks for medium to fine sand, with no shingle. There is potential for movement of sand sized sediments on the banks under both average and storm wave conditions and sand sized material within the first 4km offshore could be mobilised and moved onshore under both storm and moderate wave conditions.
- Northward transport of sediment along the Sizewell and Dunwich banks is via the suspended sediment mode, and the tidal current pathways may even be responsible for the formation of Sizewell and Dunwich Banks.

- There may be some re-circulation from the Sizewell and Dunwich banks to the Dunwich shoreline.

2.12 Coastal Change over the Study Area

2.12.1 General Area

63. The study by Pye and Blott (2005) undertook an analysis of coastal change based on historic maps. This analysis, focussed more on the northern section of the broader frontage, highlighting the substantial change and erosion of the Minsmere and Dunwich cliffs, with more variable change occurring to the south at Sizewell. The study identifies that during the period between 1836 and 1903, the northern cliffs rapidly retreated by around 150m at an average rate of 2.3 m/yr. Between 1903 and 1976, the rate of change declined to around 1.3 m/yr (continuing to reduce between 1953 and 2003 to around 0.6 m/yr).

64. Further south, along the Minsmere frontage, the rate of erosion over the period between 1836 and 1903 the rate of erosion was less, at around 1.1 m/yr, with the area around Sizewell tending to accrete. Between 1903 and 1976, at Minsmere there was a period of accretion and at Sizewell the coastline tended to remain stable.

65. These long term trends of change in behaviour have been reflected in other studies and the analysis of the more recent EA profiles (Black and Veatch 2005) showed typical erosion rates as set out in ***Table A4.5***.

Table A4.5 Average erosion rates based on 1992 to 2005 (Black and Veatch 2005).

Location	Average yearly erosion rates m/year		
	2m OD	MHWS	MSL
S1B1. Minsmere Cliffs	-1.04	-2.18	-2.13
S1B3. Minsmere Sluice	0.49	0.04	0.08
S1B6. Sizewell Village	0.15	-0.24	-0.05
S1B7. Sizewell Cliffs	0.17	-0.04	0.15

66. More specifically to the Sizewell and Thorpeness Cliffs, the summary analysis undertaken by the EA Shoreline Management Group 2011 states in relation to the relevant profiles that:

- S1B5 and S1B6 – Sizewell. Data from both profiles shows erosion to 1999/2000 followed by a period of accretion to 2010, resulting in no overall movement in trends.
- S1B7 – Sizewell Hall. Slight accretion at all levels. Mean trend of 0.3 m/yr.

2.12.2 Local Area Analysis

67. A comparison of shoreline position has been undertaken based on mapping of mean high waters from historical maps (1884, 1904 and 1927) in comparison with recent OS mapping and Lidar. The comparative plots are shown in ***Plate 2.10***

68. It may be seen from the image compared to recent (2014) Lidar that there has been a substantial but variable change, along the length of the area, in terms of beach width when compared to the very stable cliff line. Based on this, the area has been subdivided into zones A to F, as shown in ***Plate 2.10,*** and a more detailed analysis has been carried out of change in each zone based on representative profiles.

69. Cross section data has been extracted from Lidar for 1999 through to 2015, although in some areas Lidar did not provide complete coverage. These cross sections (and zones) are shown in ***Plate 2.11.***

70. The key features of change over the whole length are:

- Over the northern area (zone A), there was a significant period of accretion from 1884 through to 1927 and the subsequent erosion in width of the upper beach through to the present day. More recently the profile has remained relatively stable with some indication of steepening around the lower foreshore. This seems consistent with the analysis previously undertaken with respect to EA profile S1B6.
- Zone B, there was less marked accretion historically but a similar period of erosion between 1927 and 2014. More recently the profile appears to have remained stable.
- Zone C, while there was a short period of accretion between 1884 and 1904, there was subsequent erosion through to 1927 and a more gradual period of erosion to present day. The zone, however, covers the narrowest section of upper beach. The lower beach shows more recent variability and the possible periodic exposure of the toe of the cliff. This is reflected in the slight erosion seen of the cliff face.
- Zone D, covers the main feature of Thorpe Ness, which grew substantially through to 1927 but has subsequently eroded back quite rapidly. The area still maintains a substantial area of upper beach such that there is no indication of more recent erosion of the cliff face.
- Zone E, represents the southern flank of the existing Ness feature. As above there was growth in the Ness feature between 1884 and 1927 but subsequently there was significant erosion. Over recent times there is clear evidence of significant variability in the lower and upper beach areas. While the upper part of the cliff appears to be relatively stable, there is evidence that the toe of the cliff has eroded.

- Zone F, this area shows substantial variation with an indicted trend of erosion of the lower and upper beaches. There is clear evidence of erosion of the cliff face which seems to be persisting through the Lidar record.

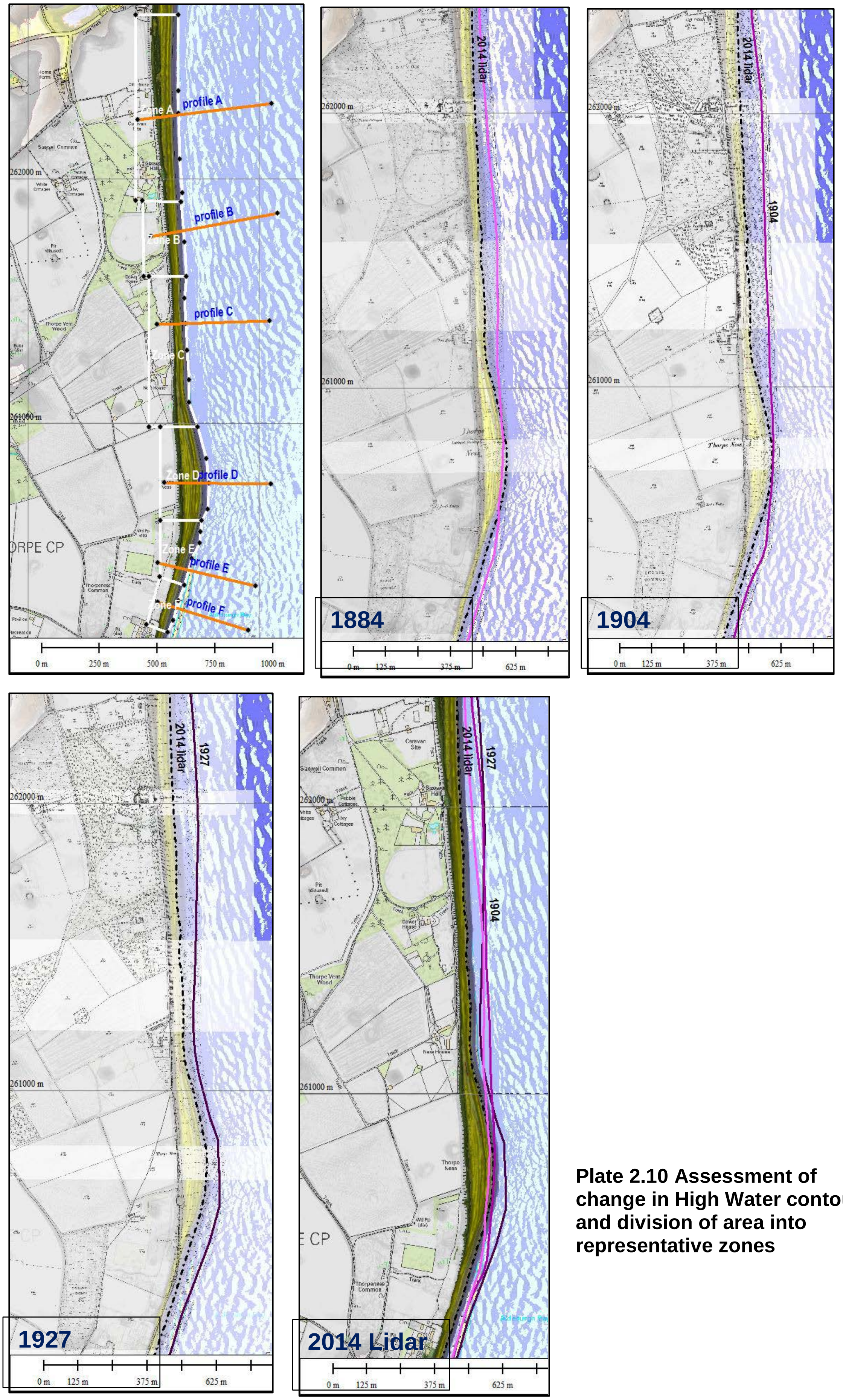


Plate 2.10 Assessment of change in High Water contour and division of area into representative zones

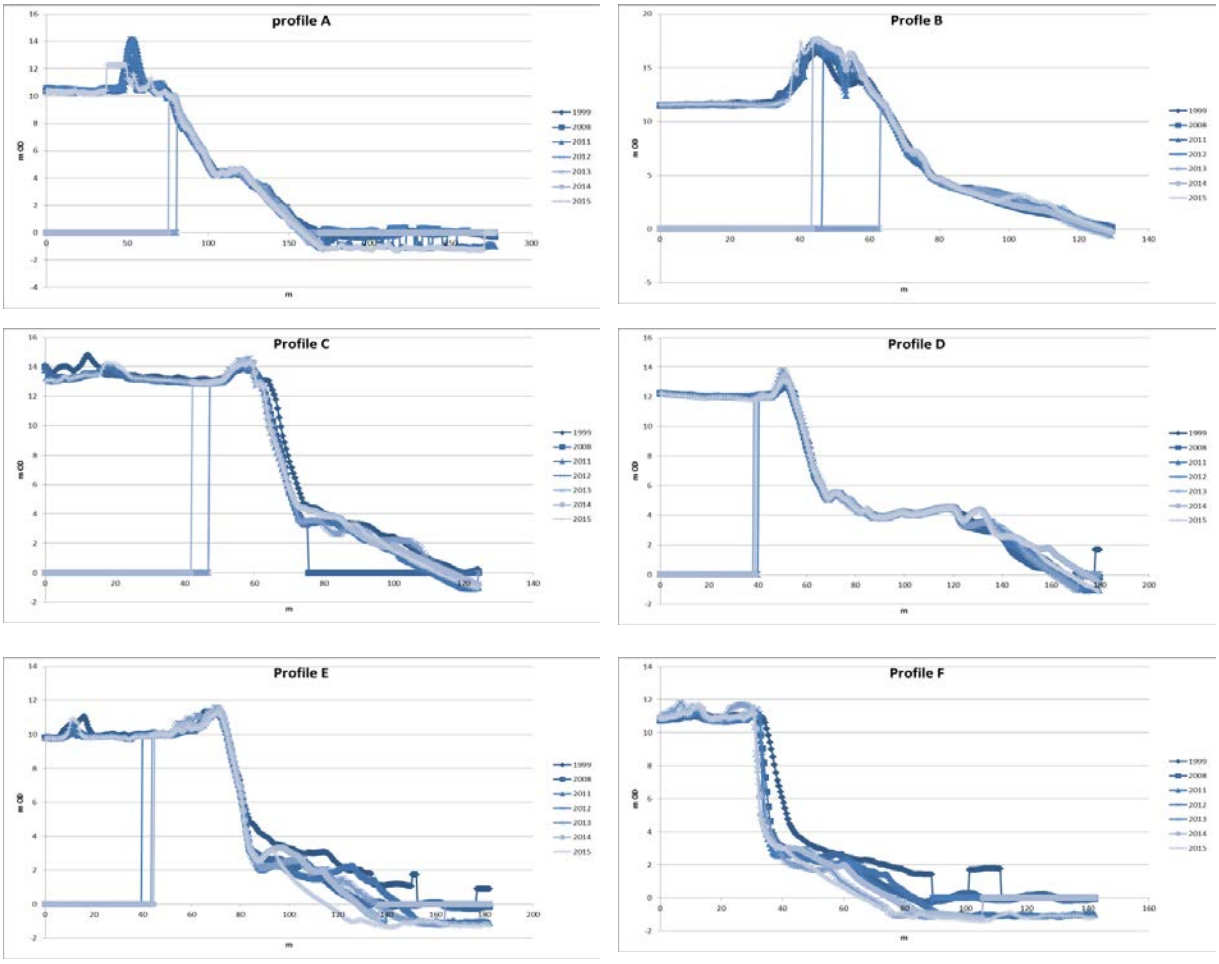


Plate 2.11 Comparison of Lidar data for profile A to F

2.12.3 Summary of Erosion Trends and Assessment of Future Behaviour

71. The general background information shows that while the direct study frontage has shown a high degree of stability in terms of the position of the cliff line, this has to be considered within the context of a broader system of change.

72. Both the historical and recent data shows that, along the study frontage, there has been significant change in beach width, in all areas, working through a period of accretion but generally trending towards a more erosive pattern of behaviour. Taking a precautionary approach, it seems sensible to assess the issues from this perspective.

73. Over recent times, as indicated by the analysis of the Lidar data particularly in terms of zones C, E and F, the erosion of the cliff toe, face and crest, critically depends on the width of protection provided by upper beach. While clearly this is a function of particular storms, this beach width also depends on the availability of sediment moving through the area from the north (this point was made in the study by Burningham and French 2016).

74. In assessing the potential for future cliff erosion, therefore, it is not sensible to merely rely on projection of current cliff erosion rates into the future. An approach has been developed considering the longer term historic rates of change with respect to the whole cliff and beach profile, using the more recent information in assessing the sensitivity of different areas.

75. In this approach, it has been taken from the recent profile information that, where there is in the order of 10m width between the toe of the cliff and the crest of the upper beach berm, there is sufficient protection to prevent substantial erosion of the cliff. As this width is reduced due to beach erosion below this width the cliff would tend to erode. It has been assumed that due to the additional supply of sediment and the higher resistance offered by the cliff this rate of erosion would be in the order of half that of the projected erosion of the beach.

76. With sea level rise, erosion generally will increase. As an indicative factor, future erosion rates may be taken as being proportional to the increase in sea level rise. On this basis, the rate of erosion has been factored over time, such that over the next 20 years erosion might have increased by a factor of 2, increasing to a factor of around 4.7 over the next 50 years and a factor of 8 over the longer term (typically 100 years).

77. In addition, examination of aerial photography has shown that very locally erosion of the cliff crest may occur, presumably year on year but during a storm event. The maximum local erosion that appears to have occurred in the way is in the order of 5m due to cliff slumping. In assessing the long term cumulative retreat a 5m buffer has been included in the assessment.

78. ***Table A4.6*** sets out the typical long term rate of change for each of the profiles considered in sub-section 2.11.2, with reference to the position of MHWS and the assessed position of the upper beach crest taken from historical mapping and Lidar (typically taken at a level of 4.5m to 5m OD depending of the specific profile).

Table A4.6 Typical long term rate of change for each of the profiles

	Long term observed erosion rates m/yr			Projection of cumulative erosion from the present-day cliff crest (m)		
Zone	MHWS	Upper beach crest	Crest of Cliff	20 years	50 years	100 years
A	0.4*	0.4*	0	5m	17m	80m
B	0.6*	0.25*	0	5m	15m	55m
C	0.18	0.18	0	5m	10m	38m

Zone	Long term observed erosion rates m/yr			Projection of cumulative erosion from the present-day cliff crest (m)		
	MHWS	Upper beach crest	Crest of Cliff	20 years	50 years	100 years
D**	0.05	0.1	0	5m	5m	5m
E	0.1	0.1	0.1	10m	18m	50m
F	0.24	0.25	0.1	12m	28m	85m
Notes: * the long term erosion rates are higher than shown from previous analysis and may therefore be taken as a worst case.						
** Zone D gains significant protection directly from Thorpe Ness. With sea level rise this protection may diminish and as such longer term erosion within this zone might be better taken from zone C.						

79. These projections of cumulative rates of retreat are higher than those assessed more generally by the SMP2. The maximum rate suggested by the SMP2 for Sizewell was 70m, with the projection for Sizewell and Thorpeness Cliffs being in the order of 30m. Although higher, the erosion rates over the next 100 years are within the same order of magnitude.

2.12.4 Conclusions

80. This study has examined available sources of information and concludes that the main uncertainty associated with the area is in terms of longer change in coastal processes, alongside change in sea levels related to climate change. It is considered that the available information allows a good assessment of the area, in terms of present day trends of erosion, but it is acknowledged that some caution has to be taken in simply extrapolating these trends into the future. A precautionary approach has, therefore been taken in assessing future erosion.

81. It is not, however, recommended that further information or study is required unless decisions being made are found to be very sensitive to the assessment of erosion.

82. The study has considered previous studies for the area, although these have tended to focus more on the area from the Sizewell Nuclear Power Station north. Even so, this background information does highlight:

- The variability, over time, in patterns of behaviour and rates of erosion taken over the coast as a whole. This has been taken in to account in considering the local frontage.
- Significantly, it has been identified that changes in the two nearshore banks have strongly influenced the development of the whole area. This appears to

have resulted in a reduction in erosion rates along the northern cliff line at Minsmere and Dunwich cliffs.

- This change may have equally influenced the supply of sediment through to the study area over time.
- It is considered that, particularly in terms of the development and change seen in the size of Thorpe Ness, this may be a significant factor in the long term behaviour of the Sizewell and Thorpeness cliffs.
- While the southerly nearshore bank appears to be the more stable, it is still changing and with sea level rise, this may result in greater erosion in the Thorpe Ness area.

83. As a result of the above more general aspects of behaviour and based on a more local examination of the Sizewell and Thorpeness cliffs the following points may be made:

- Over much of the local study frontage the retreat of the cliffs is very low at present. Greater erosion has been shown to occur to the south of Thorpe Ness.
- The low retreat rates at the crest of the cliff are due to the width of the beach and in particular the width of the upper beach berm. It is concluded, therefore, that in assessing cliff retreat in the future, the behaviour in terms of that width is critical. This relates directly to the issue of longer term supply of sediment highlighted more generally.
- Based on this, an analysis has been undertaken taking account of the longer term trends associated with the area rather than purely being based on a projection of recent local rates of erosion.

84. The study has, therefore, provided an overview of the coastal processes highlighting the main features of how the coast may develop into the future. In assessing this, the study has taken what is considered to be an appropriately cautious approach to the potential risks. The main factors in this are the continued supply of sediment to the frontage and the future behaviour of the nearshore banks.

85. In terms of the distance inland that the transition bays will need to allow for coastal erosion, this distance would vary along the frontage. This is discussed in relation to different zones as shown in ***Plate 2.9***.

- Within the northern end (Zone A) the distance is assessed as being in the order of 20m over the next 50 years and within 85m over the next 100 years.
- Within Zone B this would reduce to 15m and 55m over the next 50 and 100 years respectively.

- Within Zones C and D, the distances would be in the order of 10m and 40m over the next 50 and 100 years respectively.
- Within Zone E, the distances would be in the order of 20m and 50m over the next 50 and 100 years respectively.
- Within Zone F, the area is subject to periods of severe erosion and the assessed values increase to 30m and 85m over the next 50 and 100 years respectively.

3 Effects at Cooling Water Intakes and Outfalls

86. There currently are two nuclear power stations sited at Sizewell;

- Sizewell A has two magnox reactors and is being decommissioned;
- Sizewell B has a single pressurised water reactor and is operational.

87. A third nuclear power station, Sizewell C, is planned.

88. The cooling water intake and cooling water discharge outfall of Sizewell A are both clearly marked by the presence of towers, approximately 410m and 110m from shore, respectively. There are similarly a cooling water intake and outfall associated with Sizewell B which are located further north, approximately 500m offshore for the intake and approximately 150m offshore for the outfall. However, these have no associated towers and therefore are not visible above the waterline.

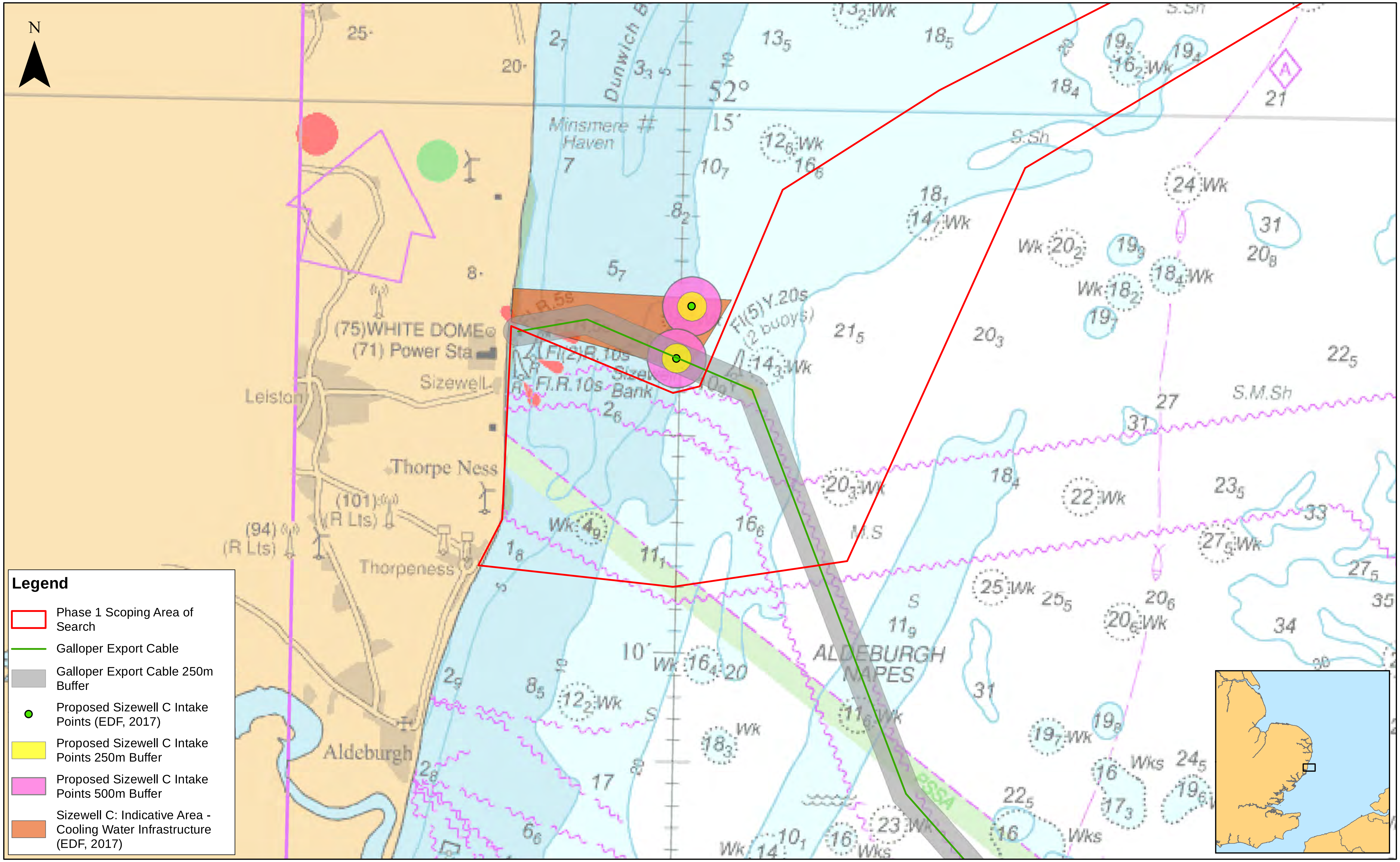
89. Although originally planned to reside inshore of the Sizewell Bank (as is the case for the Sizewell A and Sizewell B cooling water infrastructure), it is understood from Sizewell C Stage 3 Consultation that the two Sizewell C cooling water intakes and the single cooling water outfall will now be located seaward of the bank, in around 14 – 16m depth of water.

90. EDF Energy, has raised concerns with the Applicant about the potential for construction-related effects affecting the Sizewell B cooling water infrastructure. Similar concerns were experienced during installation of the Galloper Wind Farm offshore cables, which also made landfall at Sizewell albeit much closer to the Sizewell B power station than the East Anglia ONE North or East Anglia TWO projects. It is envisaged that EDF Energy's two principal concerns from construction of the offshore cable would be:

- Increased turbidity in the water column in the vicinity of the cooling water infrastructure as the cable is buried; and
- Increased deposition on the bed in the vicinity of the cooling water infrastructure of material disturbed during the cable burial.

91. The Galloper Wind Farm offshore cables were installed in very close proximity to the Sizewell B cooling water infrastructure; in fact the Sizewell A outfall was located within the original Galloper cable corridor. The actual cable location is

shown with a 250m buffer in ***Figure 3.1*** (with the orange zone marking the cooling water infrastructure area and pink spheres marking the intake points).



East Anglia ONE North

Location Plan of Cable Corridor - Landfall and Nearshore

				Prepared:	AB
1	18/07/2019	AB	First Issue.	Checked:	PM
Rev	Date	By	Comment	Approved:	PP

1:60,000 Scale @ A3 — 0 0.5 1 2 Km

Drg No	EA1N-DEV-DRG-IBR-000971	
Rev	1	Datum: WGS 1984 Projection: Zone 31N
Date	18/07/19	
Figure	3.1	

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92. The initial offshore study area for the East Anglia ONE North and East Anglia TWO offshore cable corridor overlapped with the area of Sizewell B and Sizewell C cooling water infrastructure and extended further south along the shoreline to the southern limit of Thorpe Ness. Notwithstanding this, any environmental assessment of the final offshore cable corridor would need to consider a realistic worst case effect and this would undoubtedly involve the scenario of the cables being buried in the northern-most zone of the final offshore cable corridor as it is closest to the Sizewell B cooling water infrastructure.

93. The sediment (largely comprised of shelly fine to medium sands) on the shore or nearshore sea bed would be disturbed by any installation activities that involve jetting, trenching or ploughing (or including any pre-lay dredging across the sandbanks). Any disturbed sediment would potentially become entrained in the water column and transported by a combination of tidal currents and wave-generated currents. Tidal currents alone are relatively weak and disturbed sediment is likely to settle back to the sea bed relatively quickly before being widely dispersed. However if wave action is superimposed, the sediments may reside suspended in the water column for a longer duration in the form of a plume, enabling them to be transported in the general direction of the tidal streams before the wave-generated currents drop to a sufficient level to enable deposition on the sea bed. During the time that any such sediment 'plume' resides in the water column there will be local increase in background turbidity (suspended sediment concentrations, SSC). If the plume was directed towards the Sizewell B cooling water infrastructure, then it is feasible that increased SSC could be drawn into the cooling water system, leading to increased maintenance requirements. If deposition from the plume was sufficiently high in the vicinity of the Sizewell B intakes or outfalls then there could potentially be partial limiting or blockage effects on the quantities of cooling water abstracted or discharged.

94. However, it should be noted that whilst the increased turbidity effects associated with any suspended sediment plume will be high very locally at the point of disturbance it will reduce markedly with distance from the source of the plume to reach background levels within (likely) relatively short distances. These can only be determined definitively by modelling, but the directions of transport will be governed by the tidal ellipses which prevail. Furthermore, the duration of the effect will be temporary, since shortly after cessation of disturbance caused by the installation activities the plume will disperse and/or sediment will drop to the bed and SSC will revert to background levels. As a consequence of this, it is likely that changes above background levels in the deposition of sediments will be immeasurable within a very short distance from the point of disturbance.

95. There are a number of mitigating actions that could be embedded into the design and planning or undertaken during construction to ensure that any effects upon

the cooling water infrastructure are minimised, depending on the final offshore cable corridor. These are summarised below:

- Design and Planning Phase - Optimise landfall location and offshore cable corridor routing. If possible, landfall should be made in the southern portion of the preliminary offshore development area to lessen any potential effect on the Sizewell B and Sizewell C cooling water infrastructure by increasing the direct geographical distance between the source of the impact and the potential receptor.
- Design and Planning Phase – EDF Energy and Galloper Offshore Wind agreed a 'no development' buffer zone around the Sizewell B cooling water intake and outfall structures of 300m in order to protect the Sizewell B cooling water system. By maintaining this same 'no development' buffer, the Applicant will ensure the same constraints that were successfully developed to protect the Sizewell B cooling system are applied to the East Anglia ONE North project.
- Design and Planning Phase - Minimise sediment disruption at the inter-tidal shore and in the shallow nearshore zone through appropriate selection of installation technique. For example, HDD to a point as far seaward as practicable will ensure that no sediment is disturbed from the zones nearest to shore (which is also the zone where the Sizewell B intakes and outfalls are located);
- Design and Planning Phase - Minimise sediment disruption further offshore through appropriate selection of installation technique. For example, jetting is more likely than ploughing/trenching to locally and temporarily increase SSC, although jetting is likely to result in less material being side-cast than trenching.
- Design and Planning Phase - Optimise timing of the activities with respect to tidal conditions. Where closest to shore, the installation activities could be undertaken only on the flooding tide, between low and high water, so that any plume which is created becomes advected southerly, away from the cooling water infrastructure and has the chance to settle during the slack tide before the ebb tide occurs. This helps to remove the pathway between the source of the effect and the potential receptor.
- Design and Planning Phase - Optimise timing of the activities with respect to weather conditions. Where closest to shore, the installation activities could be undertaken only during calm sea states. This would increase the likelihood of the suspended sediments settling to the bed more rapidly (and hence closer to their source of original disturbance) than if the wave-induced currents were sufficient for the sediments to reside longer in suspension in the water column

(and thus be advected over greater distances). This helps to remove the pathway between the source of the effect and the potential receptor.

- Construction Phase – undertake ‘live’ (telemetered) turbidity measurements at locations close to the cooling water infrastructure.

96. With the above mitigation in place, and given the temporary and (generally) localised nature of the increases in turbidity, it is envisaged that offshore cables could be successfully installed and landed in the Sizewell / Thorpeness area without adverse effect on the cooling water infrastructure of the Sizewell B or Sizewell C nuclear power stations.

4 Effect of Export Cable Burial or Cable Protection on the Sea Bed

97. There are three principal effects of the cable burial (or where burial is not possible, cable protection) on the sea bed and shoreline morphology and physical processes, namely;

- Direct disturbance to the morphology of the sea bed during cable burial ('footprint' effect);
- Fate of disturbed sediments during cable burial; and
- Effects of cable protection measures on sediment transport.

98. The first two issues have been previously discussed in respect of the potential effects to the Sizewell B and Sizewell C cooling water intakes and outfalls. Other than this, there will generally be only one other matter of notable consideration. That relates to any pre-sweeping that may be required across the nearshore sandbanks.

99. Pre-sweeping (if required) is intended to flatten out areas of the sea bed dominated by sand waves or megaripples. The results of ongoing bathymetric surveys is likely to advise the Applicant on the need or otherwise for this across the nearshore banks, but if it is required it is likely to involve trailer suction hopper dredging. This process will itself cause a direct 'footprint' on the sea bed and will result in the side-casting (or other licenced disposal) of dredged spill with its associated increased turbidity and changes in deposition patterns. Depending on the area involved, the quantities are likely to be relatively small and although bespoke assessment would be required, it is presently deemed unlikely to be significant in effect on the sandbanks. Notwithstanding this, it is an issue that is likely to require licence and hence further consideration should pre-sweeping be necessary for installation of the cable across the nearshore sandbanks.

100. Also, on a more minor scale then pre-sweeping, if trenching is the preferred cable installation method there would presumably be some side-casting of excavated material and either mechanical replacement of the material into the trench once the cable is laid at its base or an expectation that natural processes will return side-cast sediment back to the trench over a subsequent period. The volumes of material involved in trenching (if this is preferred) will be small per each metre length of trench and the effects of the side-cast mounds on the sea bed morphology (footprint) and processes (alterations to flow, wave and sediment regimes) are very localised, temporary and minor in significance.

101. Elsewhere across the sea bed (i.e. away from the cooling water infrastructure and away from the sandbanks) the footprint effects of sea bed disturbance and the fate of disturbed sediments will be of negligible concern.

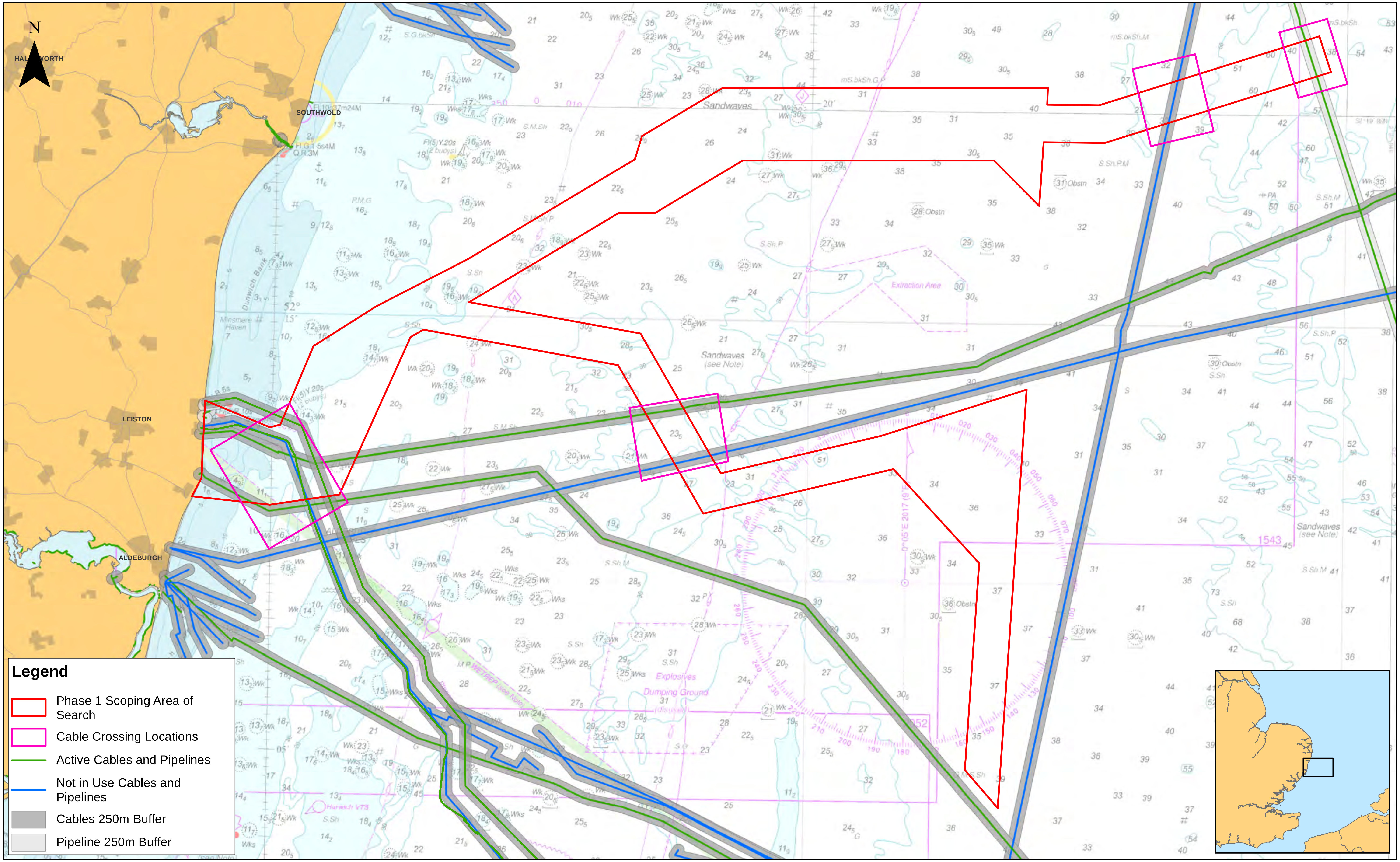
102. It is largely expected that the cables will be buried below the sea bed over much of their planned lengths, but it is reasonable to expect that there may be some locations where target burial is not achievable in practice (e.g. due to ground conditions) and therefore the cable will be surface laid and some form of cable protection (i.e. concrete mattresses, rock armour-stone or sand-filled geotextile tubes) will be used to protect the cable. This is likely to be a very small percentage of the overall cable lengths. In addition, where the cables cross existing cables or pipelines, there is likely to be the need for localised cable protection. ***Figure 4.1*** shows the indicative offshore development areas for both the East Anglia ONE North and East Anglia TWO wind farm projects. It can be seen that in the offshore regions of both cable corridors (where they are separate) there are two areas in each corridor where existing pipelines will need to be crossed. In addition, there is a greater number of cables and pipelines that will need to be crossed in the inshore section (where there is a common cable corridor). This presents a potential complication where the crossings (or any other required cable protection) are either:

- Within the 'active beach profile' (defined as being landward of the closure depth); or
- Across the nearshore banks.

103. In many parts of the east coast of England, the closure depth of the active beach profile is located in around 5m to 10m of water depth. However, since this part of the Suffolk coastline also is characterised by the Sizewell and Dunwich banks system it may reasonably be expected that the regulators will deem a water depth of 10m (or greater) to be an appropriate delineator, but certainly not less. This is partly because the banks system is physically located within this depth of water and thus any changes to the banks could directly or indirectly result in changes at the shoreline, and partly because there is a postulated connectivity (through sediment transport pathways) between the shore at Thorpe Ness and the Sizewell bank, between the Sizewell bank and the Dunwich bank, and between the Dunwich bank and the shore just north of Dunwich which would be best to avoid disrupting.

104. Due to the above, consideration should be given in the design and planning phase to achieving any necessary cable crossings as far seaward as feasible within the cable corridor (and certainly beyond the 10m CD contour).

105. Consideration should also be given to how cable burial will be achieved and maintained across the banks system since the banks are dynamic, in places changing in position (moving landwards) and elevation (lowering crest) over time.



SCOTTISHPOWER RENEWABLES

Rev	Date	By	Comment			Scale	Source
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1	18/07/2019	AB	First Issue.	Checked:	PM		Source: © Data provided by Marine Find, 2017. © British Crown and OceanWise, 2019. All rights reserved. License No. EMS-EK001-548150. Not to be used for navigation.
				Approved:	PP		This map has been produced to the latest known information at the time of issue, and has been produced for your information only. Copyright with the SPR Offshore GIS team to ensure the content is still current before using the information contained on this map. To the fullest extent permitted by law, we accept no responsibility or liability (whether in contract, tort (including negligence) or otherwise in respect of any errors or omissions in the information contained in the map and shall not be liable for any loss, damage or expense caused by such errors or omissions.

East Anglia ONE North

Likely Locations of Cable Crossings

Drg No	EA1N-DEV-DRG-IBR-000972
Rev	1
Date	18/07/19
Figure	4.1

Datum: WGS 1984
Projection: Zone 31N

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5 Cabling Options at the Landfall

106. The offshore cable corridor closest to landfall can be spilt into three distinct zones:

- The area of the corridor north of the Coralline Crag outcrop – this is characterised by the central and southern sections of the Sizewell Bank and is where the export cables of the Greater Gabbard and Galloper OWFs are located, making landfall just south of Sizewell A;
- The central area of the corridor – this is dominated by the outcrop of Coralline Crag; and
- The area of the corridor south of the Coralline Crag outcrop – this is characterised by the sediment of the ness at Thorpeness.

107. The physical process (and other relevant) considerations in relation to each of these three zones is described in ***Table A4.7***.

Table A4.7 Relevant Considerations for Cable Installation at Landfall in Different Zones of the Cable Corridor

Zone	Physical Process Considerations	Other Considerations
North	• Causes direct disturbance to the Sizewell Bank (and causes potential knock-on physical process effects associated with this) • Avoids direct disturbance to the outcropping crag (and thus avoids potential knock-on physical process effects associated with this) • Avoids direct disturbance to the ness (and thus avoids potential knock-on physical process effects associated with this) • Cable could become exposed by changes in morphology of the sandbank • Crag likely to extend below sediment surface, both beneath the sandbank and, further offshore, beneath sandwaves and megaripples • Potential greater effects (more embedded mitigation required) on Sizewell B and Sizewell C cooling water infrastructure due to closer proximity	• Precedent of Greater Gabbard and Galloper cables consented in this zone • Constraint of Greater Gabbard and Galloper cables present in this zone • Establishment of 300m ‘no development’ buffer around Sizewell B’s cooling water infrastructure for the Galloper offshore windfarm project which protected the Sizewell B’s cooling water infrastructure during Galloper construction

Zone	Physical Process Considerations	Other Considerations
Central	• Avoids direct disturbance to the Sizewell Bank (and thus avoids potential knock-on physical process effects associated with this) • Causes direct disturbance to the outcropping crag (and causes potential knock-on physical process effects associated with this). Options include: o Surface lay (armoured and pinned) – preferentially lay along 'runnels' between adjacent ridges of crag o Surface lay and cable protection (mattresses, rock berms, etc.) – adversely affect nearshore coastal process and sediment interactions with shore and nearshore banks o Burial (rock trenching) – direct physical damage to the crag • Avoids direct disturbance to the ness (and thus avoids potential knock-on physical process effects associated with this) • Crag likely to extend below sediment surface further offshore, beneath sandwaves and megaripples • Lower effects (less embedded mitigation required) on Sizewell B and Sizewell C cooling water infrastructure due to greater physical separation	• EDF Energy has stated it will object to any damage to the crag on a precautionary basis • Natural England unlikely to accept any cable protection measures in nearshore zone in an area with such physical process interconnectivity • Surface lay (armoured casing and pinned to rock) leaves cable exposed and vulnerable to damage
South	• Avoids direct disturbance to the Sizewell Bank (and thus avoids potential knock-on physical process effects associated with this) • Avoids direct disturbance to the outcropping crag (and thus avoids potential knock-on physical process effects associated with this) • Causes direct disturbance to the ness (and causes potential knock-on physical process effects associated with this) – likely to be temporary during construction only • Potential influence on the development of nearshore sediment pathway to the south, influencing erosion patterns affecting Thorpeness Village • Crag likely to extend below sediment surface, both beneath the ness and,	• Proximity to Thorpeness village • Potential for any surface armouring to influence the development of the nearshore behaviour.

Zone	Physical Process Considerations	Other Considerations
	further offshore, beneath sandwaves and megaripples • Least effects (least embedded mitigation required) on Sizewell B and Sizewell C cooling water infrastructure due to greater physical separation	

108. From purely a physical processes point of view, the ideal scenario is for an option to exist which avoids (or at least minimises) each of the following:

- Disturbance to the Sizewell Bank;
- Disturbance to the Coralline Crag;
- Disturbance to the ness (shore) at Thorpeness; and
- Disturbance to the physical processes and sediment transport between these three features.

109. It has previously been stated that in terms of the Sizewell B and Sizewell C cooling water infrastructure, the ideal scenario is for the cable to be installed as far south in the offshore development area as possible, to ensure the greatest distance between the source of the effect and the receptor, but that is not necessarily an insurmountable constraint since mitigation activities could be adopted to minimise any potential effect to within tolerable thresholds (e.g. timing of works with respect to tidal state). Furthermore a precedent has been set of the export cables of the Greater Gabbard and Galloper OWFs being installed in the north of the corridor, with suitable mitigation in place.

110. Each of the four principal physical process considerations is discussed in turn in ***Table A4.8*** in respect of potential options.

Table A4.8 Engineering Challenges in Relation to principal Physical Process Issues

Issue	Engineering Challenge
Disturbance to the Sizewell Bank	Mitigate – extend HDD to seaward side of Sizewell Bank (likely to be unfeasible due to distance >2km)
Disturbance to the Coralline Crag	Mitigate – HDD to seaward side of Coralline Crag (moving towards limits of feasibility with progression to south as the crag is not parallel with the shore but is obliquely aligned) Mitigate - HDD as far seaward as possible, emerging in the Coralline Crag and surface laying/pinning thereafter across the crag (no rock berm or concrete mattress cable protection works) until burial can be achieved to acceptable depths in surficial sediment
Disturbance to the ness (shore) at Thorpeness	Mitigate - use HDD at the shore, drilling under the beach/ness and extending as far offshore as practicable to enable suitable burial depth thereafter seawards
Disturbance to the physical processes and sediment transport between these three features	Mitigate – no cable protection works closer to shore than the 10 m CD sea bed contour (meaning suitable burial depth and no cable/pipeline crossings within this zone)

111. To select a preferred approach from the available cable landfall options, it is necessary to further investigate:

- HDD onshore location constraints;
- HDD offshore location constraints; and
- Other pipeline / cable constraints.

112. It would also be informative to investigate the sediment thickness and the location and extent of the underlying Coralline Crag deposits below the sea bed sediments in areas beyond the outcropping rock.

113. The above considerations will be concluded after receipt of geophysical survey data that is scheduled to be collected in the cable corridor in April / May 2018. Additionally, any available information from the Concerto pipeline installation would also be useful input to the deliberations

6 Conclusions

114. In identifying the final offshore cable corridor, the East Anglia ONE North and East Anglia TWO offshore wind farm projects should take into account:

- The cooling water intakes and outfalls of the Sizewell A and B and proposed C nuclear power stations;
- The dynamic Sizewell–Dunwich banks system and the outcrop of Coralline Crag Formation, both of which play an important role in influencing shoreline behaviour and have connectivity with a wider area in terms of sediment transport pathways; and
- Numerous cable and pipeline crossing to address, many of which are relatively close to shore and therefore will be subject to scrutiny by the regulators.

115. The study has provided an overview of how the main features of the coast may develop into the future. In assessing this, the study has taken what is considered to be an appropriately cautious approach to the potential risks. The main factors in this are the continued supply of sediment to the frontage and the future behaviour of the nearshore banks.

116. This Desk Based Assessment presents an overview of the key findings from the principal relevant existing literature and uses this understanding to make a judgement-based assessment of the potential effects from the cable installation on the Sizewell B and Sizewell C cooling water infrastructure and on the sea bed and shoreline morphology and physical processes. In doing so, it assists in the identification of the landfall location and offshore cable corridor, as presented within ES ***Chapter 4 Site Selection and Assessment of Alternatives***.

117. In the case of the cooling water infrastructure, it is envisaged that with appropriate embedded mitigation and a commitment to appropriate construction monitoring (with pre-agreed cessation thresholds) the offshore cables could be successfully installed and landed at Sizewell / Thorpeness area without significant adverse effect when suitable mitigation is employed. This is because any potential effects, in terms of increased turbidity and enhanced sediment deposition in the vicinity of the infrastructure will be temporary and (generally) localised nature and likely small in magnitude. Furthermore, the recommended mitigation includes:

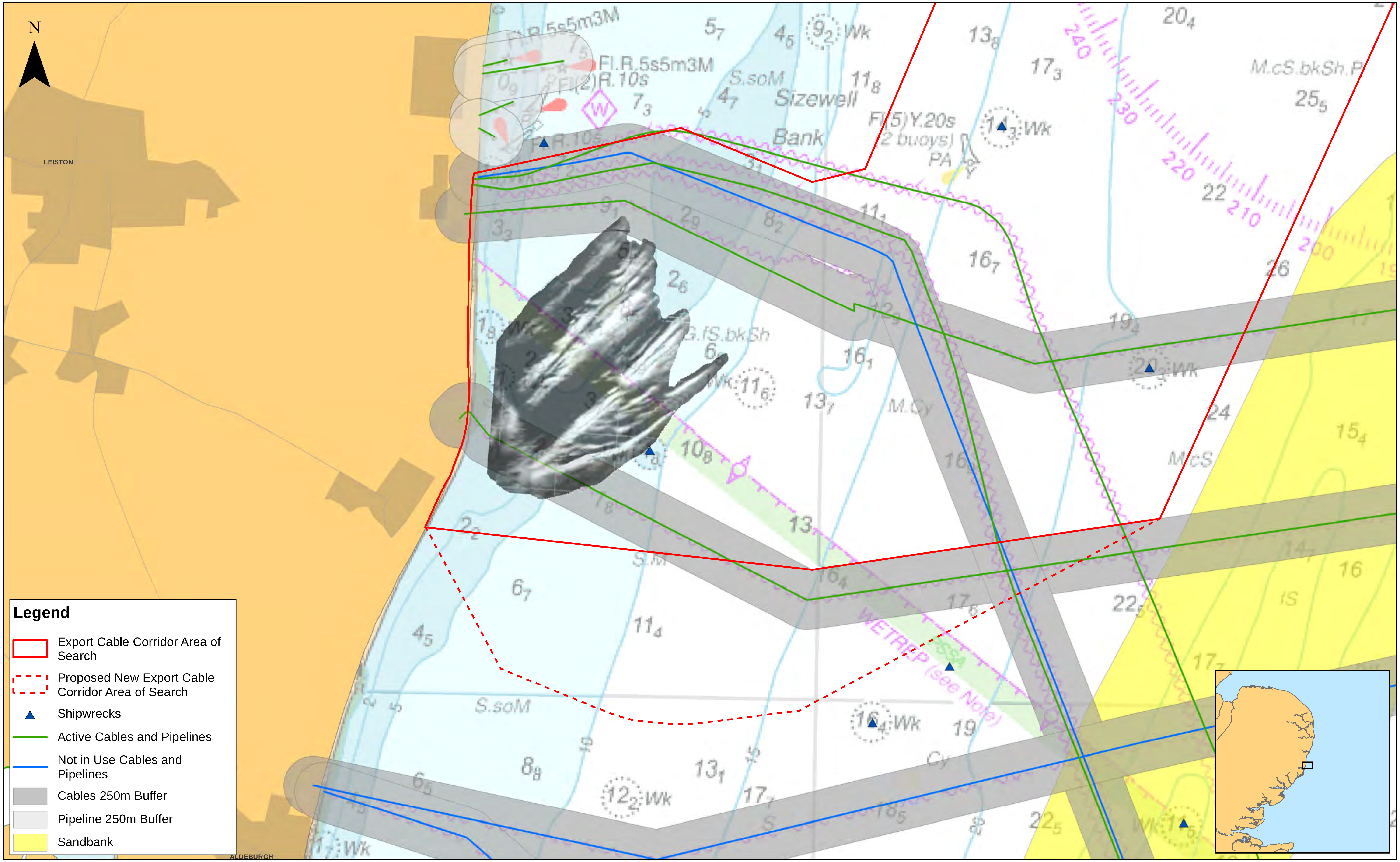
- Optimising landfall location, ideally towards the southern portion of the offshore development area, to increase the direct geographical distance between the source of the impact and the potential receptor.

- Minimising sediment disruption at the inter-tidal shore, in the shallow nearshore zone and further offshore through appropriate selection of installation technique.
- Optimising the timing of the installation activities with respect to both tidal and weather (storm wave) conditions.
- Undertaking 'live' (telemetered) turbidity measurements at locations close to the cooling water infrastructure.
- Application of a 300m 'no construction' area around the Sizewell B cooling water infrastructure as successfully adopted for the Galloper Offshore Windfarm.

118. When considering the effect of cable installation or cable protection on the sea bed, efforts should be made to ensure as much as practicable of the cable achieves target burial, thus minimising the need for cable protection. In achievement of this, the need for (and impacts of) pre-sweeping across the nearshore banks should be considered in light of the longer term trends in their position and crest heights.

119. Where cable protection is required, for example at cable or pipeline crossings, the greatest attention from regulators will be in areas closest to shore, likely within the 10m CD sea bed contour. This zone includes the nearshore banks and therefore consideration should be given in the design and planning phase to achieving any necessary cable crossings as far seaward as feasible within the cable corridor (and certainly beyond the 10m CD contour).

120. In terms of the Coralline Crag Formation, the optimum solution is to HDD from the onshore location through the Crag at a level below the sea bed surface and 'break-out' at a location that is seaward of the outcropping Crag. Given this, the boundary of the offshore development area has been slightly amended (February 2018) in order to facilitate further investigation of this option (***Figure 6.1***). Further geophysical survey and engineering investigations will be developed to consider the above matters, leading to a final cable installation location and construction method.



Rev	Date	By	Comment
1	18/07/2019	AB	First Issue.

Prepared: AB
Checked: PM
Approved: PP

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Scale @ A3

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East Anglia ONE North

Amendment to Red Line Boundary of Proposed Cable Corridor

Drg No	EA1N-DEV-DRG-IBR-000973
Rev	1
Date	18/07/19
Figure	6.1

Datum: WGS 1984
Projection: Zone 31N

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7 References

ABP Marine Environmental Research, 2008. Atlas of UK Marine Renewable Energy www.renewables-atlas.info/. Accessed August 2017.

Black and Veatch, 2005. Minsmere frontage: Dunwich Cliffs to Sizewell Power Stations Coastal Processes Report. Environment Agency.

Brooks, S.M., 2010. Coastal change in historic times – linking offshore bathymetric changes and cliff recession in Suffolk. The Crown Estate.

Burningham, H. and French, J., 2016. Shoreline–Shoreface Dynamics on the Suffolk Coast. The Crown Estate.

Cefas, 2001. Dunwich Sediment Transport. Study Report. Department for Culture, Media and Sport. November 2001.

HR Wallingford, CEFAS/UEA, Posford Haskoning and D'Olier, B., 2002. Southern North Sea Sediment Transport Study, Phase 2. Anglian Coastal Authorities Group.

Lees, B.J and Heathershaw, A.D. 1981. Sizewell Dunwich Banks Field Study Topic. Report 5: Offshore sediment movement and its relation to observed tidal current and wave data. IOS Report No. 123.

Pye, K. P and Blott, S. 2005. Coastal Processes and Morphological Evolution of the Minsmere Reserve and Surrounding Area, Suffolk. Report prepared for RSPB (East Anglia Office). February 2005. External Research report ER511.

Royal HaskoningDHV, 2010. Suffolk Shoreline Management Plan 2 (SMP2). Suffolk Coastal District Council, Waveney District Council and Environment Agency.

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