East Anglia Offshore Wind

VATTENFALL

SCOTTISHPOWER RENEWABLES

East Anglia THREE

Appendix 7.2

Marine Geology, Oceanography and Physical Processes - Environmental Baseline

Environmental Statement

Volume 3

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7.2 MARINE GEOLOGY, OCEANOGRAPHY AND PHYSICAL PROCESSES – ENVIRONMENTAL BASELINE

7.2.1 Introduction

1. This appendix characterises the baseline physical environment of the proposed East Anglia THREE project, covering both the East Anglia THREE windfarm site and the offshore cable corridor (note that the cable landfall location is considered separately in *Appendix 7.4*).

2. The location of the proposed East Anglia THREE project is shown in *Figure 7.2.1.*

3. A comprehensive understanding of the baseline physical environment, comprising the marine geology, oceanography and physical processes, provides vital context for the subsequent assessment of potential effects arising from the proposed East Anglia THREE project, which is presented in Chapter 7 Marine Geology, Oceanography and Physical Processes of this Environmental Statement (ES).

4. This appendix was written by Royal HaskoningDHV and incorporates results from other contributors, including Cefas, Fugro EMU Ltd., Geotechnical Engineering and Marine Surveys (GEMS) and Marine Ecological Surveys Ltd. (MESL).

5. This appendix also draws from findings of earlier studies undertaken to inform the East Anglia Zonal Environmental Appraisal (GL Noble Denton 2011; ABPmer 2012a) and the Environmental Statement of the proposed East Anglia ONE project (ABPmer 2012b).

6. Given the extensive work that has previously been undertaken to characterise the baseline physical environment across the East Anglia Zone, the approach taken in the proposed East Anglia THREE project has been to:

- Review existing relevant data and reports from across the East Anglia Zone;
- Acquire additional data to fill any gaps, specific to the proposed East Anglia THREE project; and
- Formulate a conceptual understanding of the baseline physical environment, specific to the proposed East Anglia THREE project.

7. It is important to recognise from the outset that the baseline physical environment is not static but instead will exhibit considerable variability due to cycles or trends of natural change. These can include the short-term effects of storms and surges, the well-observed patterns in the movement of tides during spring and neap cycles and

the longer term effects of sea level rise associated with global climate change, for example.

7.2.2 Review of Existing Data and Information

8. The data and information requirements for formulating a conceptual understanding of the baseline physical environment of relevance to the proposed East Anglia THREE project can be classified into two areas: (i) material; and (ii) process.

9. The material data includes knowledge of the geology of the sea bed and underlying strata, the bathymetry, and the lithology and distribution of mobile and non-mobile sediments.

10. The process data includes knowledge of the oceanographic forcing agents, such as winds, waves, tide-generated currents, their strengths, directions and variability with time, and the resulting sediment transport regime.

11. Considerable data and information is already in existence relating to the material and processes of the baseline physical environment across the East Anglia Zone and much was collated for the East Anglia Zone Environmental Appraisal (ZEA), including data from the following sources:

- Marine Renewable Atlas (BERR, 2008);
- Wavenet;
- National Tide and Sea Level Forecasting Service;
- Extreme sea levels database (Defra et al. 2011);
- TotalTide (UKHO tidal diamonds);
- British Oceanographic Data Centre;
- National Oceanographic Laboratory Class A tide gauges;
- Baseline numerical model runs (ABPmer 2012a; 2012b; GL Noble Denton 2011);
- United Kingdom Climate Projections '09 (UKCP09) (Lowe et al. 2009);
- British Geological Survey 1:250,000 sea bed sediment mapping;
- British Geological Survey bathymetric contours and paper maps; and

- Admiralty Charts and United Kingdom Hydrographic Office survey data.

12. In addition, considerable literature exists and was reviewed as part of the East Anglia ZEA. This includes some major publications, such as:

- Southern North Sea Sediment Transport Study (HR Wallingford et al. 2002);
- Futurecoast (Defra 2002);
- Shoreline Management Plan (Royal Haskoning 2010);
- Thames Regional Environmental Characterisation (EMU Ltd. 2009);
- East Coast Regional Environmental Characterisation (Limpenny et al. 2011);
- East Anglia Marine Aggregate Regional Environmental Assessment (EMU Ltd. 2012); and
- Industry 'best practice' guidance for offshore windfarms (Cefas 2002; ETSU 2002; COWRIE 2009).

13. Numerical modelling was previously undertaken as part of a Metocean Conditions Study (GL Noble Denton, 2011) to inform the East Anglia ZEA. Wind and wave data were obtained from the British Maritime Technology (BMT) ARGOSS WaveWatch III numerical model covering a 10 year period (Jan 1999 – Dec 2008), including wave height, period and direction, and wind speed and direction in three hour timesteps.

14. These data were used in a MIKE 21 Spectral Wave (SW) model to produce wave direction extremes at seven locations, fatigue data (frequency analyses) at three locations and spells analyses at two locations across the East Anglia Zone (*Figure 7.2.2*). The model was calibrated against measured wave data from the K13, West Gabbard and Southwold buoys, available via Wavenet.

15. Of these locations, one of the locations for wave direction extremes (Point 3) lies directly within the proposed East Anglia THREE project.

16. In addition, a Mike-21 Flexible Mesh (FM) hydrodynamic model was developed to characterise the tidal currents across the East Anglia Zone.

17. These models from the East Anglia ZEA provide a useful basis for characterising the baseline physical environment across the proposed East Anglia THREE project.

18. Project-specific surveys were also previously undertaken for the East Anglia ONE project and although not directly covering the proposed East Anglia THREE project

the data still provide a useful, detailed, characterisation of that area within the East Anglia Zone for wider context. These surveys for the East Anglia ONE project included:

- **Metocean survey data** to establish critical relationships between waves, tides and sediment mobility (suspended and bedload sediment transport);
- **Bathymetric survey data** to ascertain the depth and form of the sea bed and the presence of bedforms such as sand banks, sand waves and megaripples;
- **Geophysical survey data** to document underlying geology, sediment types and thicknesses, the geometry of bedforms and sediment transport directions; and
- **Benthic survey data** to investigate the chemical and physical composition of surface sediments.

7.2.3 Acquisition of Additional Data

19. To specifically inform the proposed East Anglia THREE project, further **metocean surveys** were undertaken for 1 year from December 2012, with one Acoustic Wave and Current (AWAC) meter and one Directional Wave Rider (DWR) buoy deployed within the proposed East Anglia THREE site (in addition to a new DWR buoy located within the proposed East Anglia ONE project site) The report associated with this data is presented in *Appendix 7.5*. The locations of these deployments are shown in *Figure 7.2.3*.

20. A **geophysical survey** of the proposed East Anglia THREE project site was published in October 2012, achieving 100% coverage with in-line spacing of no more than 100m covering sea bed bathymetry, sea bed texture and morphological features, and shallow geology. The location of the survey is shown in *Figure 7.2.4.*

21. Grab samples of surface sediments were collected as part of a comprehensive **benthic survey** undertaken in 2010 across the whole East Anglia Zone. In addition a further targeted survey was undertaken in 2013 to cover previously un-surveyed areas, mainly within the East Anglia THREE offshore cable corridor but with some samples also within the East Anglia THREE site. The location of the grab samples is shown in *Figure 7.2.5.*

7.2.4 Conceptual Understanding of Baseline Physical Environment

22. The East Anglia ZEA presents a detailed characterisation of the baseline physical environment across the East Anglia Zone. The reported baseline understanding was established on the basis of:

- Collation and comprehensive review of pre-existing published literature and available data - a large volume of published work and numerous available datasets relate to the baseline tidal, wave and sediment regimes and morphological features of the sea bed and adjacent coastlines of the southern North Sea.
- Metocean, geophysical and benthic surveys collected from the East Anglia Zone and from the East Anglia ONE project (Note: the IMO (International Maritime Organisation) Deep Water route that runs north-south through the Zone was not surveyed originally, but fill-in survey was undertaken in 2013).
- Numerical modelling of baseline tidal flow patterns (ABPmer 2012a).

23. The Environmental Statement (Volume 2 – Offshore) for the East Anglia ONE project then further developed this baseline characterisation of physical processes specific to that project's development area within the East Anglia Zone (ABPmer, 2012b).

24. Using this understanding as a starting point, the data specifically acquired for the proposed East Anglia THREE project have been analysed and interpreted to characterise the baseline physical environment across the proposed East Anglia THREE project in relation to:

- Bathymetry and morphology;
- Geology;
- Water levels;
- Currents;
- Winds and waves; and
- Sediments (including process controls on sediment mobility).

25. Each of these topics is discussed, in turn, in the following sections.

7.2.5 Bathymetry and Morphology

26. Within the East Anglia Zone, water depths are generally over 30m LAT, although they vary from a minimum of 6m LAT on top of Smiths Knoll sandbank in the north-west of the East Anglia Zone to as much as 76m LAT in the south (*Figure 7.2.6*).

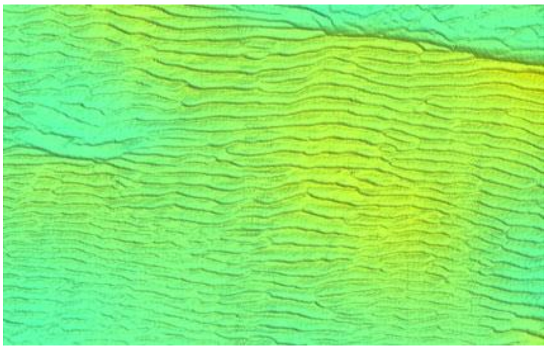
27. The most significant bathymetric feature within the East Anglia Zone is the deep north-south trending Lobourg Channel which is located close to the western margin of the East Anglia Zone (shown in *Figure 7.2.6*). This is an early Pleistocene palaeovalley which was active during periods of lower sea level (*Figure 7.2.7*).

28. The Great Yarmouth Inner Banks, located to the west of the East Anglia Zone, are valuable elements of the natural coastal protection system, dissipating the energy of waves before it reaches the shoreline. These banks are, however, known to be mobile. A series of sandbanks to the north-west of the East Anglia Zone are collectively called the North Norfolk Banks and represent the most extensive example of the offshore linear ridge type sandbanks in UK waters.

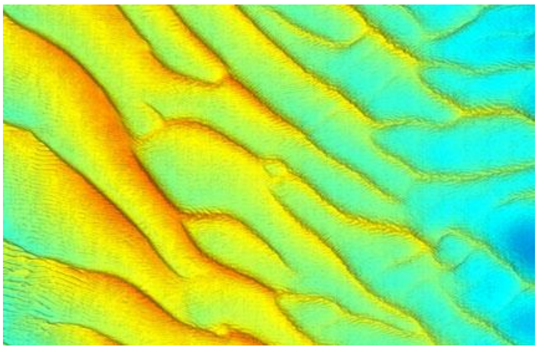
29. A geophysical survey of the East Anglia THREE site was completed between 19th June 2012 and 4th September 2012, where a multibeam echo sounder was deployed to determine bathymetry (Fugro EMU 2013a). The bathymetry varies from a maximum depth of 49m below LAT across the western part of the site to a minimum depth of 25m below LAT on the crest of a sand ridge in the centre of the site (*Figure 7.2.8*).

30. The bathymetry is dominated by a series of three north-south oriented sand ridges with widths of 2-3km and heights of up to 17m above the surrounding sea bed. Smaller bedforms, including sand waves (greater than 2m high), megaripples (less than 2m high) and sand ribbons, are present throughout the project site.

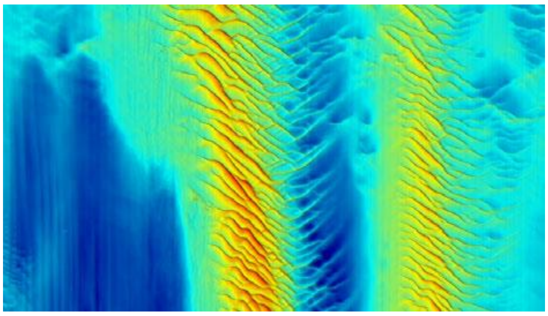
31. Examples of these sea bed features are shown in Diagram 7.2.1 (after Fugro EMU 2013a).



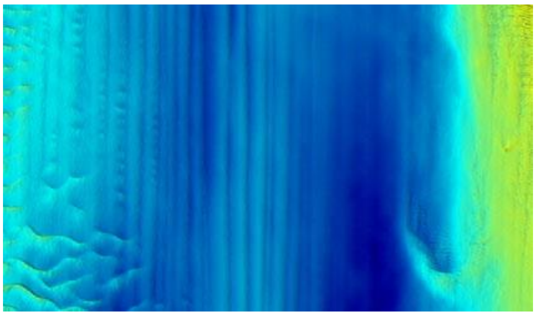
Meggaripples



Sand waves



Tidal sand ridges



Sand ribbons

Diagram 7.2.1. Examples of sedimentary bedforms (after Fugro EMU, 2013a)

32. Asymmetric sand waves occur across approximately 50% of the sea bed of the East Anglia THREE site. Where they are present along the tops of the sand ridges, their crests are oriented predominantly north-west to south-east (*Figure 7.2.8*). In deeper locations, the crests are oriented more west to east. The sand waves have wavelengths of 200-300m and heights of 2-7m and their flanks are generally covered by megaripples.

33. Megaripples are common throughout the site. They have typical wavelengths of 5-20m and heights of 0.3-2m, and their crests are oriented west to east (*Figure 7.2.8*).

34. Sand ribbons are occasional bedforms aligned south-southwest to north-northeast (*Figure 7.2.8*). They have widths of 20-100m and heights of about 0.5-1.5m and may be covered in megaripples or occasional sand waves. Sand ribbons form in areas where tidal currents are strong. They are located across the deeper parts of the project site where sand is less abundant.

7.2.6 Geology

35. The geology of the East Anglia Zone generally consists of Pleistocene sands and clays (Figure 7.2.9) overlain by Holocene sand deposits. The thickness of the Holocene sediments of the East Anglia Zone varies from less than 1m across most of the area to greater than 20m in the sand wave fields and on the sand ridges, especially in the north of the Zone.

36. A geophysical survey of the East Anglia THREE site was completed between 19th June 2012 and 4th September 2012, where sparker and pinger sub-bottom profilers were deployed (Fugro EMU, 2013a). The results of the sub-bottom survey describe three geological formations; in ascending order (older to younger) these are the Pleistocene Yarmouth Roads Formation comprising 0 to 100m thick riverine sands and channel infills, overlain by the 5-10m thick mud of the Pleistocene Brown Bank Formation), topped by 0-20m of Holocene sand.

37. Cameron et al. (1992) describe the Yarmouth Roads Formation as sand with scattered pebbles, occasional mud laminae and abundant plant debris, peat and wood deposited as part of a delta-top complex. The base of this unit was not reached by the sub-bottom profilers across the East Anglia THREE site. According to Cameron (1992), the Brown Bank Formation is predominantly brackish-water laminated silty clay.

38. The Holocene sands vary in thickness from several metres beneath tidal sand ridges and sand waves to a thinner veneer in deeper areas. The sand is marine and predominantly fine to medium grained with local laminae of mud.

7.2.7 Water Levels

39. Several sources of water level data are available across the East Anglia Zone and in particular within the East Anglia THREE site. The locations of these are provided in *Figure 7.2.10*.

7.2.7.1 Astronomical Tidal Levels

40. Marine water levels are largely dictated by a highly predictable astronomically-driven tidal signal, but can also be affected (elevated or depressed) by meteorological influences.

41. In terms of the astronomically-driven tidal signal, the East Anglia Zone is located within an area of sea bed that is subject to a micro-tidal regime, with the average spring tidal range varying between approximately 0.1 and 2.0m. This low tidal range is due to proximity to an amphidromic point that is positioned just outside the central, eastern boundary of the East Anglia Zone (*Figure 7.2.11*).

42. At the amphidromic point, the tidal range is near zero. Tidal range then increases with radial distance from this point. The crest of the tidal wave at high water circulates around this point once during each tidal period. As a result of this feature, the tidal range within the East Anglia Zone is largest towards the north and the south of the Zone and least towards the central eastern area of the Zone.

43. Within this context, the East Anglia THREE site is located only 10km to the north-west of the amphidromic point (at its closest point).

44. A metocean survey began in December 2012 for a period of 1 year, with an Acoustic Wave and Current (AWAC) instrument deployed within the East Anglia THREE site.

45. The first batch of data obtained from the AWAC covers a nine and half week period containing four spring-neap tidal cycles, between 4th December 2012 and 8th February 2013. Analysis of the measured water depths shows that values are generally within a 1.5m range through the period, with the tidal signal varying by between 0.3 to 0.7m, depending on stage of the tidal cycle (Diagram 7.2.2). The outlying data points beyond this typical range are most likely a result of meteorological effects e.g. changes to the atmospheric pressure due to storms. These events can typically change the water levels at the site by up to 1m.

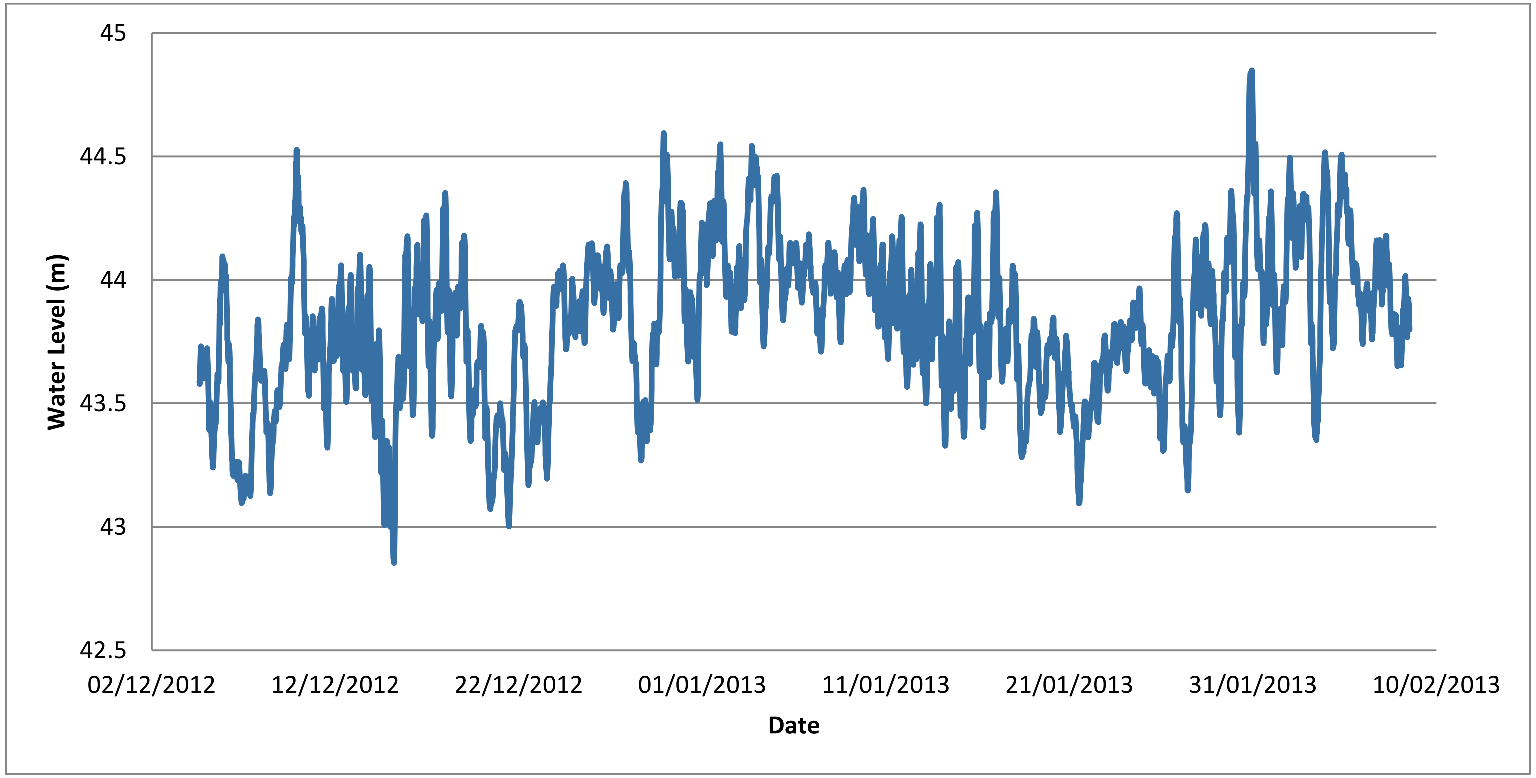


Diagram 7.2.2. Water levels measured within the East Anglia THREE site

46. With progression from the East Anglia THREE site towards shore along the offshore cable corridor, the tidal range increases. At the shore it reaches a value of 3.6m on mean spring tides at Harwich (located approximately 7km to the south-west of the cable landfall). The suite of astronomical tidal levels reported by the UK Hydrographic Office's Admiralty Tide Tables for Harwich is presented in *Table 7.2.1.*

Table 7.2.1 – Astronomical tidal levels at Harwich

Water Level	Abbreviation	Level (mCD)
Highest Astronomical Tide	HAT	4.4
Mean High Water of Spring Tides	MHWS	4.0
Mean High Water of Neap Tides	MHWN	3.4
Mean Sea Level	MSL	2.1
Mean Low Water of Neap Tides	MLWN	1.1
Mean Low Water of Spring Tides	MLWS	0.4
Lowest Astronomical Tide	LAT	-0.1
Mean Spring Tidal Range	MWHS - MLWS	3.6
Mean Neap Tidal Range	MWHN - MLWN	2.3

7.2.7.2 Non-tidal Water Levels

47. The North Sea is particularly susceptible to storm surges and water levels can become elevated by between 1.5 and 1.7m above astronomical tidal levels under a 1 in 1 year return period surge event, and between 2.3 and 2.5m under a 1 in 100 year return period surge event (GL Noble Denton 2011).

7.2.7.3 Climate Change

48. Due to global climate change and local land level changes, mean sea level at the shore is expected to be between 19 and 27cm higher by 2050 than 1990 values (Lowe et al., 2009).

49. Climate change is projected to have an insignificant effect on storm surges over the lifetime of the proposed East Anglia THREE project (Lowe et al. 2009).

7.2.8 Currents

50. Several sources of current data are available across the East Anglia Zone and in particular within the East Anglia THREE site. The locations of these are provided in *Figure 7.2.12*.

7.2.8.1 Tidal Currents

51. The tidal current patterns across the East Anglia Zone are strongly influenced by the presence of the amphidromic point. Despite the low tidal range, the tidal currents within the East Anglia Zone are influenced by the anti-clockwise circulation of the tide around the amphidrome.

52. *Figure 7.2.13* depicts current roses from a number of previous observations from within the East Anglia Zone (ABPmer 2012a). This shows that in the north of the East Anglia Zone, current is generally aligned along a north to south axis, but in the south sections of the East Anglia Zone a stronger north of north-east to south of south-west axis is evident, influenced by the shape of the coastline further to the west.

53. It can also be seen from *Figure 7.2.14* that in the north-eastern part of the East Anglia Zone, the tidal ellipses are more north-south aligned and less elongated than in other locations.

54. The tidal currents were modelled using Delft 3D FLOW software as part of the East Anglia ZEA (ABPmer, 2012a). This work demonstrated that tidal currents are generally to the south in the northern part of the East Anglia Zone and towards south-south-west in the southern part during the peak of the flooding tide (*Figure 7.2.15*). They then reverse to the north and north-north-east, depending on location within the East Anglia Zone, during the peak of the ebbing tide (*Figure 7.2.15*).

55. Tidal current speeds show spatial variation across the East Anglia Zone, with stronger currents in the south and west. The greatest currents occur during spring tides.

56. The fastest recorded flows within the East Anglia Zone are typically associated with the ebb tide, with speeds reaching in excess of 1.2m/s. The weakest currents are observed in the north-east of the East Anglia Zone in deeper water where maximum speeds, even on the ebb tide, do not exceed 0.9m/s.

57. Further afield, tidal currents increase in the shallow waters nearer to shore, especially just offshore from Norfolk to the west of the East Anglia Zone.

58. Current data measured by an AWAC located in 45m of water within the East Anglia THREE site between 4th December 2012 and 7th October 2013 have been analysed to determine the dominant current speeds and directions.

59. Diagram 7.2.3 shows a current rose using data from near the surface of the water column (where currents are greatest) within the AWAC data record. The majority of the currents flow along a north of north-east to south of south-west aligned axis. This is in keeping with the patterns observed from previous measurements within the East Anglia Zone (ABPmer, 2012a).

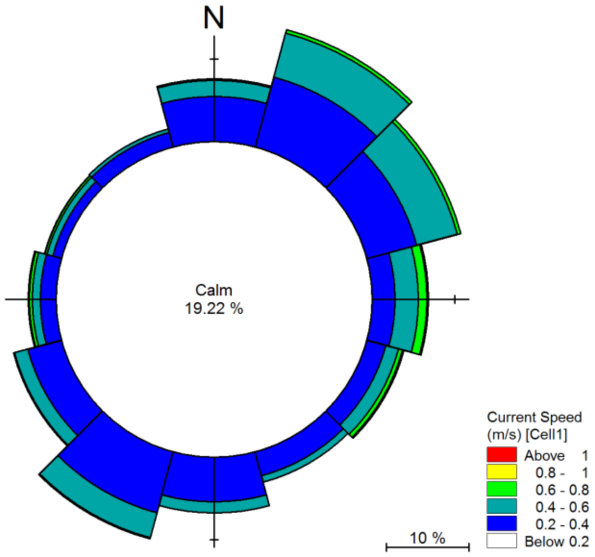


Diagram 7.2.3. Current rose (near surface current) measured within the East Anglia THREE site

60. Diagram 7.2.4 shows a timeseries of near-surface current speeds recorded by the AWAC between 30th July and 7th September 2013.

61. The near-surface current speeds are generally below 1m/s, except for at the very peak of the spring tides or during surges when they can exceed this value. During neap tides, peak currents range between 0.5-0.6m/s.

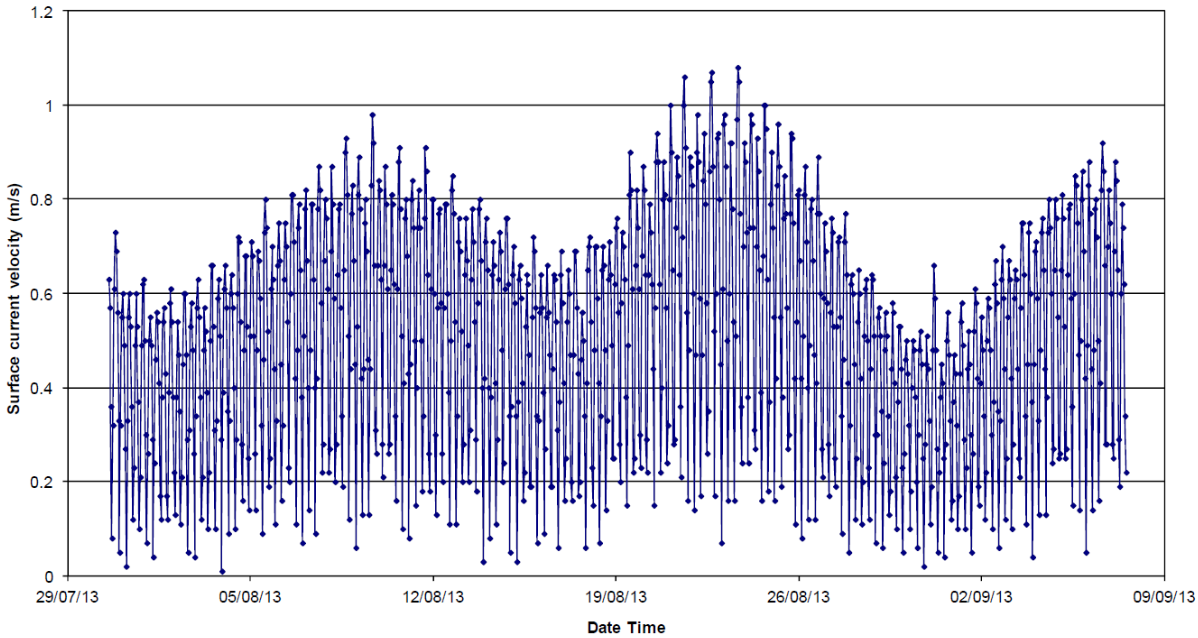


Diagram 7.2.4 Timeseries of near-surface current speeds measured within the East Anglia THREE site

7.2.8.2 Non-tidal Currents

62. In addition to astronomical tidal influences, current patterns can become modified for short durations due to other processes, such as meteorological conditions and stratification in the water column.

63. Storm surges can elevate currents by up to 0.4m/s during a 1 in 50 year return period event, typically orientated in a south of south-westerly direction (Noble Denton 2011).

64. Currents can also be enhanced by stratification effects. The waters of the southern North Sea are generally well-mixed throughout the year, whereas the central North Sea, to the north of the East Anglia Zone and across the Norfolk banks, tends to be vertically-stratified during the summer. Due to this, there is an intermitted current that follows a north-eastwards pathway from the Outer Thames area towards the island of Texel in the Netherlands; this is called the English River.

7.2.9 Wind and Wave Regimes

7.2.9.1 Wind

65. The wind regime is important in generating local wind waves. The dominant wind direction is from the south-west.

7.2.9.2 Waves

66. Several sources of wave data are available across the East Anglia Zone and in particular within the proposed East Anglia THREE project. The locations of these are provided in *Figure 7.2.16*.

67. The wave regime across the East Anglia Zone is highly episodic and exhibits strong seasonal variation. It is comprised of swell waves generated offshore and locally-generated wind-waves.

68. *Figure 7.2.17* depicts wave roses from a number of previous observations from within the East Anglia Zone. It shows that prevailing waves arrive from south of south-west in the north of the East Anglia Zone and from north of north-east in the south of the East Anglia Zone (ABPmer 2012a).

69. A general north to south reduction in maximum observed wave heights occurs across the East Anglia Zone. On the northern boundary, a 1 in 50 year return period event has a significant wave height in excess of 8m whereas on the southern boundary a corresponding event has a significant wave height below 6.5m (GL Noble Denton 2011).

70. Extreme return period wave data were provided within the East Anglia THREE site from previous wave modelling undertaken for the East Anglia ZEA (located at Point 3, shown in the earlier *Figure 7.2.2*). These data are reproduced in *Table 7.2.2* and show a 1 in 1 year return period significant wave height of 6.0m with an associated peak wave period of 11.1s. Under a 1 in 50 year return period, the corresponding values increase to 7.5m and 12.5s, respectively.

Table 7.2.2. Schedule of return-period metocean conditions (Noble Denton, 2011)

Point	Lat °N	Lon °E	Depth (m LAT)	Return period (years)	Surge (m)	H_s (m)	T_p (s)	U_c (m/s)
03	52.665	2.884	30.8	1	1.6	6.0	11.1	1.3
03	52.665	2.884	30.8	10	2.0	6.8	11.8	1.4
03	52.665	2.884	30.8	50	2.3	7.3	12.3	1.4
03	52.665	2.884	30.8	100	2.4	7.5	12.5	1.5

71. Across the majority of the East Anglia Zone, water depths are likely to be sufficient to limit the effect of wave action on sea bed sediments, apart from during exceptionally stormy seas or over shallower areas.

72. Wave data measured by the Waverider buoy in 43m water depth located within the East Anglia THREE site between 4th December 2012 and 24th October 2013 have been analysed to determine the dominant wave heights, periods and directions (Further information is provided in *Appendix 7.5*).

73. Diagram 7.2.5 shows the wave rose derived from the Waverider buoy data. In keeping with the findings from analysis of data collated during the Zonal Environmental Appraisal (ABPmer 2012a) in the vicinity of the East Anglia THREE site, the waves mimic, to some extent, the dominant wind regime for the zone, with a considerable percentage of the waves arriving from the south-west. The next most significant grouping of waves arrive from the north-east, as a result of swell waves generated further afield in the North Sea. Waves can, however, approach from all directions.

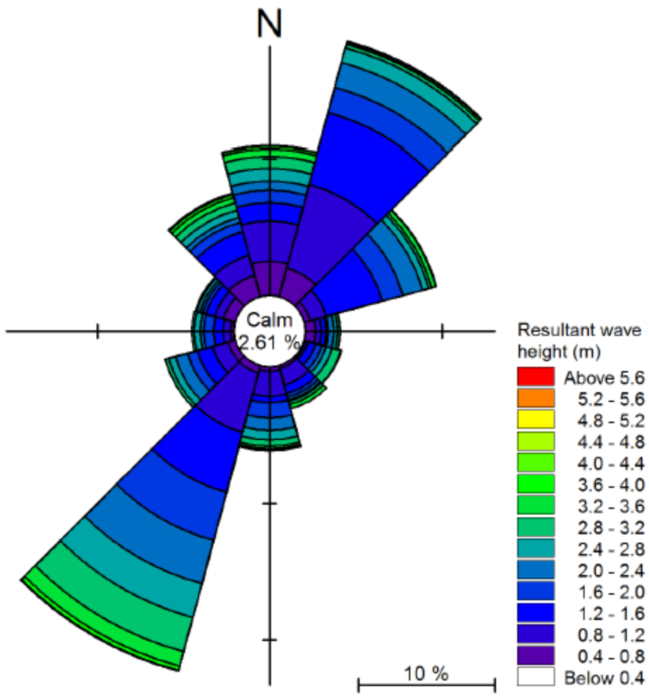


Diagram 7.2.5. Wave rose measured by the Waverider buoy within the East Anglia THREE site

74. Diagram 7.2.6 shows a timeseries of the significant wave height data recorded by the Waverider buoy between 4th December 2012 and 24th October 2013. The significant minimum wave height recorded during this period was 0.18m, with a maximum value of 6.03m being around the value of a 1 in 1 year return period event. The mean significant wave height was 1.27m.

75. The peak wave period was recorded at a minimum value of 1.7s, a mean value of 6.3s and a maximum value of 16.04s.

76. It should be noted that whilst a 1 in 1 year event was captured in the data record, there only five unique periods within the timeseries when wave heights exceeded 4m. In general, the waves appear to be confined to less than 3m, apart from during storm events when the wave height significantly increases.

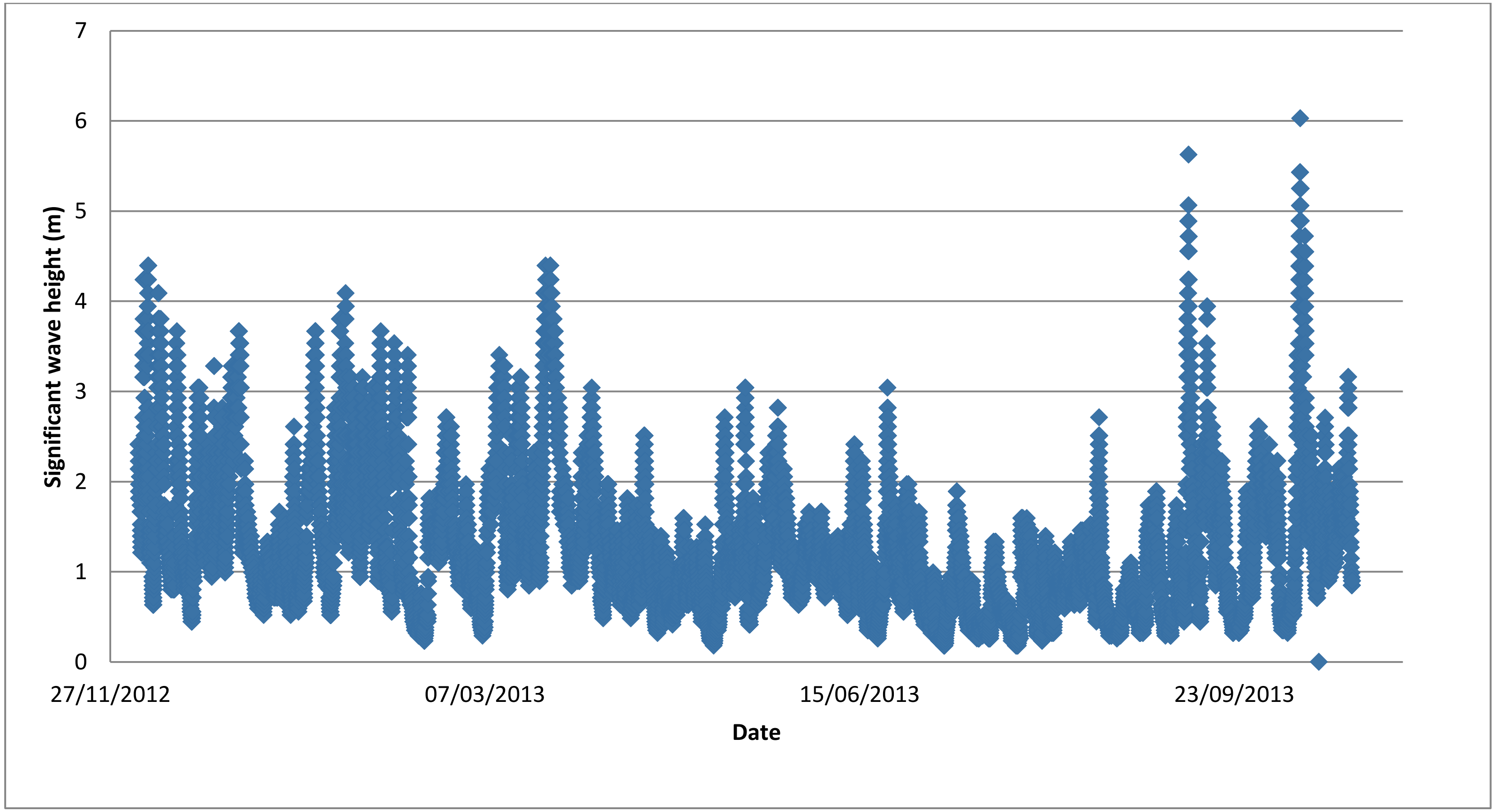


Diagram 7.2.6. Timeseries of significant wave heights (H_s) measured by the Waverider buoy within the East Anglia THREE site

77. Closer to shore, water depths reduce and wave effects become more important in governing sediment transport. At shallow water locations off the East Anglian coast, waves are dominated by short period wind-generated waves and generally reveal a predominant wave direction from the east. Along the shore itself the wave energy varies significantly and in places is heavily influenced by the sheltering effect of nearshore banks.

7.2.9.3 Climate Change

78. Climate projections indicate that wave heights in the southern North Sea will only increase by between 0 and 0.05m by 2100 (Lowe et al. 2009).

7.2.10 Sediment Regime

7.2.10.1 Surface Sediments

79. Between September 2010 and January 2011, an extensive zone-wide benthic and epibenthic characterisation survey was undertaken by Marine Ecological Surveys Limited (MESL 2011) (*Figure 7.2.18*).

80. The particle sizes of the grab samples collected across the East Anglia Zone correlate well with existing British Geological Survey sea bed sediment data and reveal that across 90% of the East Anglia Zone the sea bed sediments are either sand, slightly gravelly sand or gravelly sand. Remaining areas are primarily sandy gravel, although there are localised pockets of muddy sand and (slightly) gravelly muddy sand. Over 85% of the grab samples contained less than 5% mud.

81. The median particle size of over 75% of the samples taken from across the East Anglia Zone was within the medium sand range (0.25-0.5mm). Between 80% and 100% of the gravel is biogenic material (e.g. shells and shell fragments) and some boulders are scattered across the sea bed.

82. A total of 48 of these samples were collected within the East Anglia THREE site. The median particle size (d_{50}) and percentages of mud, sand and gravel are available from these samples.

83. A follow-up benthic survey was undertaken in April and May 2013, from which a further five sea bed sediment samples were collected from within the East Anglia THREE site (Fugro EMU 2013c). Detailed particle size analysis is also available for these further five samples.

84. The 48 samples collected as part of the zone-wide survey show that the predominant sea bed sediment across the East Anglia THREE site is sand (*Table 7.2.3*). The proportion of sand within each sample ranges from 50% to 99%, with the majority of samples (45 no.) containing greater than 79% sand. The gravel content varies from zero to 8% in all samples. The three samples which contain relatively small amounts of sand (less than 79%) contain between 20% and 49% mud. The d_{50} across the East Anglia THREE site ranges from 0.21mm to 0.36mm (medium sand) with a single sample containing a d_{50} of 0.07mm (very fine sand) (*Table 7.2.3*).

Table 7.2.3– Particle size classification of sea bed sediment samples in the East Anglia THREE site (September 2010 to January 2011)

Station	Easting	Northing	Gravel (%)	Sand (%)	Mud (%)	d_{50} (mm)
157	488000.95	5841993.90	0.89	49.73	49.38	0.07
161	486028.35	5840018.93	1.66	95.69	2.65	0.21
162	489995.17	5839724.18	7.08	85.67	7.25	0.21
179	490011.43	5831991.27	1.19	78.72	20.08	0.21
169	500009.72	5837995.25	4.49	92.34	3.17	0.22
173	498020.95	5835983.79	0.59	97.76	1.64	0.22
160	500010.63	5842000.61	0.52	97.72	1.76	0.24
163	493986.92	5839984.60	3.03	92.24	4.73	0.25
154	498005.42	5844008.80	2.31	95.59	2.10	0.25
175	488030.61	5833962.79	3.81	68.07	28.12	0.25
172	494039.58	5835991.13	0.66	94.49	4.86	0.25
158	491985.90	5841990.68	0.82	97.28	1.90	0.25
156	484021.73	5842012.32	1.00	97.76	1.24	0.26
149	500005.15	5845995.64	0.97	97.41	1.61	0.27
183	492004.02	5829990.90	0.10	98.57	1.33	0.27
165	484007.83	5837998.59	0.36	98.20	1.44	0.27
178	485995.70	5831997.22	0.19	95.80	4.01	0.27
166	487987.44	5837997.02	1.81	96.04	2.15	0.27
159	495997.15	5842019.19	1.07	96.93	2.00	0.28
151	485979.55	5843992.66	5.36	93.02	1.62	0.28
167	491982.96	5837995.13	0.15	98.83	1.02	0.29
164	498003.78	5839965.84	2.17	96.00	1.83	0.29
184	486001.83	5828024.40	0.07	98.26	1.67	0.30
182	487983.34	5829992.76	0.85	97.58	1.57	0.30
168	495997.30	5837988.51	0.19	98.52	1.29	0.30
185	489996.27	5828018.23	0.95	97.45	1.60	0.30
153	494004.96	5843995.26	2.11	96.00	1.88	0.31
190	485974.08	5824049.68	0.82	96.95	2.22	0.31
171	490003.69	5835993.08	2.93	95.02	2.06	0.31
197	488011.58	5817982.98	8.37	88.54	3.09	0.31
194	485996.51	5819993.86	0.12	98.68	1.20	0.31
189	492023.33	5826001.79	1.14	97.34	1.52	0.31
195	489979.37	5820003.64	6.84	89.26	3.89	0.31
152	490015.76	5843972.39	0.11	98.72	1.17	0.31
188	487987.41	5826031.81	0.43	98.43	1.14	0.32
176	492027.58	5834004.03	0.34	98.18	1.48	0.32
186	494007.61	5828032.64	1.61	96.65	1.74	0.32
170	485980.31	5835995.08	0.74	97.53	1.73	0.32
180	494007.35	5831983.04	0.96	97.29	1.75	0.32

Station	Easting	Northing	Gravel (%)	Sand (%)	Mud (%)	d_{50} (mm)
181	483998.33	5829987.85	0.15	98.48	1.38	0.32
155	501989.71	5844025.19	0.20	98.16	1.64	0.33
193	487982.26	5822005.98	0.46	98.20	1.34	0.33
192	483993.67	5821999.69	0.79	98.18	1.04	0.33
191	489992.48	5824001.62	0.55	98.16	1.29	0.33
150	503991.04	5846016.45	0.82	98.26	0.92	0.33
174	483986.06	5833984.69	0.30	98.36	1.34	0.34
177	495996.80	5833995.00	2.34	96.05	1.60	0.35
187	483998.04	5826010.96	0.08	98.70	1.22	0.36

85. The detailed particle size analyses from the additional five samples within the East Anglia THREE site shows that the d_{50} ranges from 0.30mm to 0.36mm (medium sand) (*Table 7.2.4*).

Table 7.2.4. Particle size classification of sea bed sediment samples in the East Anglia THREE site (April and May 2013)

Station	Easting	Northing	Gravel (%)	Sand (%)	Mud (%)	d_{50} (mm)
45	499456	5843696.8	1.01	96.17	2.83	0.30
46	499704.4	5845984	0.86	98.07	1.06	0.30
47	497025.8	5840818.4	6.72	92.54	0.74	0.35
48	494388	5833654.1	1.42	97.80	0.78	0.36
49	488257.6	5822973.9	1.30	97.71	0.99	0.33

86. In addition, Cefas has collected day grab samples at the location of the AWAC deployment within the East Anglia THREE site at the time of instrument installation and during each service visit (Cefas 2012; 2013). Results on most sampling occasions reveal the presence on the sea bed of well sorted medium sand with a d_{50} in the range 0.36 – 0.43mm. The samples often contained ~100% sand (although sometimes a small proportion, generally <1%, of gravel was noted), which predominantly consisted of medium sand, with some coarse sand and small quantities of fine sand (Plate 7.2.1). On one occasion (8th February 2013) the samples revealed a slightly coarser particle size distribution, caused by the presence of shells and large shell fragments.

Plate 7.2.1. Grab sample at AWAC deployment location within the proposed East Anglia THREE site

87. Fugro EMU (2013a) collected multibeam backscatter data and side scan sonar images across the East Anglia THREE site, and combined this with the zone-wide particle size data to interpret sea bed sediment distribution. The sea bed is homogeneous and is characterised by mainly sand with some muddy sand. This is supported by the types of bedforms (sand waves, megaripples, sand ridges) that are present across the East Anglia THREE site. The areas of muddy sand are in deeper areas and correlate with locations where the surface sediments are a thin veneer and the underlying muddy Brown Bank Formation is close to sea bed. At these locations bedforms are absent.

88. As part of the zone-wide survey, a total of 38 samples were also collected within the offshore cable corridor. The median particle size (d_{50}) and percentages of mud, sand and gravel are available from these datasets. A follow-up benthic survey within the offshore cable corridor was also undertaken in April and May 2013, from which a further 39 sea bed sediment samples were collected (Fugro EMU 2013c). Detailed particle size analysis is also available for these further 39 samples.

89. The 38 samples collected during the zone-wide survey show that the predominant sea bed sediment along the offshore cable corridor is sand (*Table 7.2.5*). The proportion of sand ranges from 57% to 99%, with the majority of samples (34 no.) containing greater than 80% sand. The gravel content varies from zero to 13% in 33 samples, with the other five containing between 12% and 41% of gravel. All samples contain less than 3% mud with the majority (32 no.) containing less than 2%. The d_{50} along the offshore cable corridor ranges from 0.30mm to 0.50mm (medium sand) with a single sample with a d_{50} of 0.77m (coarse sand) (*Table 7.2.5*).

Table 7.2.5 – Particle size classification of sea bed sediment samples within the offshore cable corridor (September 2010 to January 2011)

Station	Easting	Northing	Gravel (%)	Sand (%)	Mud (%)	d_{50} (mm)
198	486014.21	5816007.03	0.02	97.74	2.24	0.30
196	483989.89	5817987.75	0.89	97.47	1.63	0.31
404	468991.13	5808632.12	1.82	96.46	1.72	0.34
392	468985.45	5812746.75	2.48	96.26	1.26	0.34
499	454958.47	5783017.15	0.20	98.39	1.41	0.34
199	483975.51	5815552.99	5.77	92.72	1.50	0.35
492	444974.10	5783810.21	11.46	87.31	1.23	0.35
413	466997.93	5806986.11	0.50	98.50	1.00	0.35
505	456998.68	5781004.47	4.53	93.31	2.17	0.36
485	452989.71	5788718.57	1.19	97.44	1.37	0.36
504	453005.49	5780994.66	1.49	97.48	1.03	0.36
423	464991.51	5804176.21	0.77	98.35	0.88	0.36
493	449042.86	5785020.80	0.89	97.78	1.33	0.36
471	451028.64	5795723.68	0.82	97.92	1.26	0.38
452	454973.16	5799026.69	9.15	89.68	1.17	0.39
442	457015.48	5800992.79	6.93	91.60	1.47	0.39
495	457022.10	5785017.92	21.40	77.63	0.97	0.39
510	458989.46	5778990.43	12.35	85.97	1.69	0.39
491	440986.95	5784998.44	3.65	95.05	1.30	0.40
443	461002.62	5800983.14	10.21	88.25	1.54	0.41
433	459002.12	5802979.25	4.42	94.53	1.05	0.41
482	454983.24	5791186.40	34.55	62.59	2.85	0.41
434	462979.23	5803011.70	0.76	98.16	1.08	0.42
496	443002.59	5783997.17	5.63	92.24	2.12	0.43
494	453004.76	5785050.12	0.84	98.09	1.07	0.45
479	443027.85	5790998.35	40.89	56.83	2.29	0.50
497	446995.61	5782986.62	2.50	96.39	1.12	0.77
571	467005.1	5799244	0.54	98.15	1.32	0.34
577	464982.8	5796985	27.56	71.33	1.11	0.41
579	468981.7	5797001	3.18	95.14	1.69	0.36
589	466995.3	5795018	2.91	94.76	2.33	0.36
616	462967.2	5790996	11.00	87.81	1.19	0.36
618	466997.9	5791011	11.00	87.81	1.19	0.37
630	464993.5	5788984	0.39	98.41	1.20	0.39
632	468982.8	5789159	1.68	97.02	1.30	0.37
640	458992.8	5786855	17.70	80.97	1.33	0.50
653	460962.2	5785001	1.16	97.57	1.27	0.37
673F	460978.9	5780991	4.22	93.80	1.98	0.36

90. The detailed particle size analyses from the additional 34 samples shows that the d_{50} ranges from 0.23mm to 0.45mm (medium sand) apart from three samples between 0.54mm and 0.65mm (coarse sand) (*Table 7.2.6*).

Table 7.2.6 – Particle size classification of sea bed sediment samples within the offshore cable corridor (April and May 2013)

Station	Easting	Northing	Gravel (%)	Sand (%)	Mud (%)	d_{50} (mm)
1	482984	5852967.5	1.15	98.11	0.74	0.35
2	482867	5848960.4	18.37	67.65	13.98	0.35
3	482976	5844972.5	11.76	73.14	15.10	0.23
4	481972	5840985.4	1.29	97.67	1.04	0.23
5	482813	5836478.8	1.46	97.65	0.90	0.34
6	481988	5832971	1.12	97.84	1.04	0.33
7	482977	5828976.3	0.34	98.70	0.96	0.32
8	481982	5824968.3	0.34	98.91	0.74	0.34
9	479985	5824978.3	0.82	98.14	1.03	0.32
10	477989	5824976.2	0.96	98.21	0.83	0.33
11	482979	5820995.2	4.97	92.42	2.61	0.30
12	480983	5820969.5	22.23	76.70	1.07	0.36
13	478992	5820973.5	0.38	98.65	0.97	0.32
14	476984	5820975	8.25	91.05	0.70	0.41
15	474988	5820981.8	0.62	98.29	1.10	0.33
16	471998	5816969.7	8.04	91.18	0.78	0.36
17	471003	5812981.6	37.97	60.94	1.09	0.55
18	471691	5808619.6	36.00	63.11	0.90	0.43
19	471019	5804479.9	2.56	96.51	0.93	0.35
20	471989	5800989.5	5.78	93.30	0.92	0.35
21	470981	5796985.7	2.48	96.67	0.85	0.35
22	481989	5800989.7	4.10	95.16	0.74	0.54
23	478753	5800432.3	2.93	96.22	0.84	0.35
24	475646	5800181	20.73	77.91	1.36	0.34
25	482997	5804977.7	3.70	86.61	9.68	0.29
26	482987	5812970.2	5.41	85.99	8.60	0.25
28	480991	5811857.6	0.38	98.54	1.08	0.31
29	477007	5812046.8	0.93	98.43	0.65	0.65
30	472993	5812177.8	6.75	91.51	1.74	0.36
31	440974	5789008.4	0.71	98.44	0.85	0.44
32	439981	5785012.3	10.34	67.59	22.07	0.30
33	438016	5784997.7	3.27	95.99	0.74	0.45
35	431003	5781000.2	14.35	84.31	1.34	0.38
36	428994	5780991.6	11.49	86.38	2.13	0.36

7.2.10.2 Bedload Transport Pathways

91. Across the East Anglia Zone sediment transport pathways have been extensively investigated in previous studies when analysing of the orientation of bedforms. The key active bedforms located within the East Anglia Zone are shown in *Figure 7.2.19*.

92. The sand waves present within the East Anglia Zone exhibit a consistent asymmetry that indicates a net direction of transport to the north. Locally, however, more complex transport patterns exist around the Norfolk banks.

93. Tidal currents are the main driving force of sediment transport and, due to the tidal asymmetry in the bedforms (*Figure 7.2.20*), generally move sediments in a northerly direction across the East Anglia Zone. However, during storm surges, bedload transport can be dominated by southerly movement across the East Anglia Zone.

94. Within the East Anglia THREE site, the steeper slopes of the sand waves face to the north or north-east indicating a migration direction, and hence sediment transport, to the north or north-east.

7.2.10.3 Suspended Sediments

95. Suspended sediment concentrations across the East Anglia Zone are typically in the range 1 to 35mg/l. The highest values are generally found along the western margin and during winter months (ABPmer 2012a). During storm surges, suspended sediment concentrations can become further enhanced.

96. An 18-month deployment made during the Land Ocean Interaction Study (LOIS) research project recorded mean turbidity values of 15mg/l in the vicinity of the East Anglia Zone, aligning with the above range.

97. Eisma and Kalf (1987) carried out a water sampling programme in the North Sea in January 1980 and differentiated general surface concentrations from bottom concentrations. They showed that across the East Anglia Zone, the concentrations were similar at both elevations, ranging from 5-10mg/l, again aligning with the above range.

98. Measurements of suspended particulate matter (SPM) concentrations were carried out at the AWAC station in the East Anglia THREE site in December 2012, February 2013 and April 2013 using water sampling and laboratory analysis. Concentrations of 4.5-11.5mg/l were recorded in December 2012, 3-4mg/l in February 2013, and 10-13.5mg/l in April 2013 (*Table 7.2.7*). Overall, SPM concentrations were between 3mg/l and 13.5mg/l throughout that winter.

Table 7.2.7 – Suspended particulate matter (SPM) at the AWAC station in the East Anglia THREE site

Station	Sample Depth (m)	Collection Date	SPM (mg/l)
21	42.00	04/12/2012	11.56
21	20.00	04/12/2012	8.91
21	4.00	04/12/2012	4.51
130	43.10	08/02/2013	4.05
130	22.30	08/02/2013	3.33
130	3.10	08/02/2013	3.03
140	43.00	08/02/2013	3.72
140	21.00	08/02/2013	3.96
140	2.30	08/02/2013	3.05
27	35.10	16/04/2013	13.34
27	18.80	16/04/2013	13.04
27	2.40	16/04/2013	11.92
30	42.40	16/04/2013	10.91
30	20.40	16/04/2013	11.75
30	2.20	16/04/2013	10.27

99. Diagram 7.2.7 shows the how the pattern of suspended sediment in the water column (measured by turbidity) within the East Anglia THREE site mirrors the governing wave climate, but with a time-lag before background values are restored, with only a modest modulation due to tidal current speeds alone.

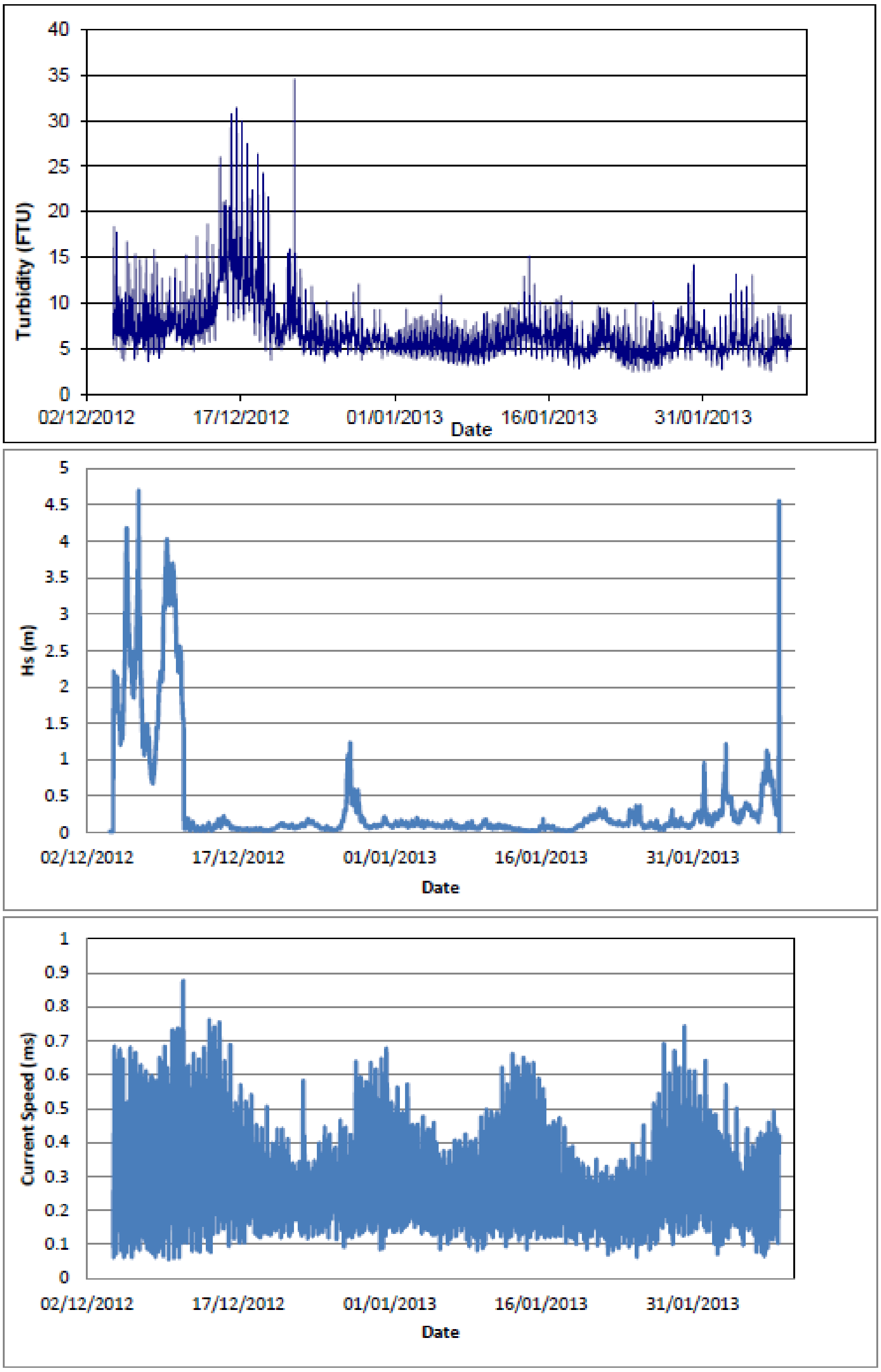


Diagram 7.2.7. Process controls on suspended sediment concentrations within the East Anglia THREE site

100. Suspended sediment concentrations nearer the coast can be greater and values up to 170mg/l have been recorded in the vicinity of the coast at Great Yarmouth (ABPmer 2012a).

7.2.10.4 Littoral (Shoreline) Transport Pathways

101. Along the East Anglian coastline, longshore drift is generally to the south, although localised departures from this trend are apparent at the mouths of estuaries. Seaward of approximately the 20m isobath, even large waves have a very limited influence on the sea bed processes.

102. Further detailed description of the littoral transport processes is provided in *Appendix 7.4.*

7.2.11 References

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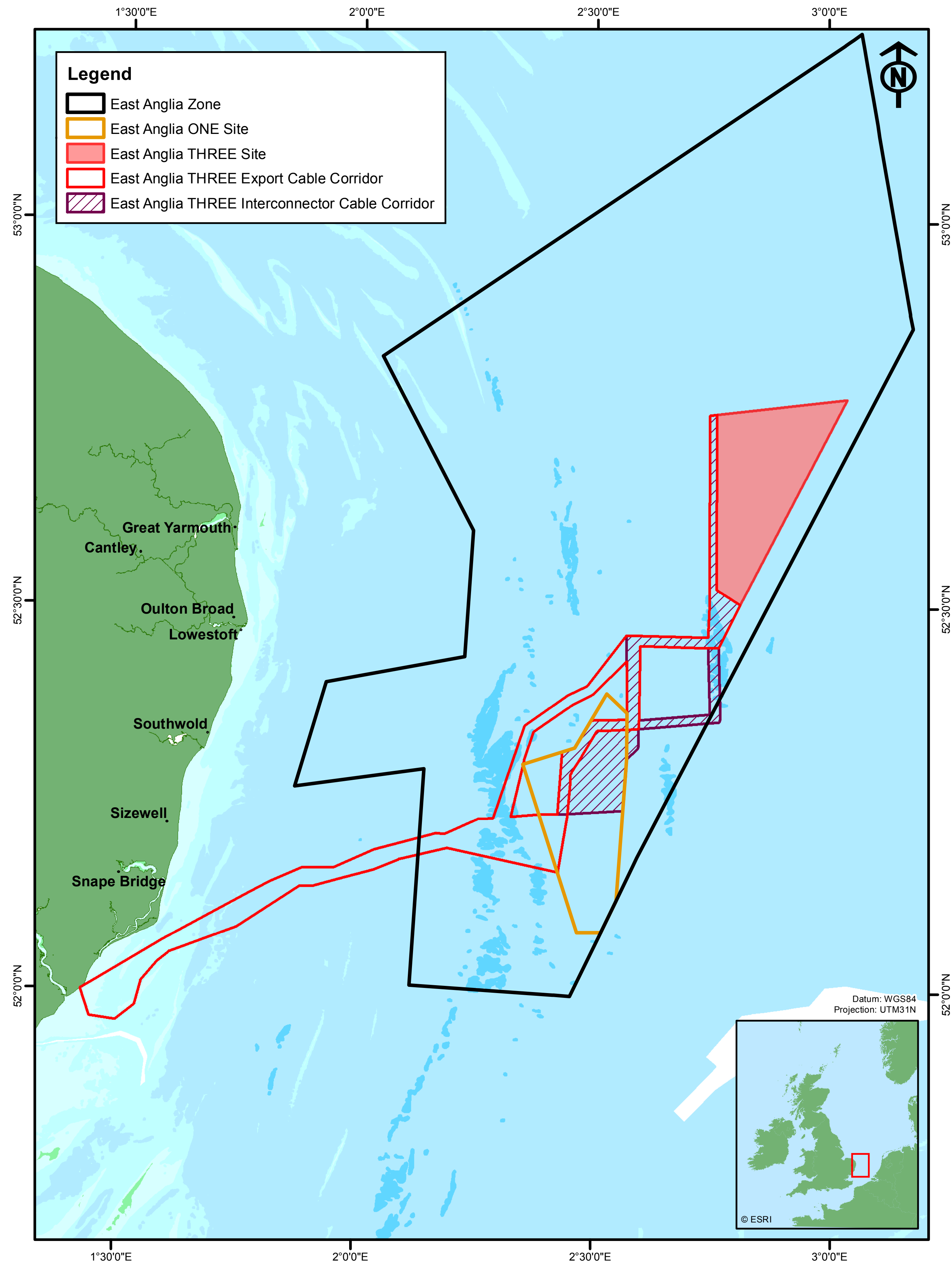
7.2.12 Figures

103. Provided below are *Figure 7.2.1* to *Figure 7.2.20*.



VATTENFALL

SCOTTISHPOWER RENEWABLES

East Anglia THREE Limited

East Anglia THREE Offshore Windfarm Location

Rev	Date	By	Comment
2	20/10/15	AB	Second Issue.
1	07/07/15	BN	First Issue.

Original A4 Plot Scale 1:750,000

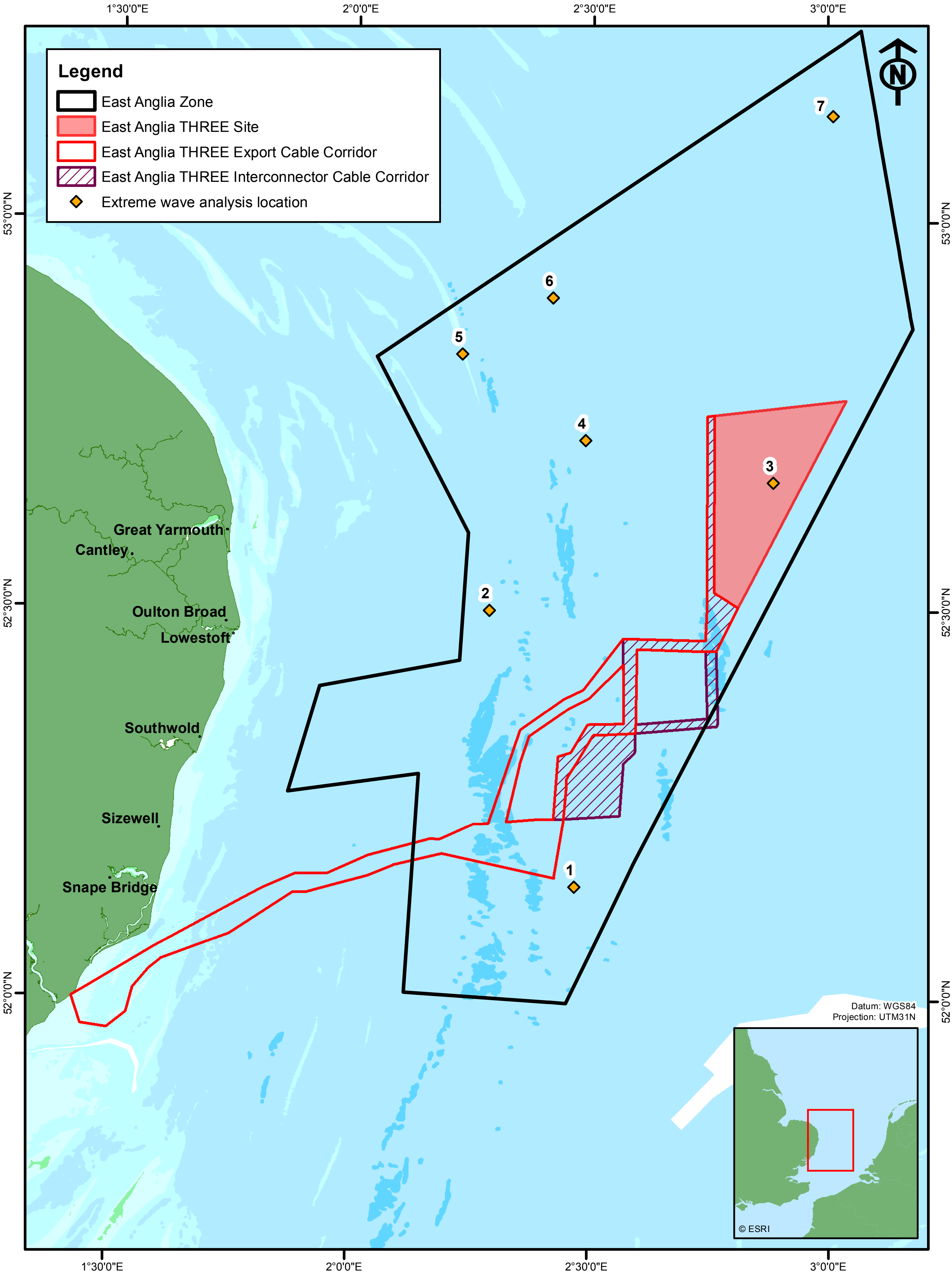
0 5 10 km

0 2 4 6 nm

Volume 3 | **Figure 7.2.1**

Layout	Date	Rev	Dwg No.
N/A	20/10/2015	2	EA3-O-069

Ref:



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SCOTTISHPOWER RENEWABLES

East Anglia THREE Limited

Sources of wave data

Rev	Date	By	Comment
2	20/10/15	AB	Second Issue.
1	07/07/15	BN	First Issue.

Original A4 Plot Scale 1:750,000

0 5 10 km

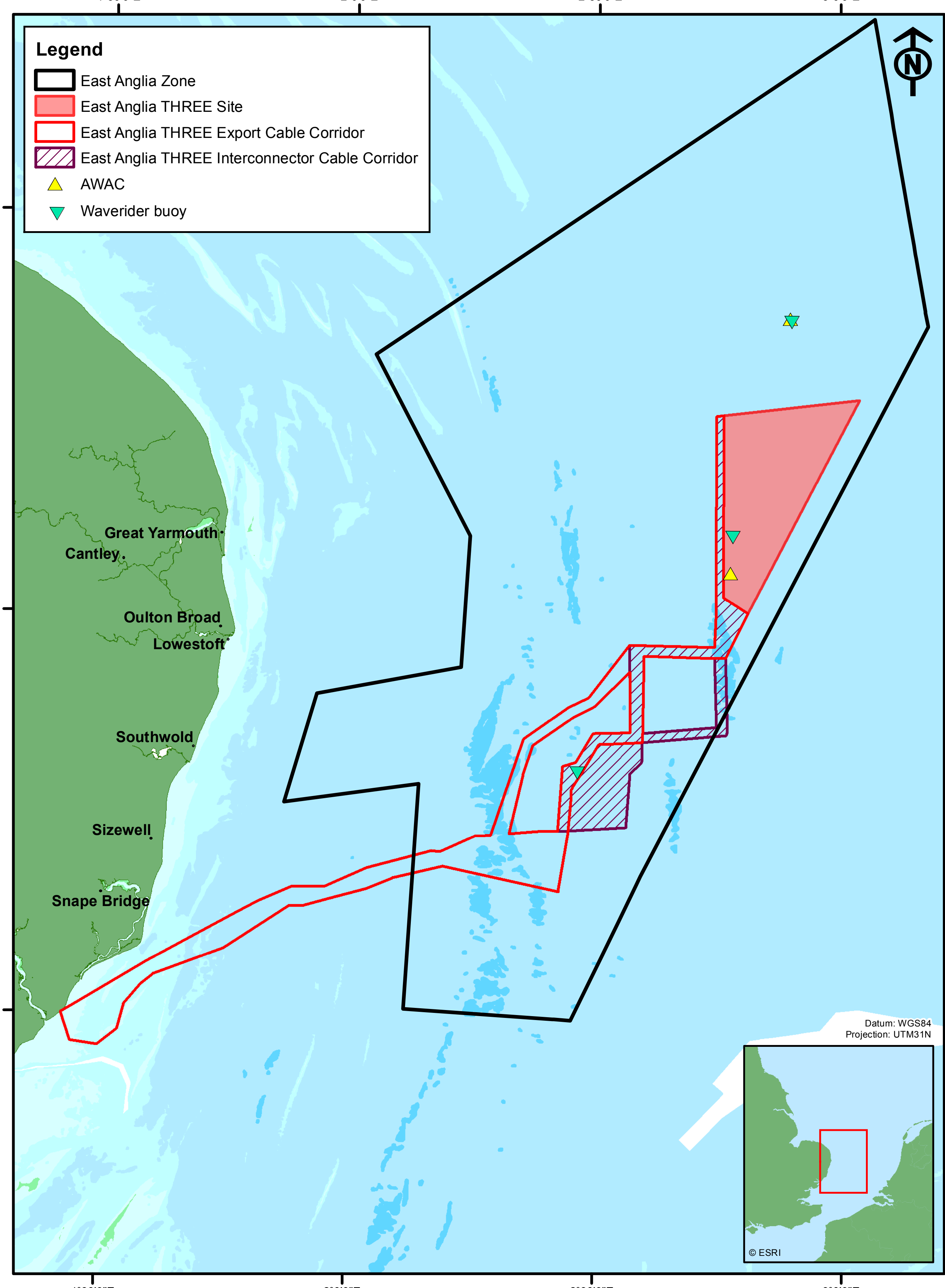
0 2 4 6 nm

Volume 3

Figure 7.2.2

Layout	Date	Rev	Dwg No.
N/A	20/10/2015	2	EA3-O-070

Ref:



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Metocean survey deployments

Rev	Date	By	Comment
2	20/10/15	AB	Second Issue.
1	07/07/15	BN	First Issue.

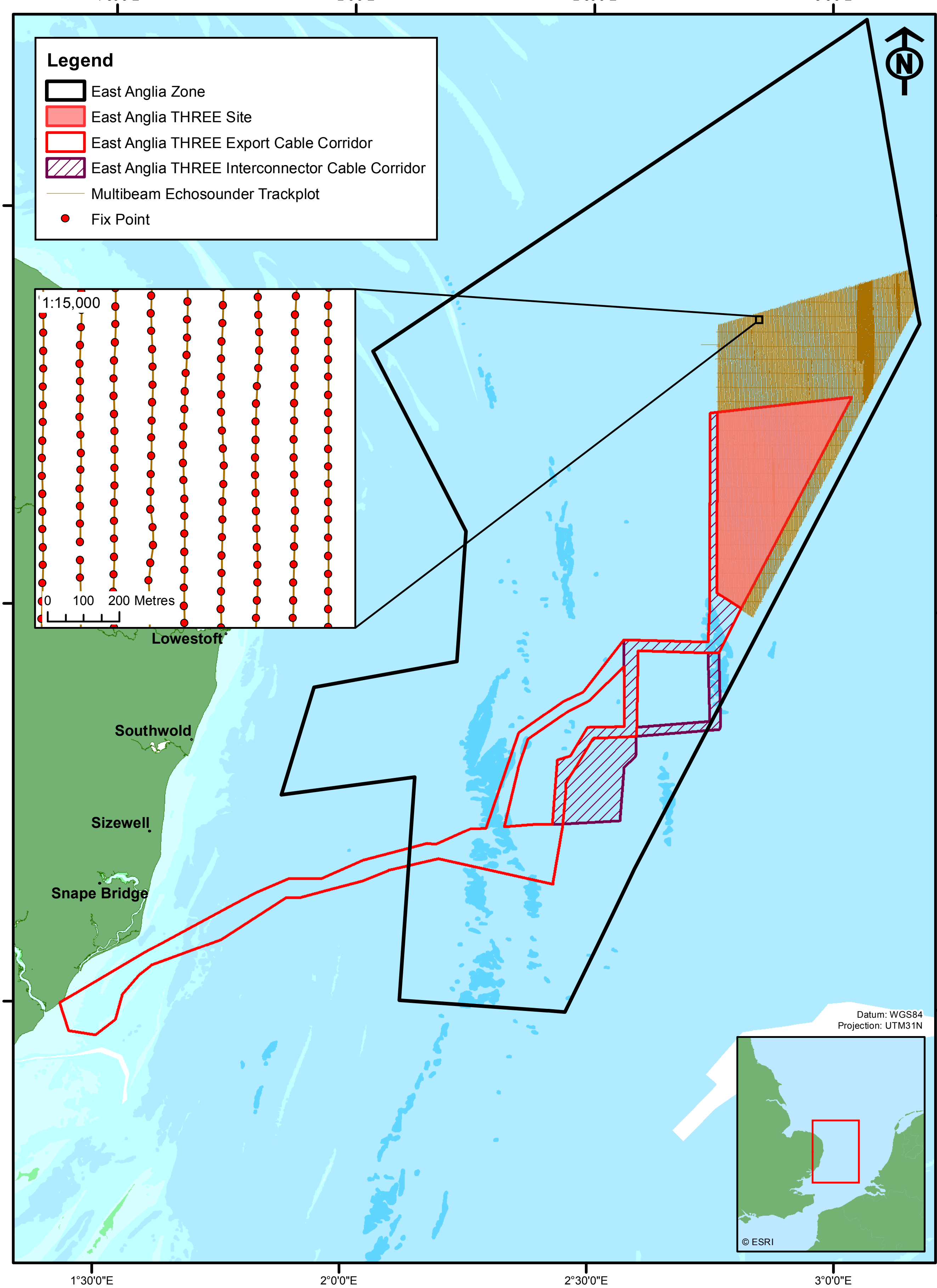
Original A4 Plot Scale 1:750,000

0 5 10 km

0 2 4 6 nm

Volume 3	Figure 7.2.3		
Layout	Date	Rev	Dwg No.
N/A	20/10/2015	2	EA3-O-071

Ref:



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Note: Survey data from EMU Ltd. Surveys conducted by Fugro Survey B.V between June and September 2012.

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Geophyscial Survey Coverage

Rev	Date	By	Comment
2	20/10/15	AB	Second Issue.
1	07/07/15	BN	First Issue.

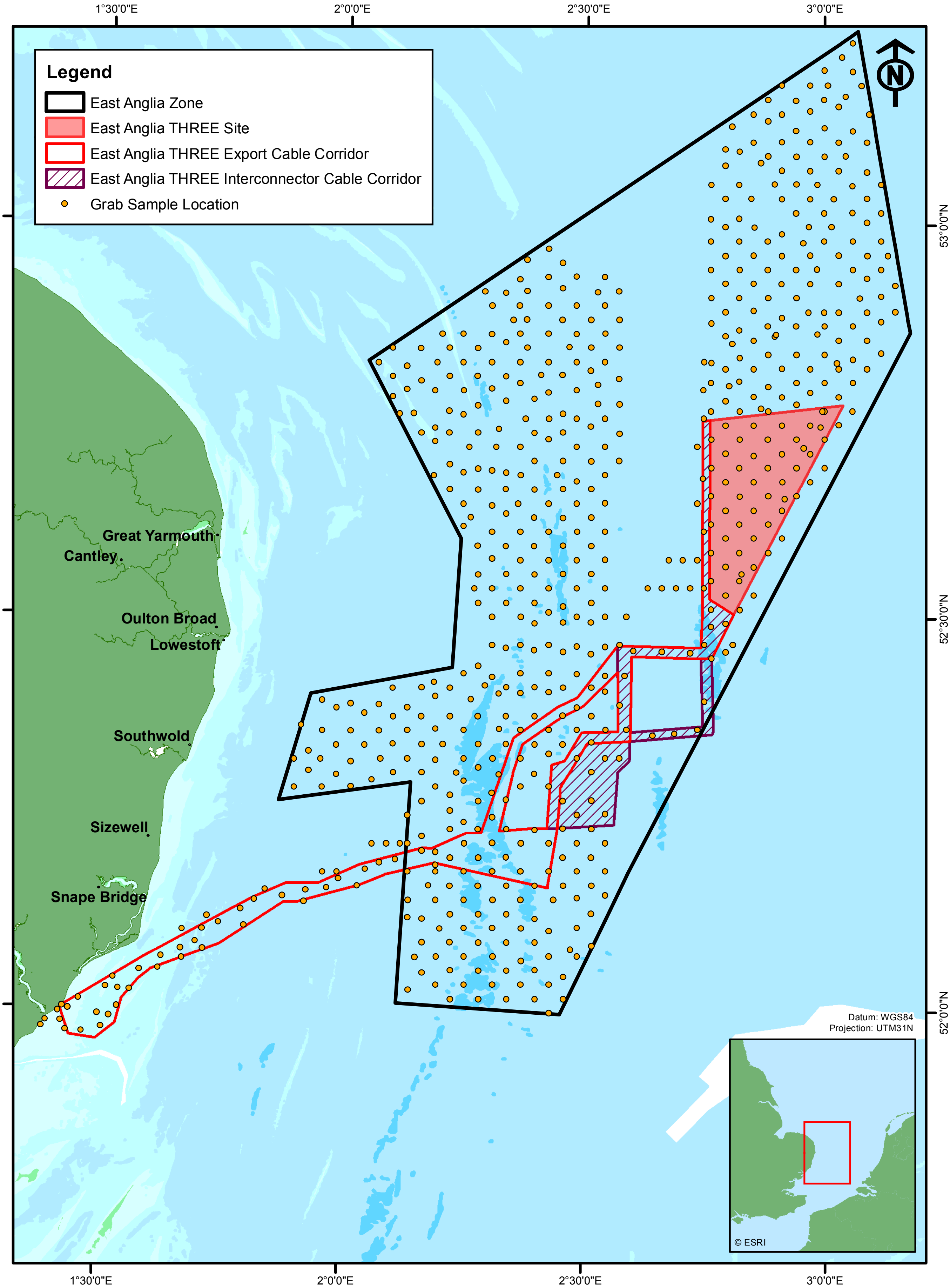
Original A4 Plot Scale 1:750,000

0 5 10 km

0 2 4 6 nm

Volume 3		Figure 7.2.4	
Layout	Date	Rev	Dwg No.
N/A	20/10/2015	2	EA3-O-072

Ref:



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Grab Sample Survey Converage

Rev	Date	By	Comment
2	21/10/15	AB	Second Issue.
1	07/07/15	BN	First Issue.

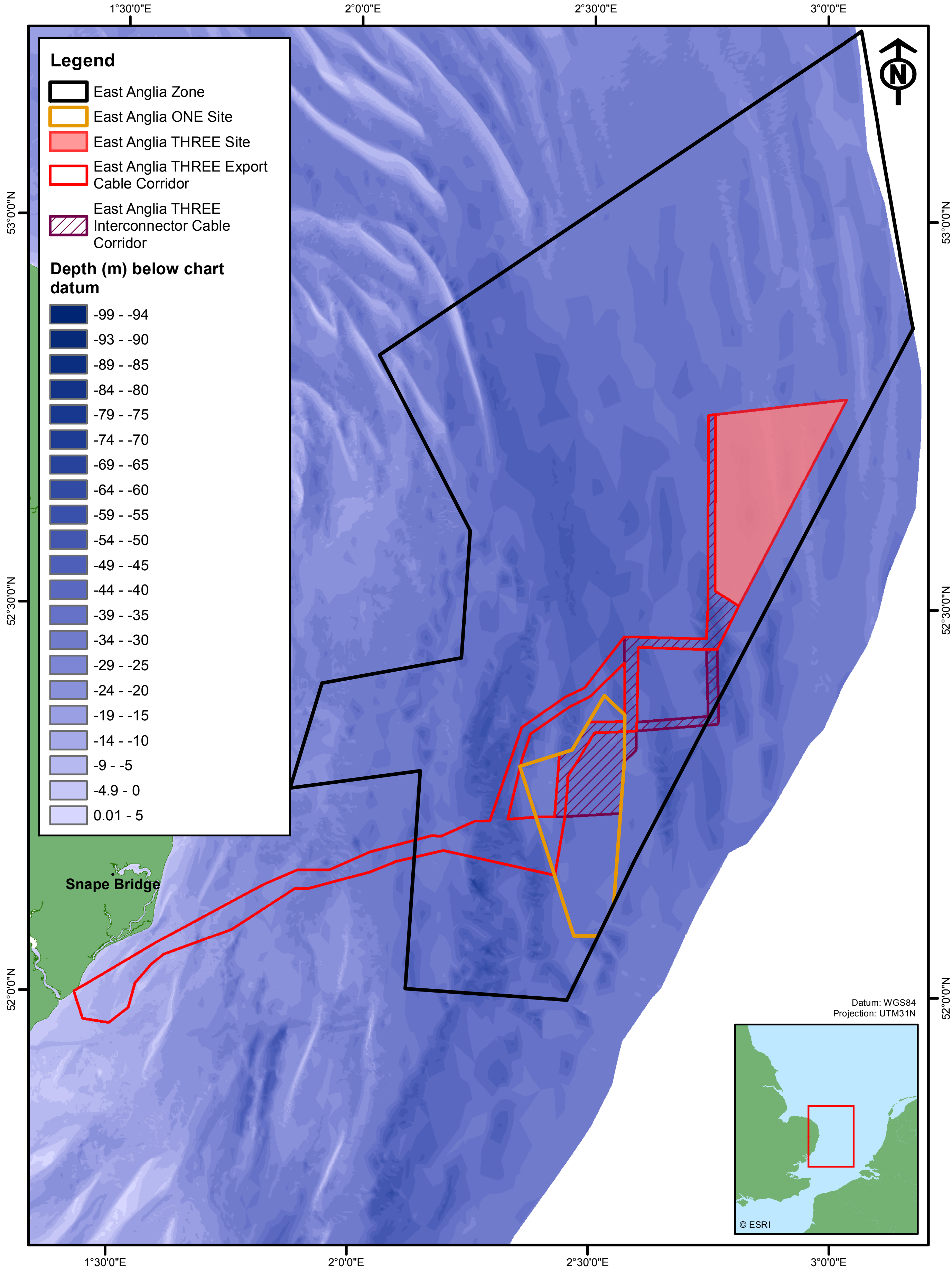
Original A4 Plot Scale 1:750,000

0 5 10 km

0 2 4 6 nm

Volume 3		Figure 7.2.5	
Layout	Date	Rev	Dwg No.
N/A	21/10/2015	2	EA3-O-073

Ref:



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Sea Bed Bathymetry

Rev	Date	By	Comment
2	21/10/15	AB	Second Issue.
1	07/07/15	BN	First Issue.

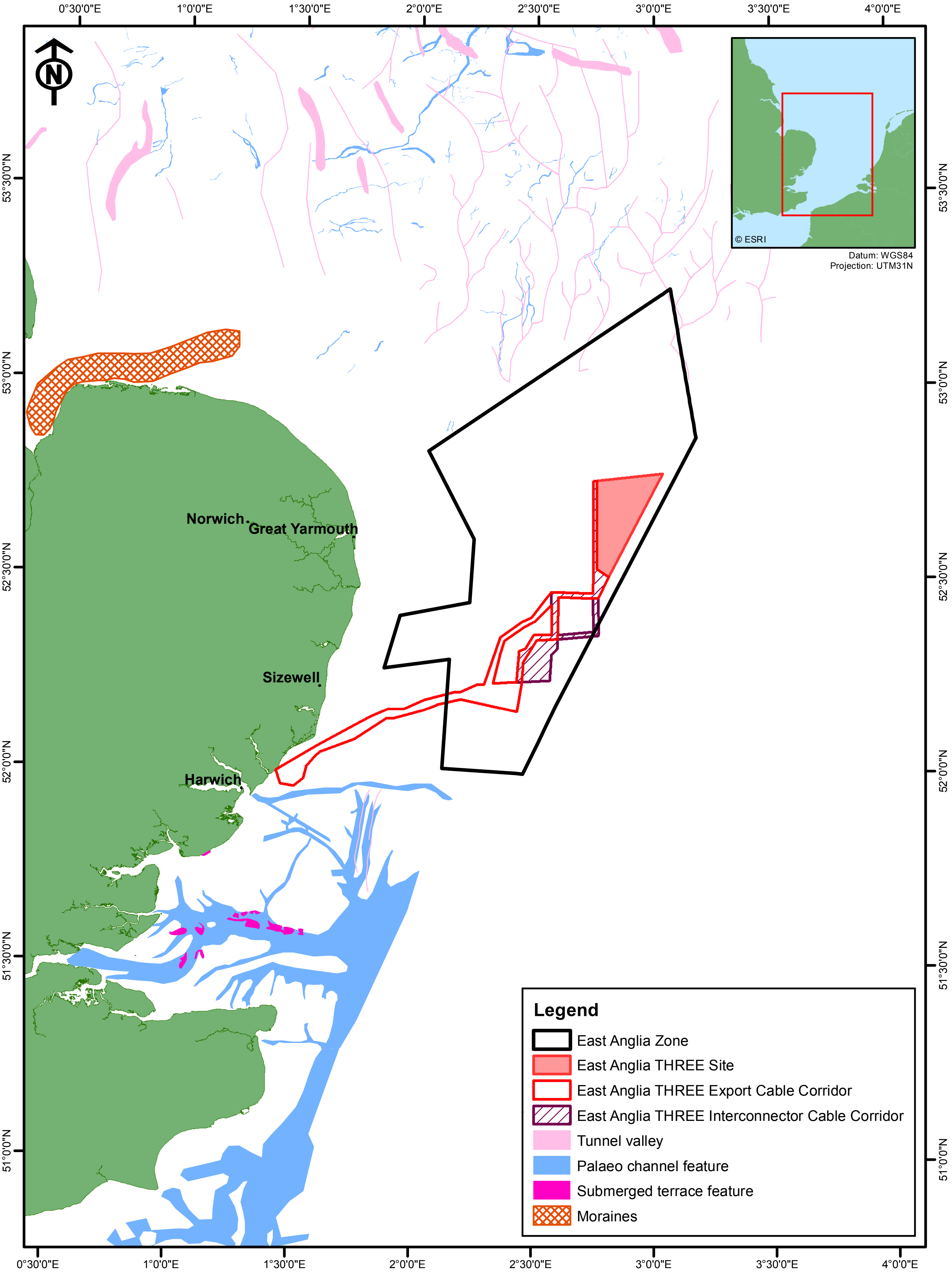
Original A4 Plot Scale 1:750,000

0 5 10 km
0 2 4 6 nm

Volume 3 | **Figure 7.2.6**

Layout	Date	Rev	Dwg No.
N/A	21/10/2015	2	EA3-O-074

Ref:



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Relict sea bed bedforms

Rev	Date	By	Comment
2	21/10/15	AB	Second Issue.
1	07/07/15	BN	First Issue.

Original A4 Plot Scale 1:1,500,000

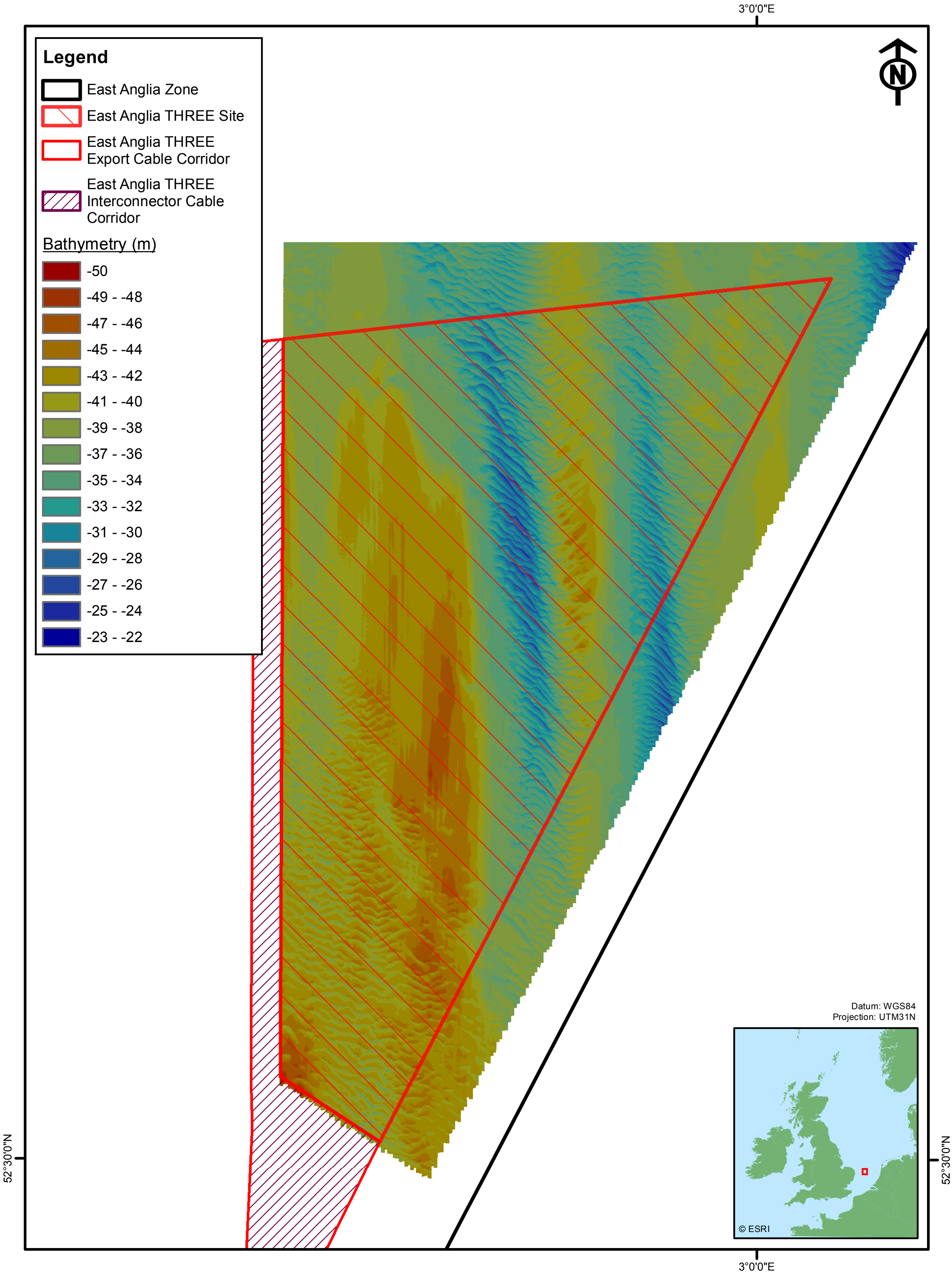
0 5 10 km

0 2 4 6 nm

Volume 3 | **Figure 7.2.7**

Layout	Date	Rev	Dwg No.
N/A	21/10/2015	2	EA3-O-075

Ref:



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Detailed bathymetry of the proposed East AngliaTHREE windfarm area

Rev	Date	By	Comment
2	21/10/15	AB	Second Issue.
1	07/07/15	BN	First Issue.

Original A4 Plot Scale 1:180,000

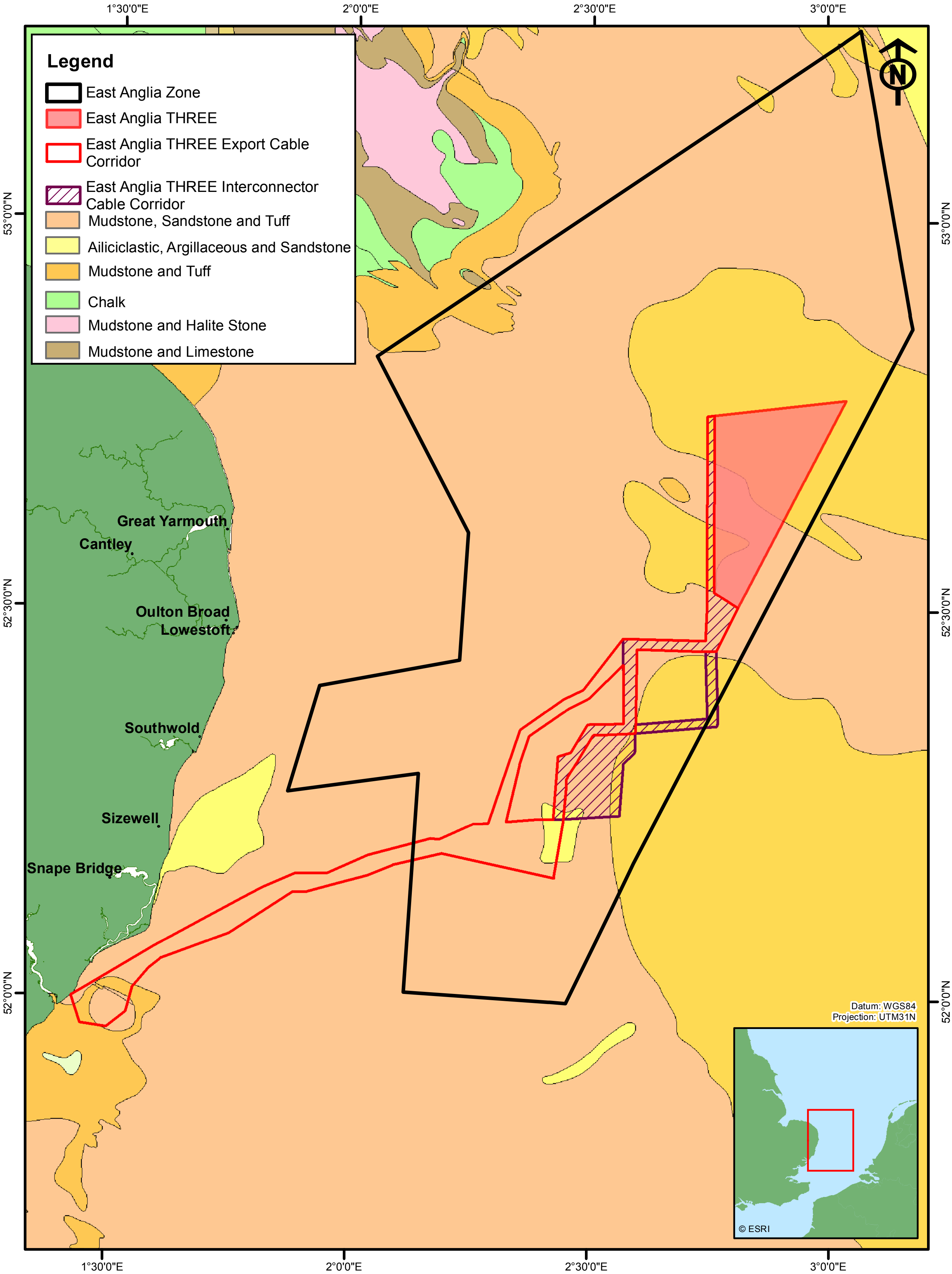
0 1 2 km

0 1 nm

Volume 3 **Figure 7.2.8**

Layout	Date	Rev	Dwg No.
N/A	21/10/2015	2	EA3-O-076

Ref:



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East Anglia THREE Limited

Bedrock Geology

Rev	Date	By	Comment
2	21/10/2015	AB	Second Issue.
1	13/07/2015	BN	First Issue.

Original A4 Plot Scale 1:750,000

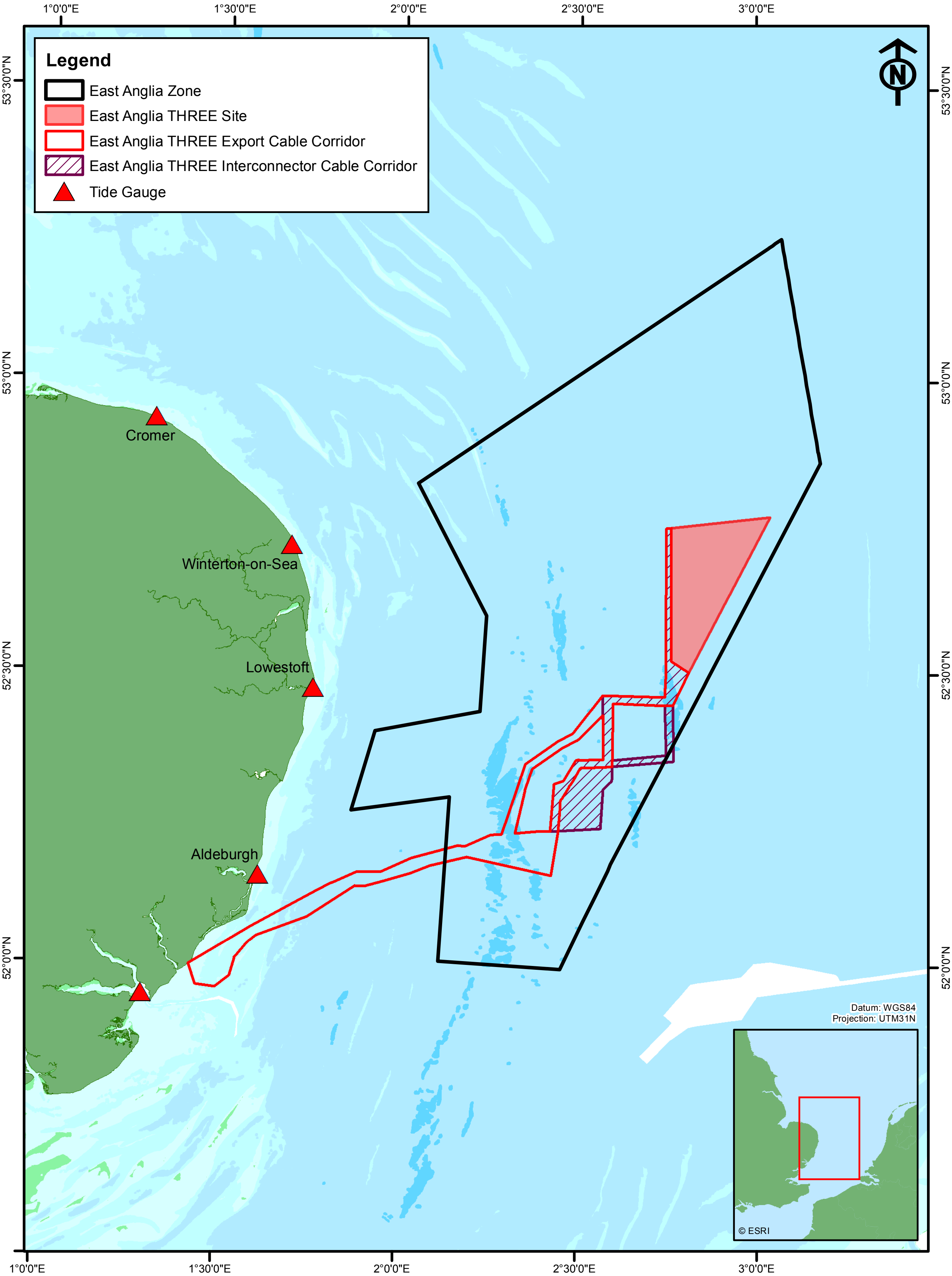
0 5 10 km

0 2 4 6 nm

Volume 3 **Figure 7.2.9**

Layout	Date	Rev	Dwg No.
N/A	21/10/2015	2	EA3-O-077

Ref:



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Sources of water level data

Rev	Date	By	Comment
2	21/10/15	AB	Second Issue.
1	07/07/15	BN	First Issue.

Original A4 Plot Scale 1:1,000,000

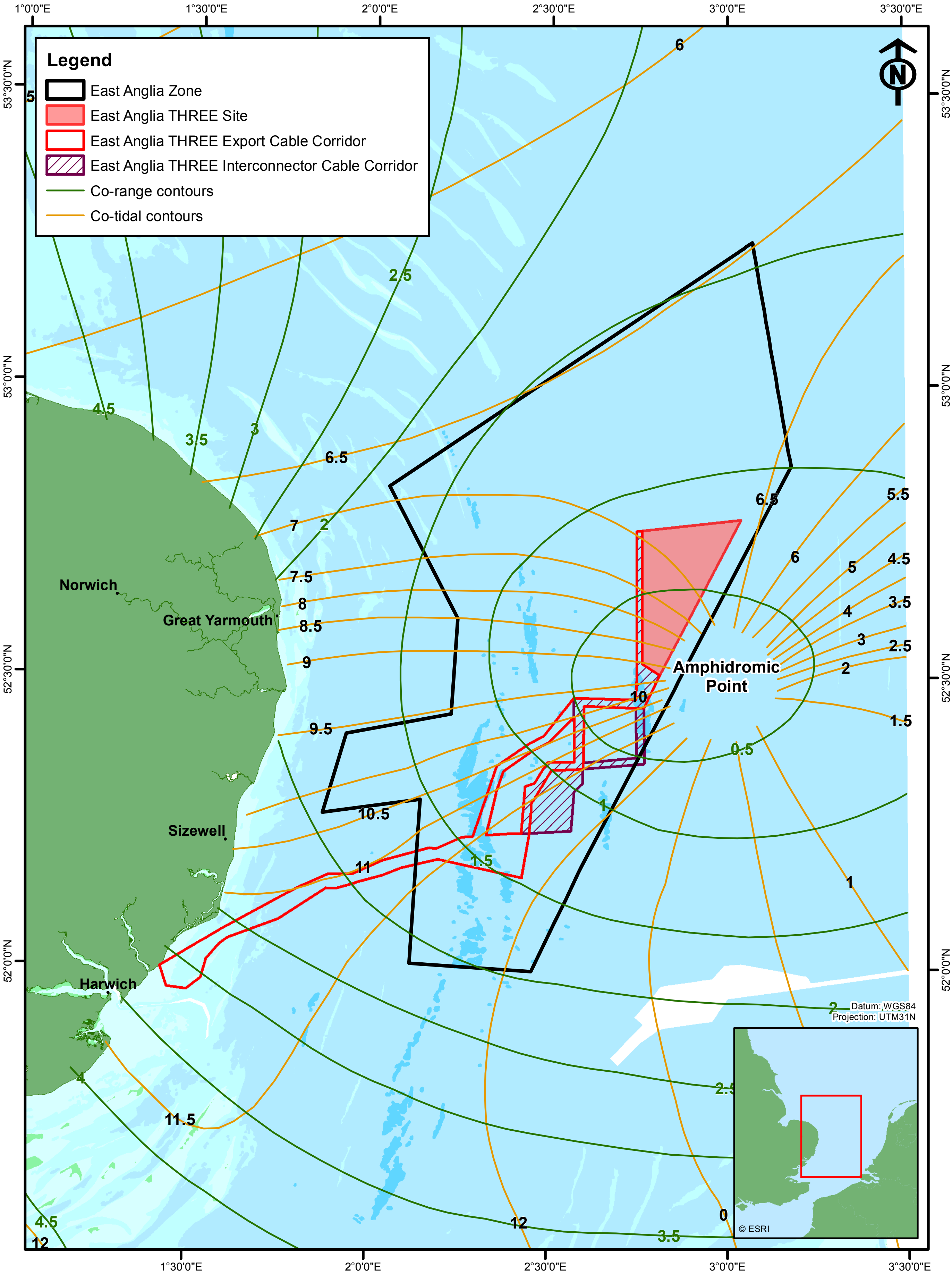
0 5 10 km

0 2 4 6 nm

Volume 3 | **Figure 7.2.10**

Layout	Date	Rev	Dwg No.
N/A	21/10/2015	2	EA3-O-078

Ref:



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Position of the amphidromic point

Rev	Date	By	Comment
2	21/10/15	AB	Second Issue.
1	07/07/15	BN	First Issue.

Original A4 Plot Scale 1:1,000,000

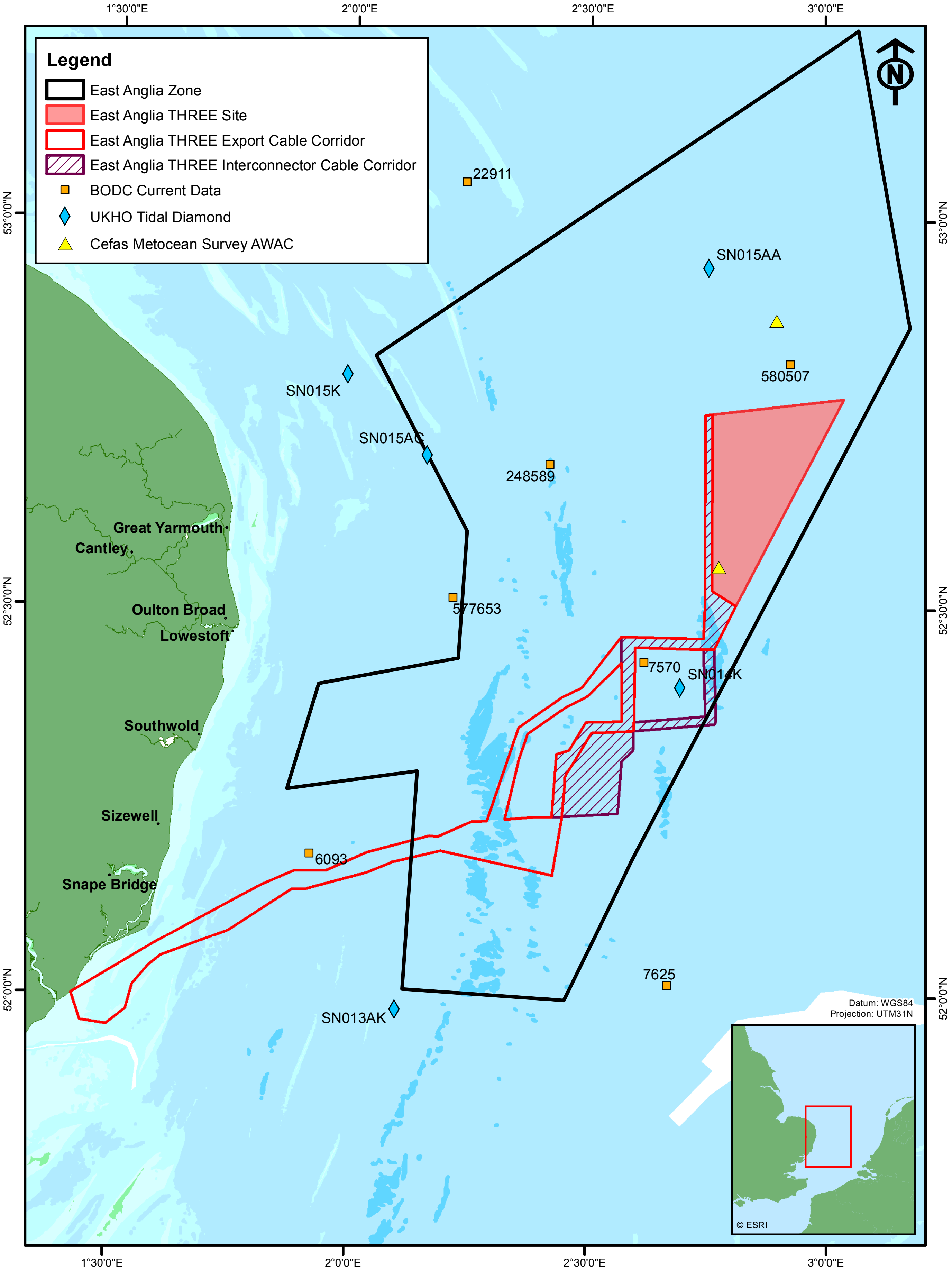
0 5 10 km

0 2 4 6 nm

Volume 3 | **Figure 7.2.11**

Layout	Date	Rev	Dwg No.
N/A	21/10/2015	2	EA3-O-079

Ref:



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Sources of current data

Rev	Date	By	Comment
2	21/10/15	AB	Second Issue.
1	07/07/15	BN	First Issue.

Original A4 Plot Scale 1:750,000

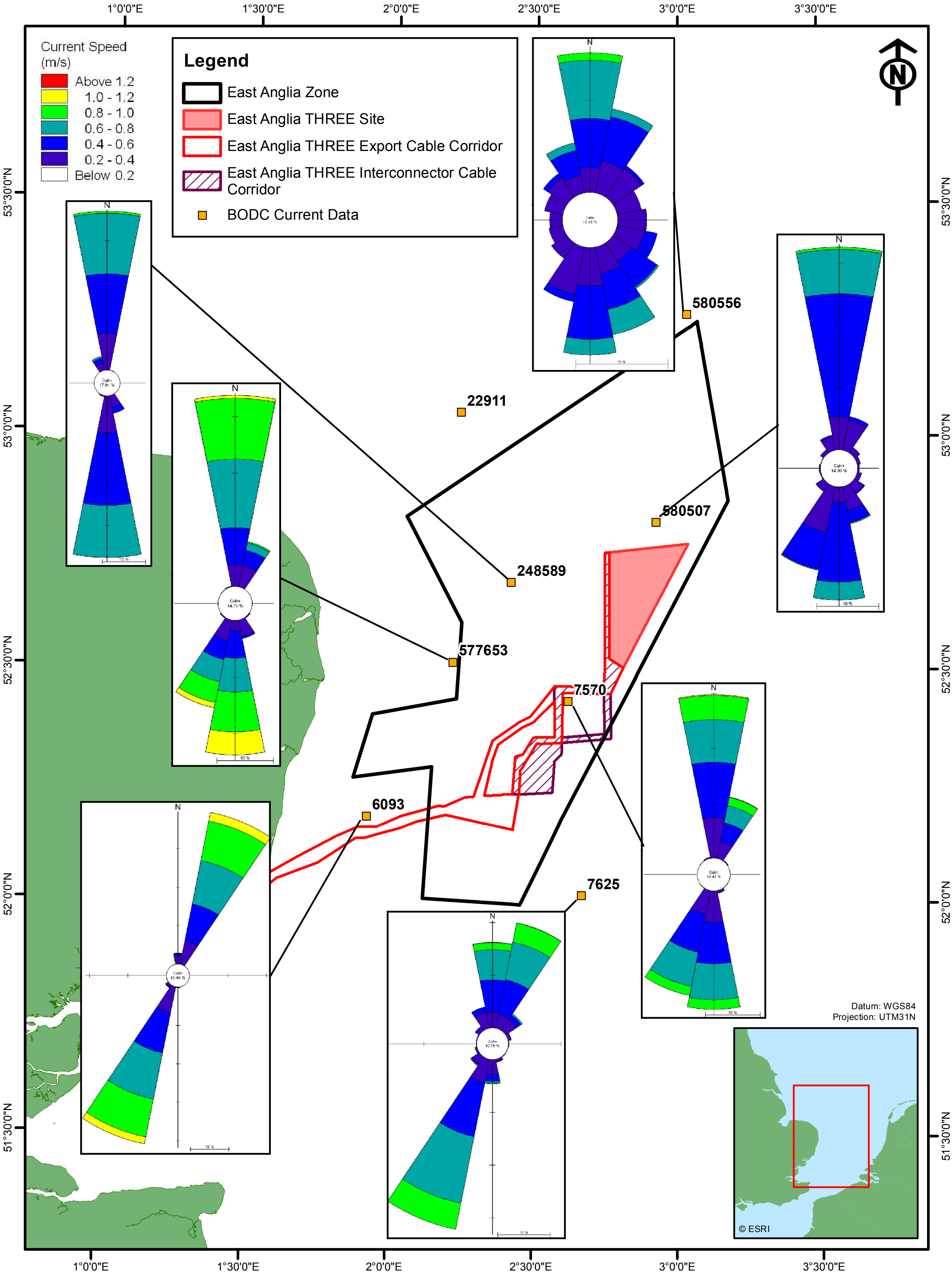
0 5 10 km

0 2 4 6 nm

Volume 3 | **Figure 7.2.12**

Layout	Date	Rev	Dwg No.
N/A	21/10/2015	2	EA3-O-080

Ref:



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SCOTTISHPOWER RENEWABLES

East Anglia THREE Limited

Current roses within the East Anglia Zone

Rev	Date	By	Comment
2	21/10/15	AB	Second Issue.
1	07/07/15	BN	First Issue.

Original A4 Plot Scale 1:1,250,000

0 5 10 km

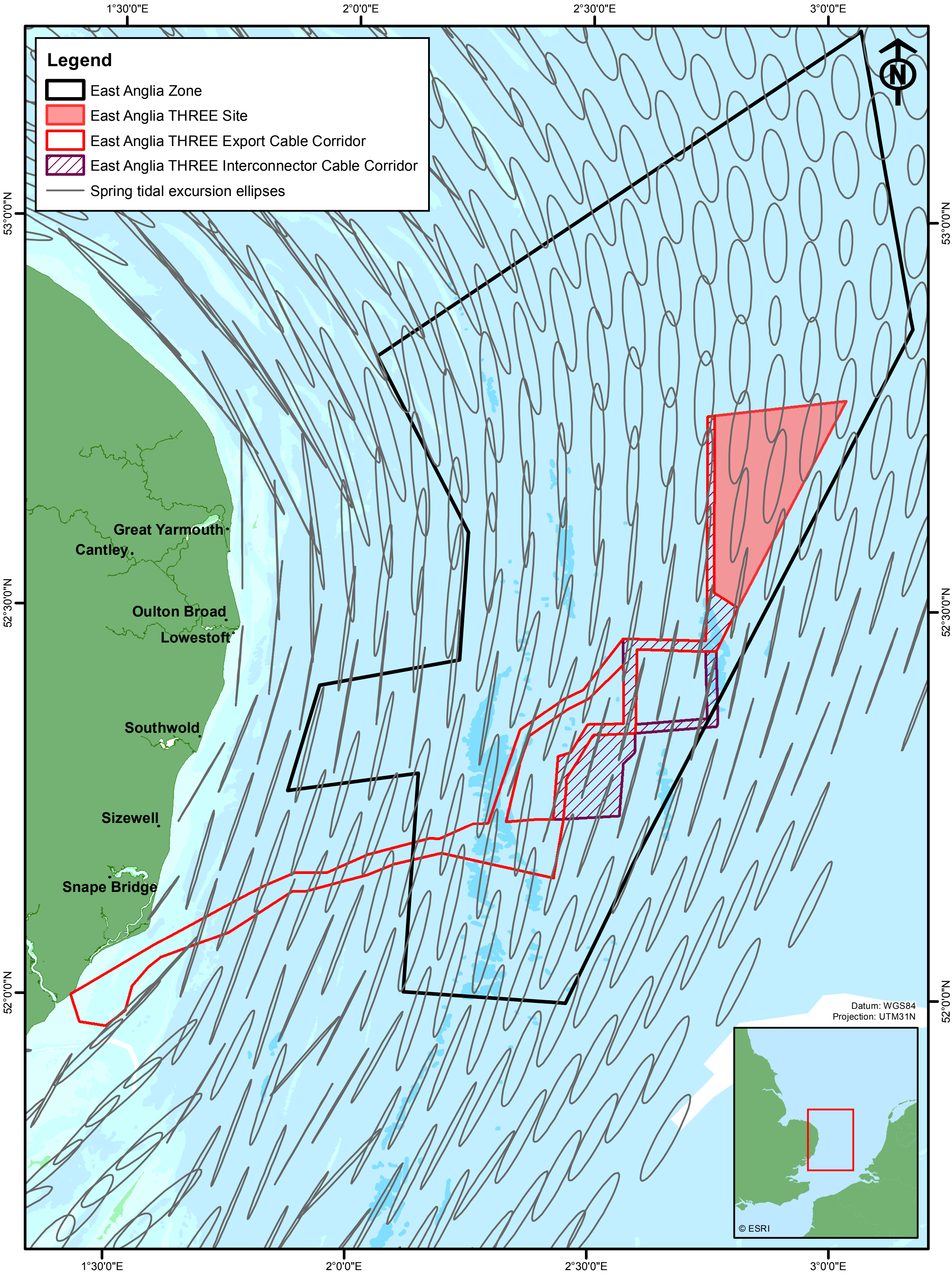
0 2 4 6 nm

Volume 3

Figure 7.2.13

Layout	Date	Rev	Dwg No.
N/A	21/10/2015	2	EA3-O-081

Ref:



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SCOTTISHPOWER RENEWABLES

East Anglia THREE Limited

Tidal Ellipses

Rev	Date	By	Comment
2	21/10/15	AB	Second Issue.
1	07/07/15	BN	First Issue.

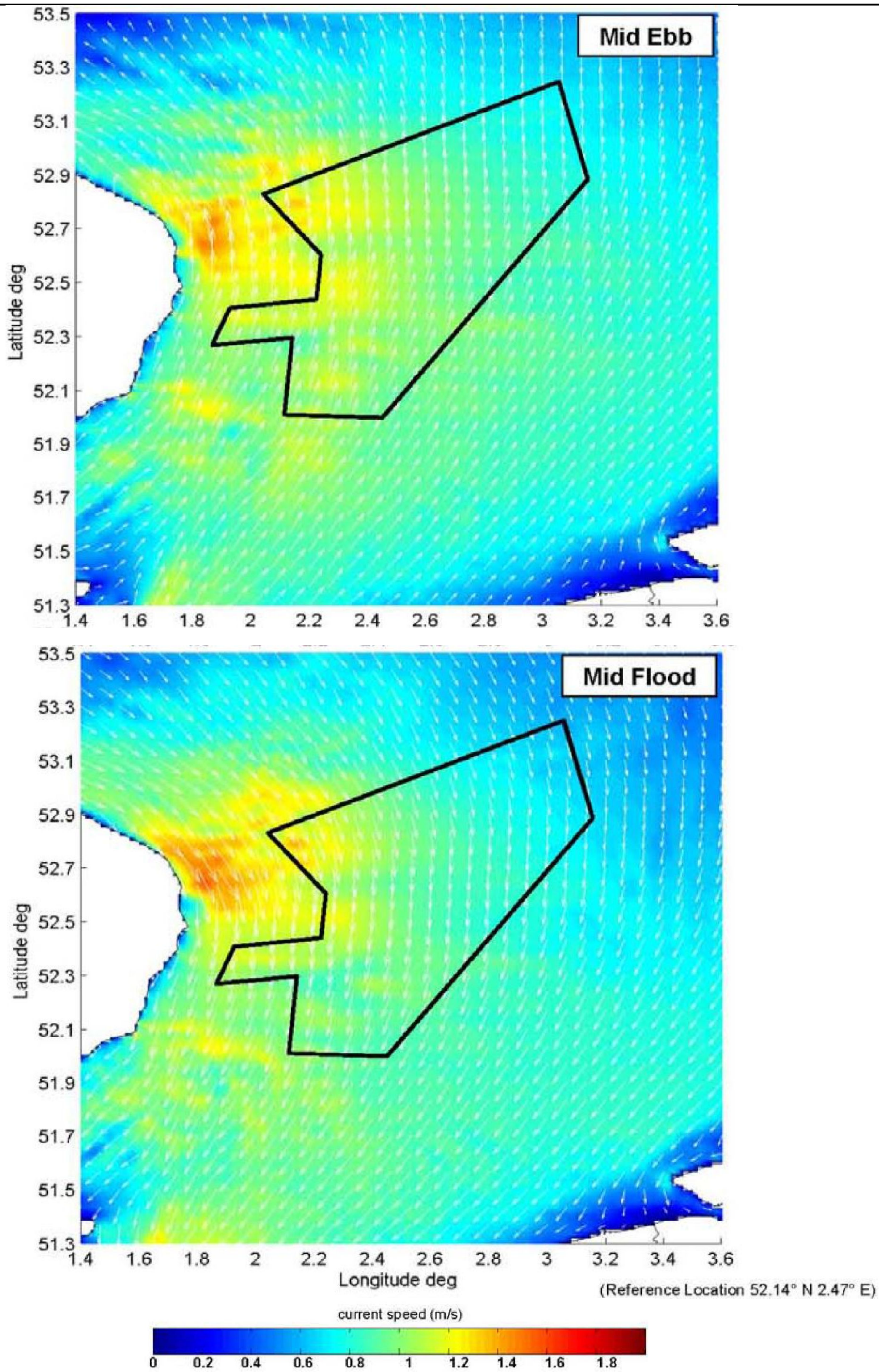
Original A4 Plot Scale 1:750,000

0 5 10 km

0 2 4 6 nm

Volume 3		Figure 7.2.14	
Layout	Date	Rev	Dwg No.
N/A	21/10/2015	2	EA3-O-082

Ref:



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SCOTTISHPOWER RENEWABLES

East Anglia THREE Limited

Modelled Tidal Currents

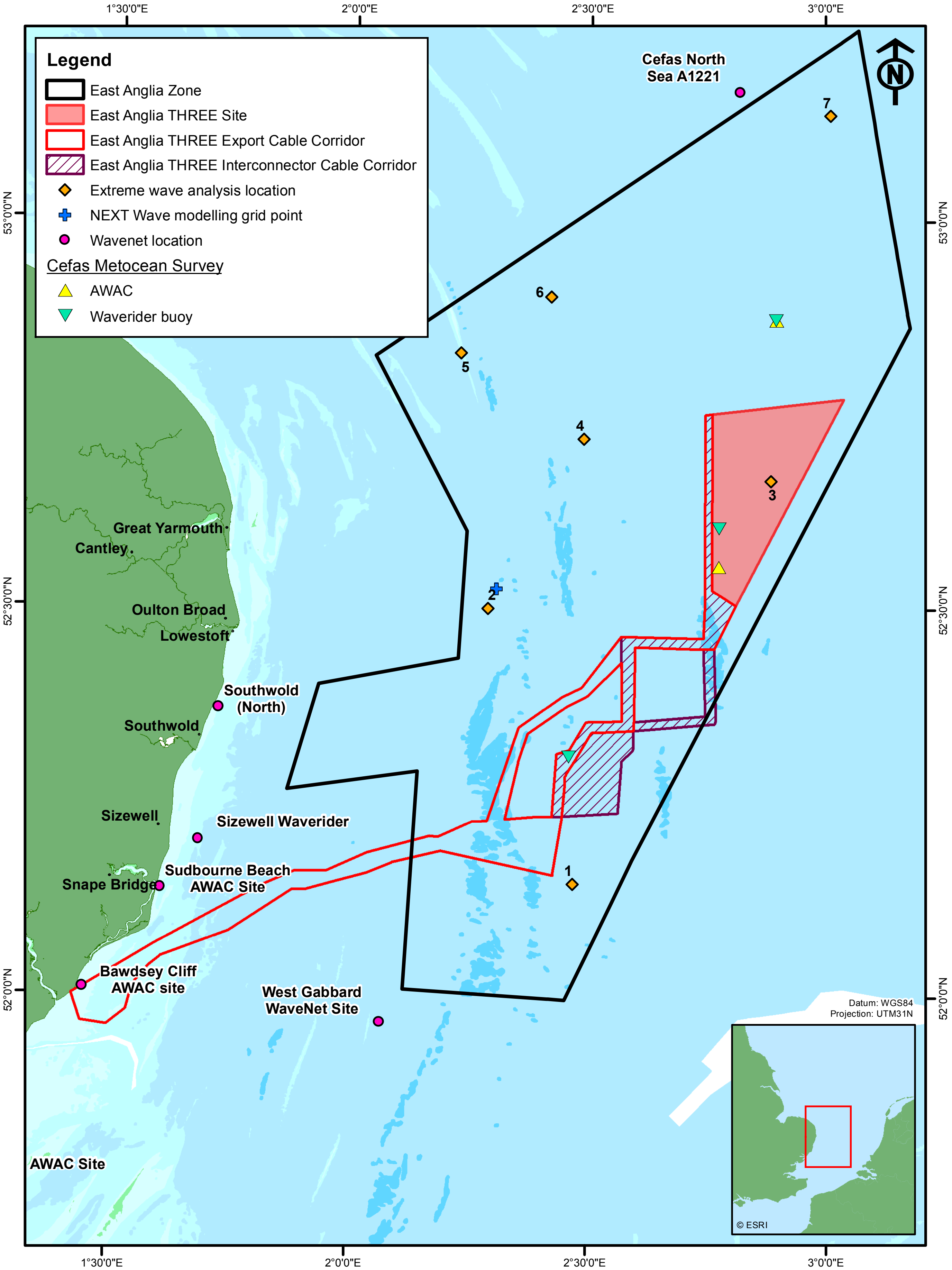
Rev	Date	By	Comment
2	21/10/15	AB	Second Issue.
1	07/07/15	BN	First Issue.

Original A4 Plot Scale

Volume 3 | **Figure 7.2.15**

Layout	Date	Rev	Dwg No.
N/A	21/10/2015	2	EA3-O-083

Ref:



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East Anglia THREE Limited

Sources of wave data

Rev	Date	By	Comment
2	21/10/15	AB	Second Issue.
1	07/07/15	BN	First Issue.

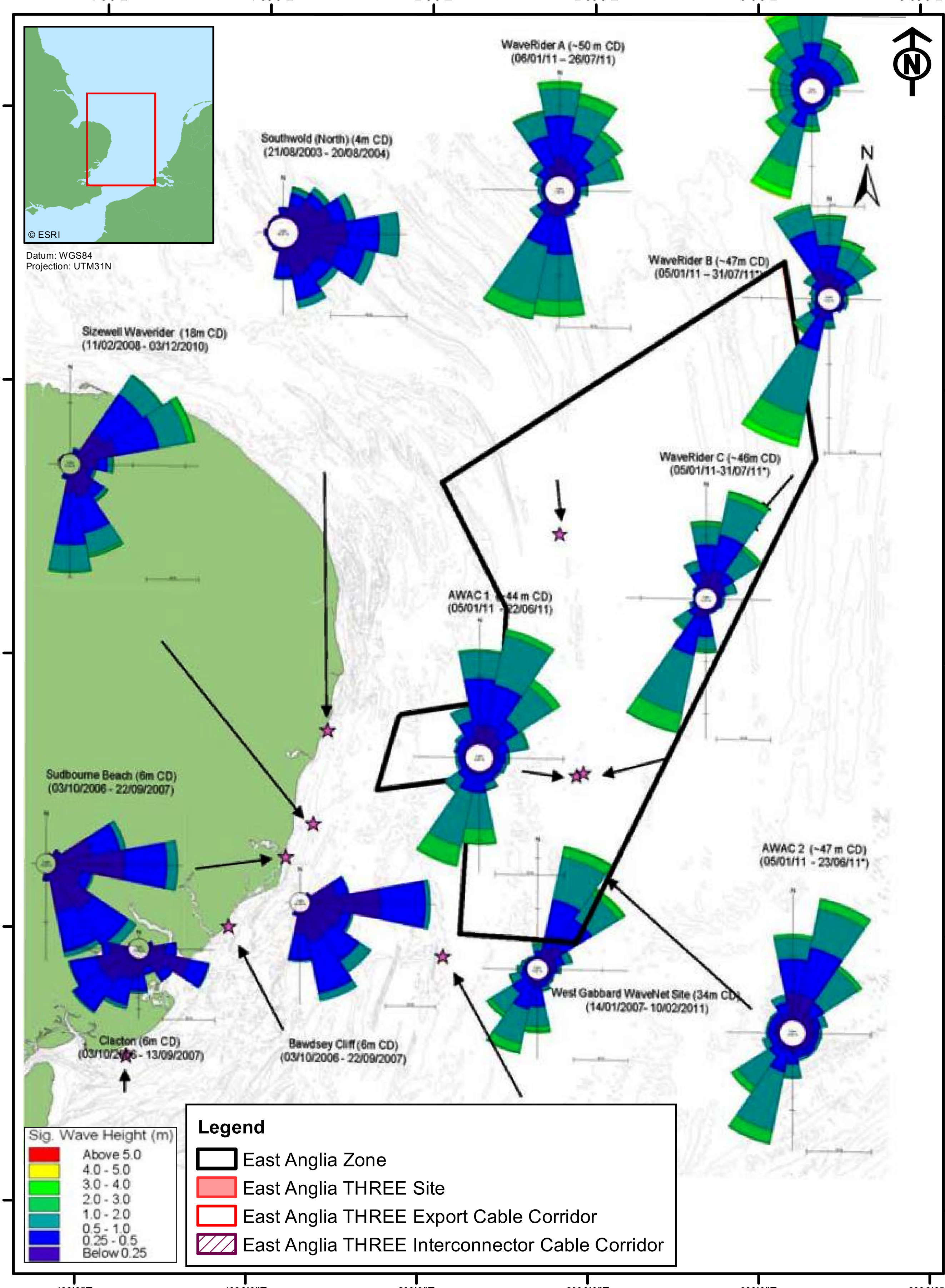
Original A4 Plot Scale 1:750,000

0 5 10 km

0 2 4 6 nm

Volume 3		Figure 7.2.16	
Layout	Date	Rev	Dwg No.
N/A	21/10/2015	2	EA3-O-084

Ref:



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SCOTTISHPOWER RENEWABLES

East Anglia THREE Limited

Wave roses within the East Anglia Zone

Rev	Date	By	Comment
2	21/10/15	AB	Second Issue.
1	07/07/15	BN	First Issue.

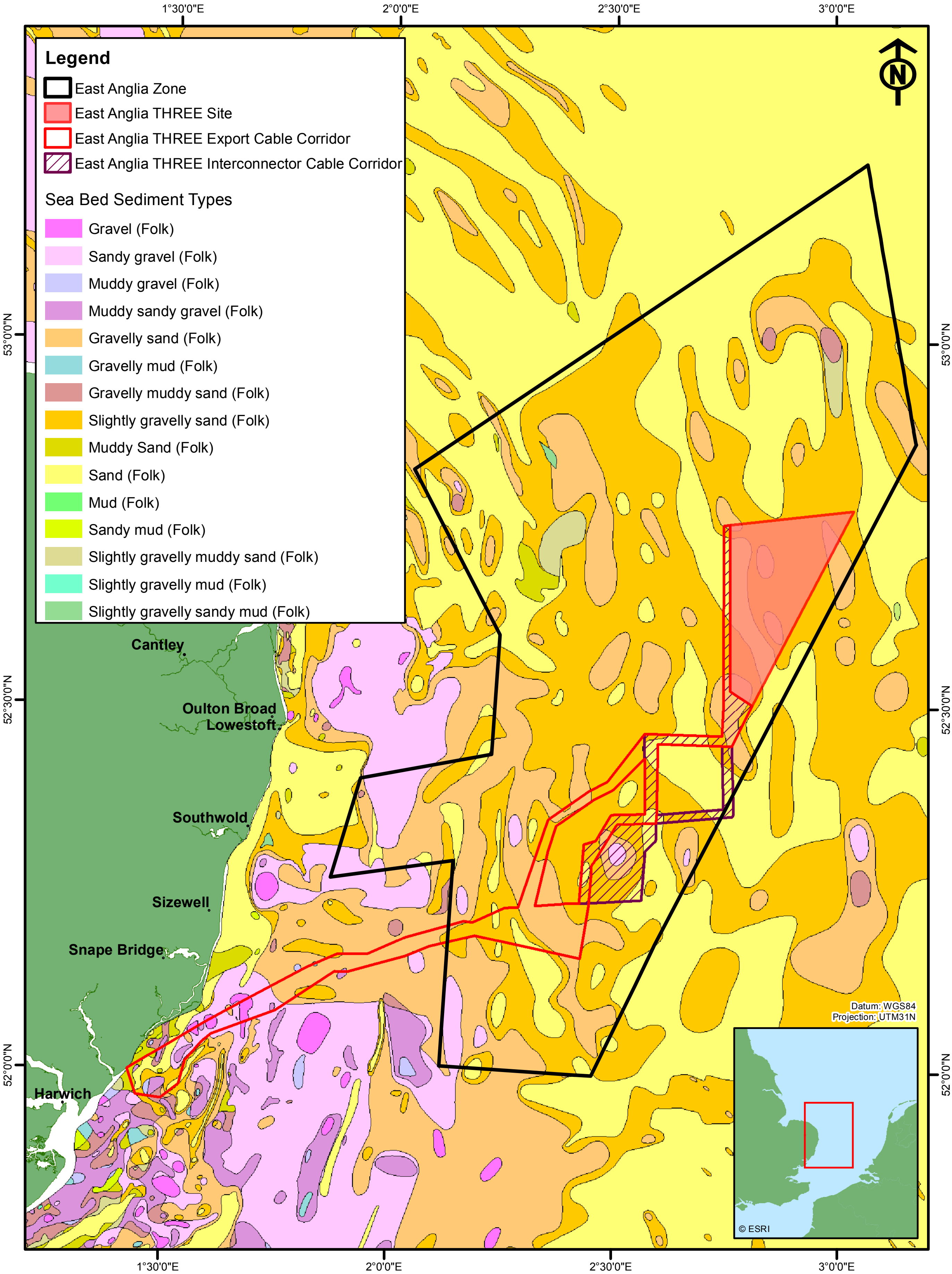
Original A4 Plot Scale 1:1,100,000

0 5 10 km

0 2 4 6 nm

Volume 3		Figure 7.2.17	
Layout	Date	Rev	Dwg No.
N/A	21/10/2015	2	EA3-O-085

Ref:



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SCOTTISHPOWER RENEWABLES

East Anglia THREE Limited

Sea Bed Sediments

Rev	Date	By	Comment
2	21/10/15	AB	Second Issue.
1	13/07/15	BN	First Issue.

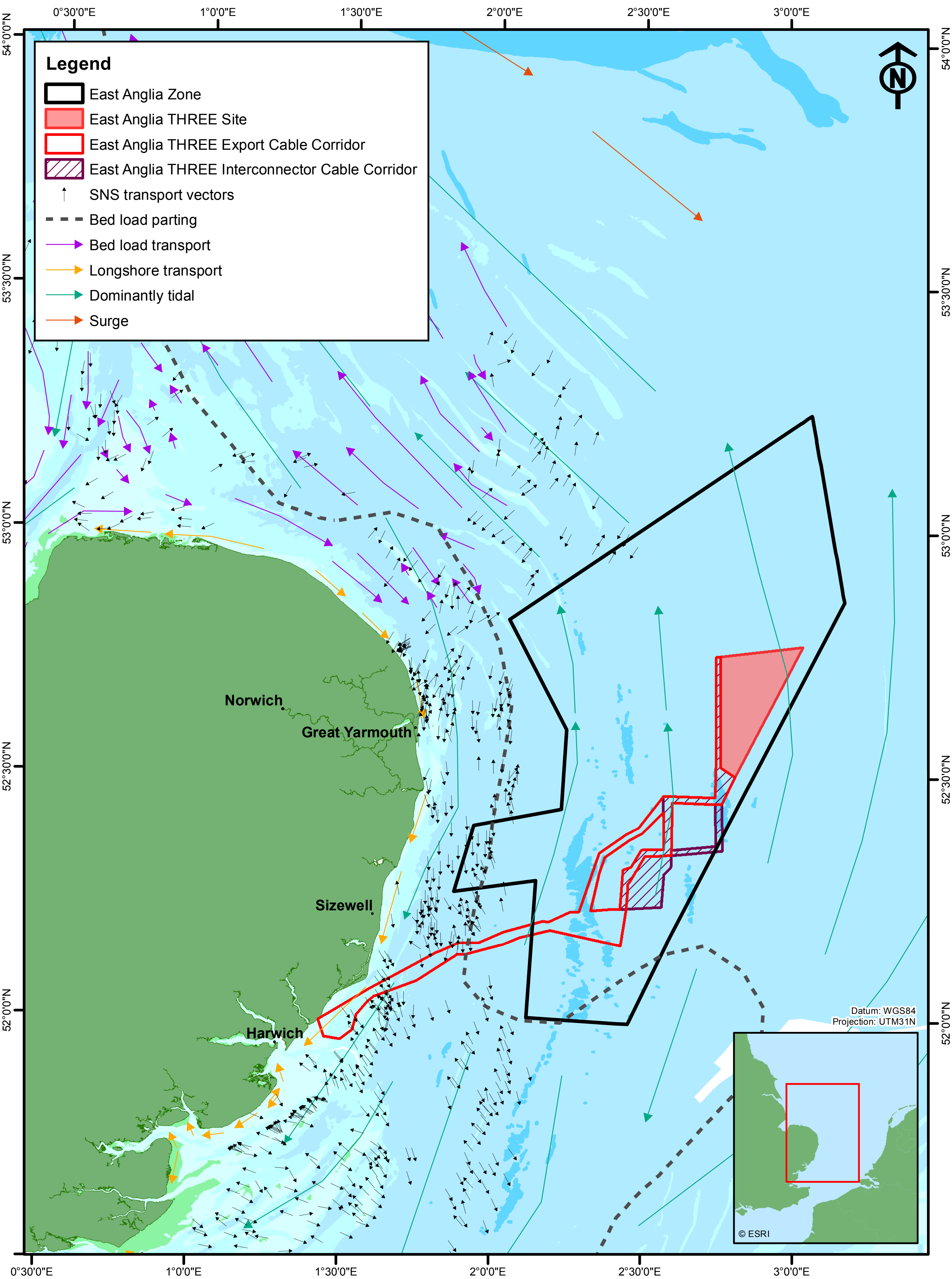
Original A4 Plot Scale 1:800,000

0 5 10 km

0 2 4 6 nm

Volume 3	Figure 7.2.18		
Layout	Date	Rev	Dwg No.
N/A	21/10/2015	2	EA3-O-086

Ref:



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SCOTTISHPOWER RENEWABLES

East Anglia THREE Limited

Sediment Transport Pathways

Rev	Date	By	Comment
2	21/10/15	AB	Second Issue.
1	13/07/15	BN	First Issue.

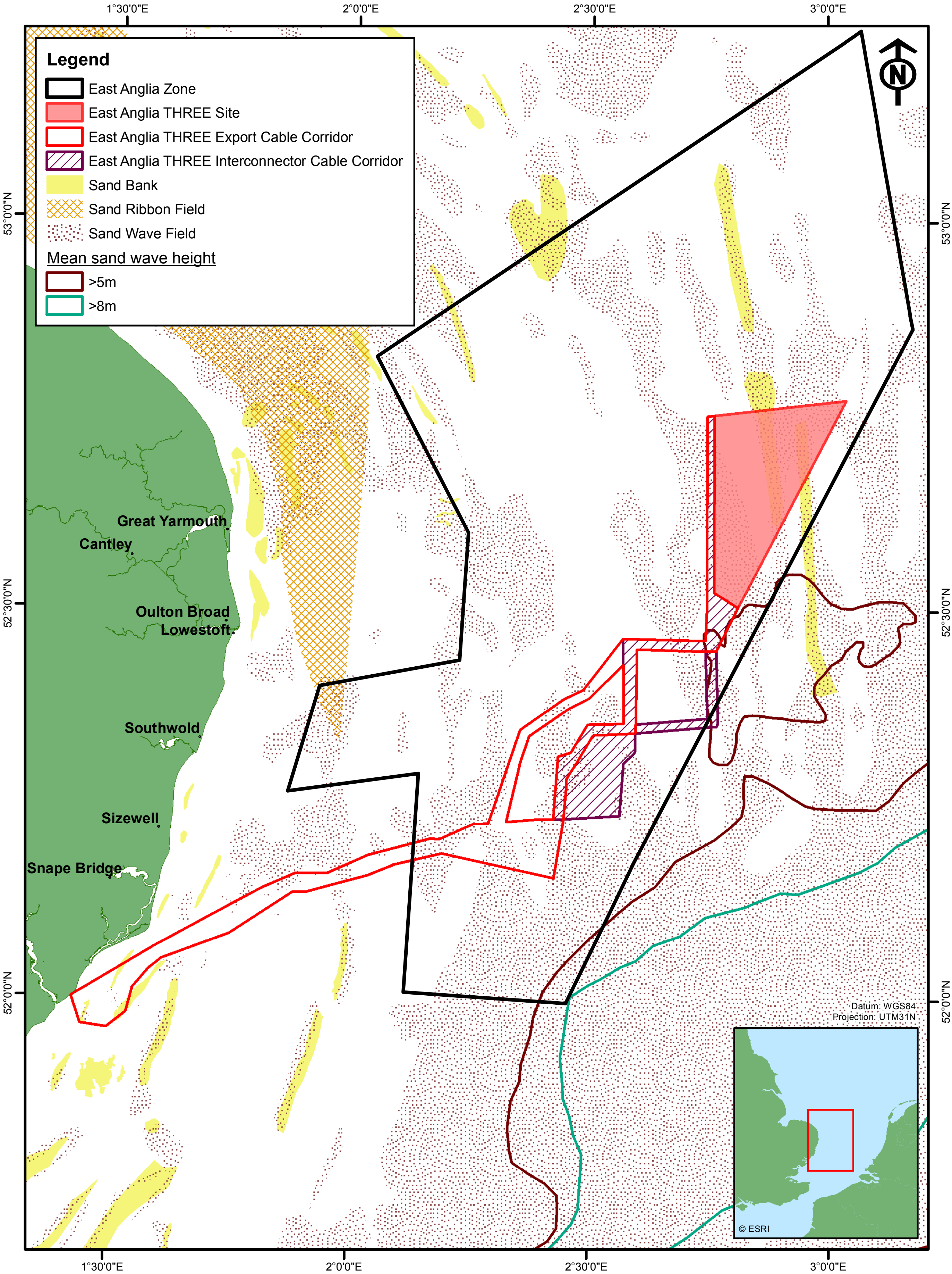
Original A4 Plot Scale 1:1,200,000

0 5 10 km
0 2 4 6 nm

Volume 3 | **Figure 7.2.19**

Layout	Date	Rev	Dwg No.
N/A	21/10/2015	2	EA3-O-087

Ref:



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East Anglia THREE Limited

Active sea bed bedforms

Rev	Date	By	Comment
2	21/10/15	AB	Second Issue.
1	13/07/15	BN	First Issue.

Original A4 Plot Scale 1:750,000

0 5 10 km

0 2 4 6 nm

Volume 3		Figure 7.2.20	
Layout	Date	Rev	Dwg No.
N/A	21/10/2015	2	EA3-O-088

Ref:

Appendix 7.2 Ends Here