Hornsea
Offshore Wind Farm Project One

REPORT

Hornsea Project One Offshore Wind Farm

Review of Geophysical and Bathymetric Data

Prepared	Brandon Mason (MA_BM) 13 February 2017
Checked	Garry Momber (MA_GM) 17 February 2017
Accepted	Ninna Fevre Bertelsen (NINBE), 8 March 2017
Approved	Marc Browne (MBROW), 9 March 2017

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1. Introduction

In February 2015, DONG Energy Wind Power A/S (DE) took full ownership of Hornsea Offshore Wind Farm Project One ("Hornsea Project One"). Hornsea Project One was awarded consent by the Secretary of State (SoS) on 10 December 2014. The Development Consent Order (DCO) was subsequently amended on 30 April 2015 by the Hornsea One Offshore Wind Farm (Correction) Order 2015 and on the 31 March 2016 by the Hornsea One Offshore Wind Farm (Amendment) Order 2016[1]. The undertakers named in the DCO are Heron Wind Limited ("Heron") Njord Limited ("Njord") and Vi Aura Limited ("Vi Aura") (the Project One companies[2]). Maritime Archaeology Ltd has been commissioned by Hornsea Project One "the Client" to conduct a review of AEZs (Archaeological Exclusion Zones) previously identified within the Hornsea Project One Offshore Wind Farm by archaeological contractors.

The focus of this report is the review of selected AEZs within the project site and the offshore export cable. Twelve locations are discussed in this report that lie within, or in proximity to, the current development footprint (Figures 1 and 2). The review of newly acquired geophysical data is intended to provide the most accurate positioning and extent of AEZs to ensure that they are optimised and provide adequate protection to any features of archaeological potential without unnecessary hindrance to development of the project

The project has been undertaken in accordance with the guidance contained in *Model Clauses for Written Schemes investigation – Offshore Renewables Projects* (The Crown Estate, 2010) and the existing Archaeological *Written Scheme of Investigation* (WSI) (Maritime Archaeology Ltd, 2016).

1.1 Brief Scheme Background

The Hornsea Project One DCO grants development consent for, and authorises DE to construct, operate and maintain a 1,200 Megawatt (MW) offshore wind farm project that will consist of up to 174 (7MW) wind turbine generators (WTGs) and will be located 120km off the Yorkshire coast, covering an area of approximately 407 square kilometres. The Hornsea Project One DCO also grants four deemed Marine Licences (dMLs) for the marine licensable activities, these being the deposit of substances and articles and the carrying out of works involved in the construction of the generating station and associated development. The offshore cable route extends from the proposed landfall at Horseshoe Point in Lincolnshire, offshore in a north-easterly direction to the southern boundary of the Project. The route is approximately 150 km in length.

DE took over full ownership of Hornsea Project One on 4th February 2015 following years of development alongside SMart Wind. Following the Final Investment Decision (FID) announced in February 2016, DE will now develop Hornsea Project One through into construction and operation. . Onshore construction of the project started early 2016 with offshore construction beginning in Q1 2018. HDD landfall construction is planned early 2017.

[1] A further non material amendment application and an application to vary the deemed marine licences numbered 1, 2 and 3 were submitted to the Secretary of State and the Marine Management Organisation respectively in July 2016. The applications are currently being determined and relates to two changes to the DCO and deemed Marine Licences 1, 2 and 3 (1) an increase to the name plate capacity of the wind farm to increase it from 1200MW to 1218MW and (2) changes to the coordinates of the internal boundaries between each wind farm area namely Work Number 1, Work Number 2 and Work Number 3. Details of this non material amendment application can be found on the Planning Inspectorate website https://infrastructure.planninginspectorate.gov.uk/projects/yorkshire-and-the-humber/hornsea-offshore-wind-farm-zone-4-project-one

[2] Heron and Njord are owned 100% by DONG Energy Wind Power A/S ("DONG Energy"). Vi Aura is owned 100% by Heron

1.2 Aims and Objectives

The main aim of the project is the review of AEZs based on newly acquired (2016) geophysical survey data, with a view to their alteration (being enlarged, reduced, moved or removed (The Crown Estate, 2010)) in order to provide the most appropriate mitigation for the archaeological feature and for the Project.

This has been achieved through the completion of the following objectives:

i. Post-processing and setup of data projects for the following data types:
   - Side scan sonar imagery
   - Multibeam echosounder bathymetry
   - Magnetometer data

ii. Review of 12 AEZs highlighted by the Client as being within or in proximity to the current development footprint using 2016 data;

iii. Comparison with previous geophysical data review result;

iv. Formulation of updated mitigation recommendations;

1.2.1 Archaeological DCO Conditions

This project has been conducted in accordance with parts iii, iv, and v of Schedule 8-11, Condition 13 (2)(g) of the Deemed Marine Licenses (DML) 1- 4 in relation to the offshore Order limits under the auspices of the archaeological WSI:

> *A written scheme of archaeological investigation in relation to Wind Farm Area 1, 2, 3 & offshore order limits in accordance with industry good practice to include—*
> *(i) details of responsibilities of the licence-holder, archaeological consultant and contractor;*
> *(ii) a methodology for any further site investigation including any specifications for geophysical, geotechnical and diver or remotely operated vehicle investigations;*
> *(iii) analysis and reporting of survey data to be submitted to the MMO within four months of survey completion;*
> *(iv) delivery of any mitigation including, where necessary, archaeological exclusion zones;*
> *(v) monitoring during and post construction, including a conservation programme for finds;*
> *(vi) archiving of archaeological material; and*
> *(vii) a reporting and recording protocol, including reporting of any wreck or wreck material during construction, operation and decommissioning of the authorised scheme;*

1.3 Previous Work in Relation to Hornsea Project One AEZs

An offshore marine archaeological impact assessment report (SMart Wind, 2013a), a Technical Report (SMart Wind, 2013b) and a geophysical data assessment (MA Ltd, 2015), as well as Written Schemes of Investigation (OFTO: DONG Energy, 2016a; Non-OFTO: DONG Energy, 2016b), have been produced that identify the known and potential archaeology within the development area, review potential impacts, and put forward mitigation proposals.

As a result of the archaeological work listed above, there exist a total of 47 AEZs currently in place at Hornsea Project One (28 within the Project Site and 19 within the export cable route corridor).

The following AEZs have been reviewed using 2016 geophysical and bathymetric data in this report (Table 1):

Table 1: List of AEZs reviewed during this project.

LOT Number (Location)	ID
3 (Export Cable)	70008
3 (Export Cable)	70045
3 (Export Cable)	70088
3 (Export Cable)	70116
3 (Export Cable)	70122
3 (Export Cable)	70157
3 (Export Cable)	70159
3 (Export Cable)	70183
1&2 (WTG)	71035
1&2 (WTG)	71029
1&2 (WTG)	70605
1&2 (AC)	70589

2. Methodology

MA Ltd has undertaken a review of the newly acquired high frequency side scan sonar, multibeam echo-sounder bathymetry and magnetometer data, compared against the existing baseline and geophysical data, compiled during the assessment of the initial Hornsea Subzone One environmental impact assessment.

2.1 Data Specification

The geophysical data from 2016 were acquired by two contractors, Bibby HydroMap (export cable route, inter-link cable routes, substations) and Fugro (WTG positions and inter-array cable routes).

All data were received in the ETRS89 UTM 31N coordinate reference system.

2.1.1 Side scan sonar (SSS)

Bibby HydroMap deployed an Edgetech 4200 dual frequency digital high resolution side scan sonar system comprising a digital tow fish and a transceiver processor unit (TPU) interfaced to a CODA DA4G geophysical data acquisition system running Coda GeoSurvey acquisition software. The tow fish positioning was carried out using the USBL system onboard which calculated a range and bearing to a beacon installed on the tow cable (1m from the tow fish) relative to a known vessel offset.

Over 200% coverage was achieved allowing targets to be identified on more than one survey line and the centres of each swath to be covered. Side scan sonar line spacing was 14 metres and an operating range of 35 metres was utilised. The fish was towed at an optimum height (for the range of 35 metres) of approximately 3.5-5 metres above the seabed.

Fugro also utilised an Edgetech 4200 system at 400/900 kHz and the high frequency channel (900 kHz) was used for this survey. The side scan sonar was positioned using a USBL beacon; all positions were applied to the data during online acquisition.

All Fugro data were processed within SonarWiz software where gain settings, bottom tracking and layback were applied to each surveyed line. The files were amalgamated into mosaic tiles and exported as a GeoTIFF at 0.1 m cell size for plotting in GIS. Overview GeoTIFF tiles were also produced at 1.0 m cell size.

2.1.2 Multibeam echo sounder bathymetry (MBES)

Bibby HydroMap utilised “Two Reson SeaBat 7125 multibeam echo sounders to collect bathymetry data within the survey area. Within the transducer mounting a sound velocity sensor was fitted to provide real-time SV values. The system was interfaced with the iXBlue Hydrins to provide timing and motion data to the collected bathymetry data. The MBES and peripheral sensors were interfaced to QPS QINSy, which stored and visualised the data during acquisition” (Bibby HydroMap Ltd, 2016).

Fugro utilised three different survey vessels: “on *Victor Hensen*, a dual-head Teledyne RESON 7125 MBES was mounted on the hull of the vessel. Attitude, time and sound velocity were interfaced into the RESON topside processor unit to aid in their operation. A Valeport mini SVS sensor was attached to the hull at the water depth of the multibeam transducers and a Valeport SVP was deployed to measure the sound velocity of the water column, prior to the start of survey operations and at regular intervals.

On Fugro Frontier, a dual-head R2Sonic 2024 MBES was mounted on a moon pool frame on the vessel. Attitude, time and sound velocity were interfaced into the R2Sonic topside processor unit to aid in their operation. A Valeport mini SVS was mounted near the multibeam transducers and a Minos X SVP was deployed to measure the sound velocity of the water column, prior to the start of survey operations. A Valeport mini SVS was mounted to the sidescan sonar and used in place of the Minos X SVP during operations to ensure rapid collection of sound velocity profiles.

On Fugro Helmert, a Kongsberg EM2040 MBES was permanently mounted on the hull of the vessel. Attitude, time and sound velocity were interfaced into the EM2040 topside processor unit to aid its operation. An AML Micro-X SV sensor was located in a moon pool pipe at the water depth of the multibeam transducer. An AML SV&P mounted on the Moving Vessel Profiler (MVP) system was deployed to measure the sound velocity of the water column, prior to the start of survey operations and at regular intervals” (Fugro, 2016).

2.1.3 Magnetometer (MAG)

Fugro and Bibby HydroMap deployed magnetometer arrays in various setups, The maximum distance between the sensors was 5 meters and the components were marine Caesium vapour Geometrics G-882 magnetometers with altimeters capable of recording variations in magnetic field strength with sensitivity up to 0.02 nT/m.

2.2 Data Processing (MA Ltd)

2.2.1 Side scan sonar (SSS)

Side scan sonar data was received for the relevant survey blocks where the 12 AEZs are positioned and were imported into SonarWiz 5 with five lines selected at random for the purpose of quality checking. Gain threshold were analysed on the sample data and were used to determine the import gain parameters. Following import, empirical gain normalisation was performed on pre-bottom-tracked data, with the results being applied to all values. Each survey block was established as a separate project. No other optimisations were required.

2.2.2 Multibeam echo sounder bathymetry (MBES)

Ungridded xyz data were received for all relevant survey blocks. The data were gridded using DMagic, part of the Fledermaus suite, and were exported to ArcGIS Grids for visualisation and synthesis in ArcMap at 0.5m grid size. Further 3D visualisation and measurements were undertaken in Fledermaus where required.

2.2.3 Magnetometer (MAG)

Magnetometer data were received as processed gridded data for all relevant survey blocks. These were imported and visualised in ArcGIS for synthesis with the other related datasets. No further processing was required in order to analyse this data.

2.3 Archaeological Review

Shapefiles of the centres and extent of each of the 12 AEZs under review were imported into the projects listed above and were further examined in ArcGIS. Analysis of each feature using each data set was compiled in tabular form, including metric observations, and interpretation by a qualified and experienced marine archaeologist.

As well as the specific feature, notes were also taken on the sediment type of the surrounding seabed with and well beyond the limits of the existing AEZ in order to understand the potential for material movement and feature burial or further exposure in the intervening period between surveys.

Information regarding data coverage was also recorded, and where no contact was observed in areas of good coverage this was also detailed.

2.4 Mitigation

Based on the analytical and interpretative process detailed above, recommendations regarding each AEZ were formulated, where possible. Where survey data did not cover the recorded target position, not changes to existing AEZ have been presented as there is no basis for understanding positional accuracy, significance, potential or change between surveys.

Where sufficient data enabled a clear and well-founded interpretation, recommendations for the alteration of AEZs in line with *Model Clauses for Written Schemes of Investigation* (The Crown Estate, 2010), have been proposed. Such recommendations are intended to provide better in situ protection to features with archaeological potential while relieving pressure on the scheme development.

3. Results

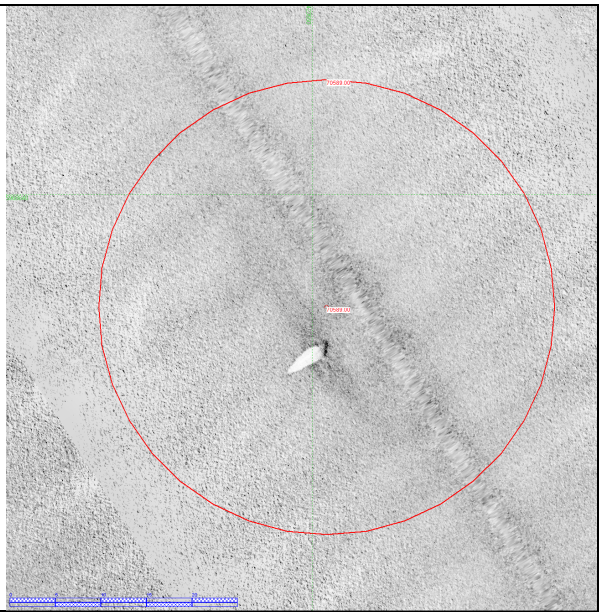
3.1 Data Quality Assessment

Five side scan sonar lines were selected at random and were assessed in terms of data quality and were clearly very good. All data reviewed for this project were of good quality, and all sonar lines were well positioned with seabed features closely aligned on adjacent lines in the final mosaics. Side scan sonar overage ranged from 300 – 900 % on all AEZs where the target position was covered. Similarly the MBES data reviewed was all of good quality and facilitated a successful archaeological interpretation.

3.2 AEZs Reviewed within the Project Site

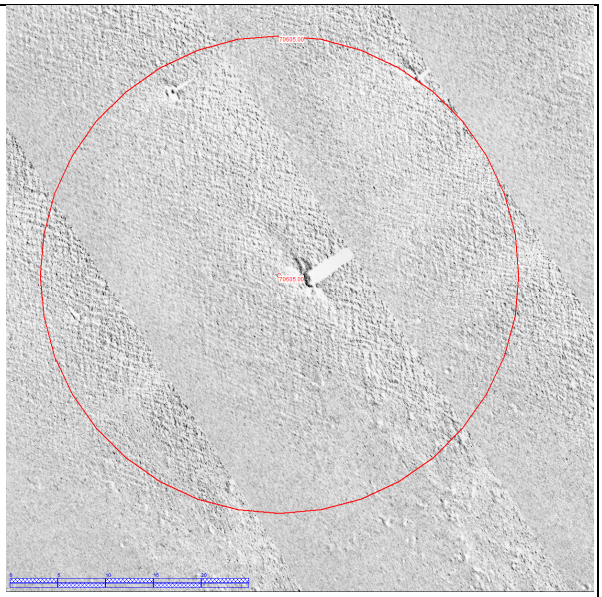
3.2.1 WA70589, 25m AEZ

ID	WA70589
2016 data coverage	100% all data.
Survey block	B51
Original description	Large irregular reflector. Probable anthropogenic material.
SSS	Linear hard reflector measuring 2 x 1 x 0.9 m, standing well proud of the seabed.
MBES	Matching contact, 5m diameter scour, 0.2m deep.
MAG	No magnetic anomaly.
Interpretation	**Closely matches original observation and position.**



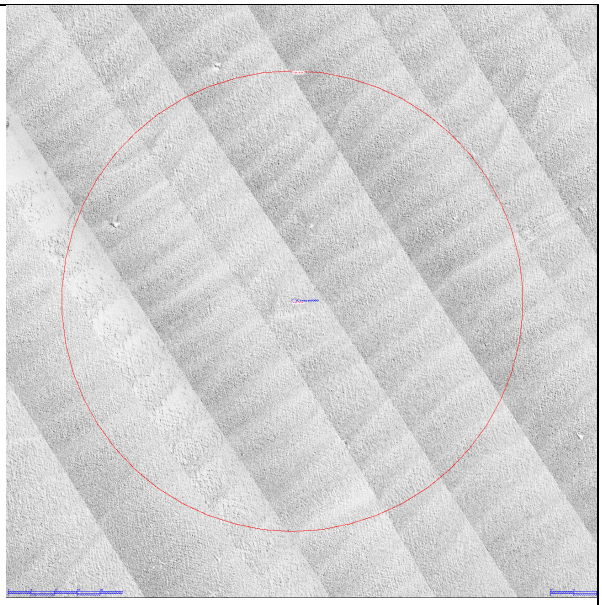
3.2.2 WA70605, 25m AEZ

ID	WA70605
2016 data coverage	100% all data.
Survey block	B066
Original description	Contact located 2.85m from AEZ centre, clearly observed on all three coincident survey lines.
SSS	Curvi-linear hard reflector, probable anthropogenic origin. 4.1 x 1.3 x 0.5m. AEZ also covers smaller possibly related feature 23m N.
MBES	Raised object in slight circular scour feature c. 5m in diameter, 0.1m deep scour.
MAG	Amplitude 18.3 nT monopole anomaly.
Interpretation	**Closely matches original observation and position.**



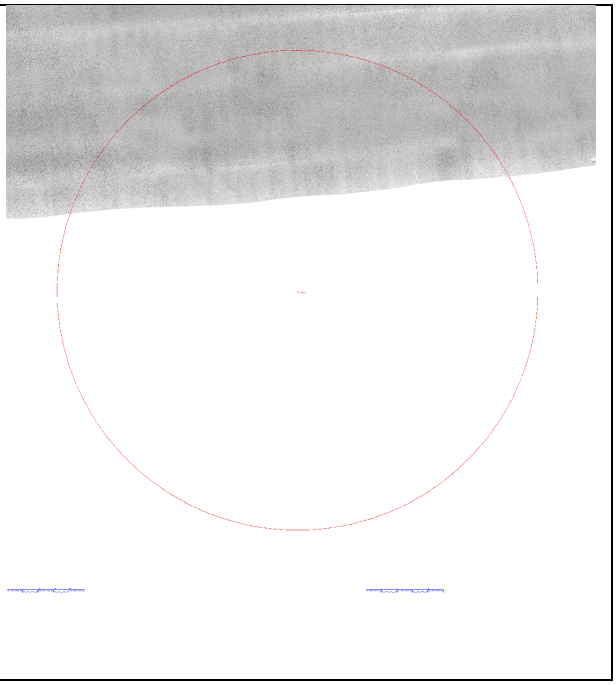
3.2.3 WA71029, 50m AEZ

ID	WA71029
2016 data coverage	100% all data.
Survey block	B110
Original description	Location of two recorded obstruction, approx. 10m apart and possibly referring to the same object. Not identified by Emu in their geophysical data.
SSS	Nothing observed on five sonar lines at this location. Small boulder, 17m N and 41m WNW, < less than 0.5m.
MBES	No contact observed, area of raised sand waves.
MAG	No magnetic anomaly.
Interpretation	**DEAD, not observed on repeat survey, no magnetic signature.**



3.2.4 WA71035, 150m AEZ

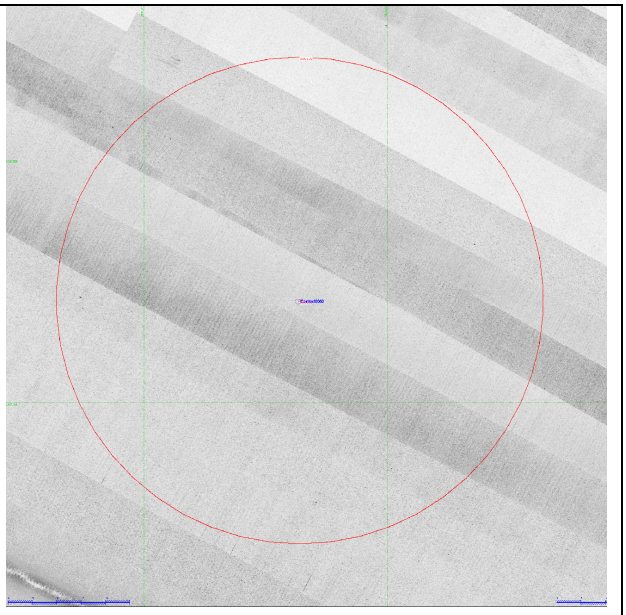
ID	WA71035
2016 data coverage	c. 25% SSS, 20% MBES, 20% MAG, target missed, south of survey lines.
Survey block	B25
Original description	Distinct wreck site. Acoustic and magnetic signatures suggest this is a metal wreck with several large flat sections, some of which appear to be the result of outwards collapse. Associated with a recorded wreck site.
SSS	No coverage of recorded target position.
MBES	No data over recorded target position.
MAG	No data over recorded target position.
Interpretation	**No new interpretation**.



3.3 AEZs Reviewed within the Export Cable Route Corridor

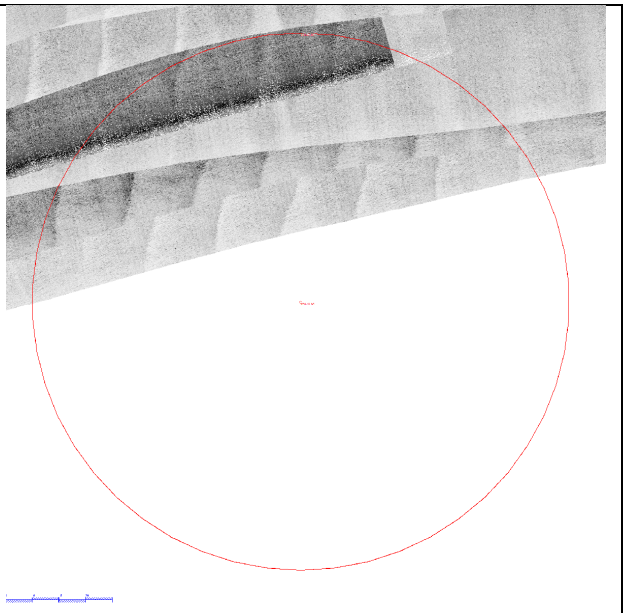
3.3.1 WA70008, 50m AEZ

ID	WA70008
2016 data coverage	100% SSS, c. 10% MBES, 100% MAG.
Survey block	Block 1
Original description	Distinct elongate dark reflector with well-defined shadow located at the edge of a natural seabed feature. Associated with a large magnetic anomaly identified on a number of survey lines. Probable piece of ferrous debris.
SSS	No anomaly observed across nine lines of overlapping data. Data is of good quality. Flat sand.
MBES	No data over recorded target position
MAG	High amplitude anomaly within original AEZ, though new data shows that the feature extends further ESE over a 70m long area.
Interpretation	**No new interpretation.**



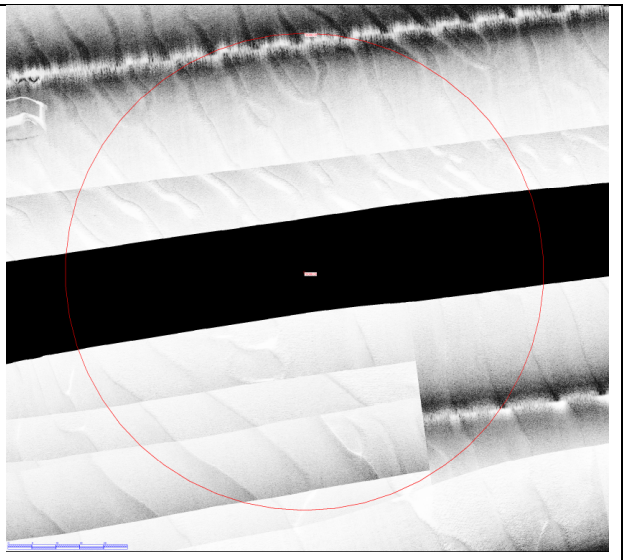
3.3.2 WA70045, 50m AEZ

ID	WA70045
2016 data coverage	c. 30% SSS, 10% MBES, 15% MAG, target missed, south of survey.
Survey block	Block 2
Original description	Very large, distinct, bur broad and complex magnetic anomaly identified on a number of survey lines. No associated side scan sonar or multibeam bathymetry anomaly. Located approximately 40m SE of a recorded obstruction, also recorded to be the location
SSS	No coverage of recorded target position. Adjacent lines within northern limits of AEZ show no features.
MBES	No data over recorded target position.
MAG	No data over recorded target position.
Interpretation	**No new interpretatio**n.



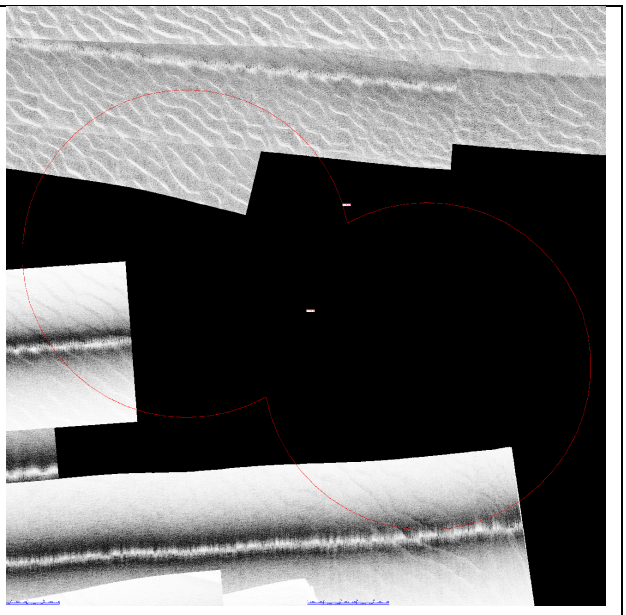
3.3.3 WA70088, 50m AEZ

ID	WA70088
2016 data coverage	c. 60% SSS, 10% MBES, 30% MAG, target missed, between lines.
Survey block	Block 2
Original description	Large, distinct magnetic anomaly without an associated side scan sonar or multibeam bathymetry contact, identified on more than one survey line. Possible large piece of buried ferrous debris.
SSS	No coverage of recorded target position. Adjacent lines north and south within limits of AEZ demonstrate sand wave migration.
MBES	No data over recorded target position
MAG	No data over the target position, though high amplitude anomalies are located directly north and south within the limits of the AEZ's outer extent.
Interpretation	**No new interpretation.**



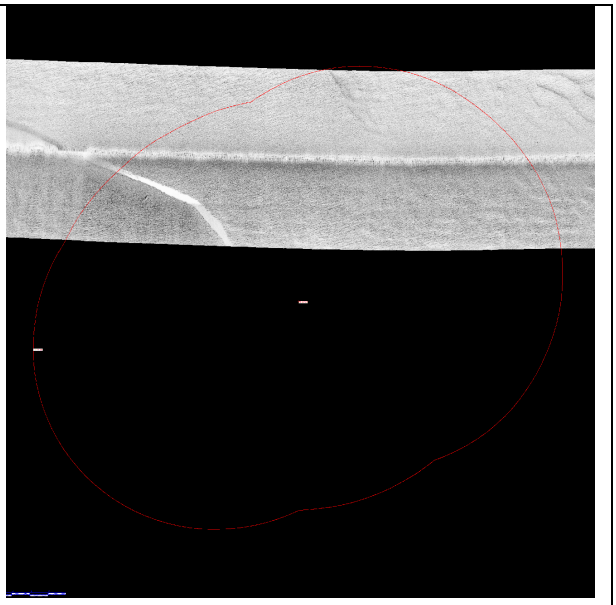
3.3.4 WA70116, 80 x 100m AEZ

ID	WA70116
2016 data coverage	c. 15% SSS, 5% MBES, 15% MAG, target missed, east of survey.
Survey block	Block 2
Original description	Large, distinct magnetic anomaly without an associated side scan sonar or multibeam bathymetry contact, possibly identified on two survey lines. Possible large piece of ferrous debris. Part of an area of approximately 11 similar magnetic anomalies.
SSS	No coverage of recorded target position.
MBES	No data over recorded target position
MAG	No data over recorded target position.
Interpretation	**No new interpretation.**



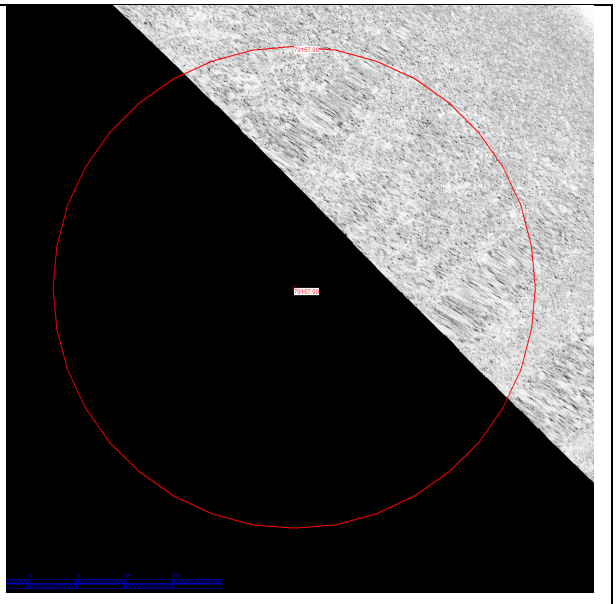
3.3.5 WA70122, 110 x 150m

ID	WA70122
2016 data coverage	c. 40% SSS, 5% MBES, 15% MAG, target missed, south of survey.
Survey block	Block 2
Original description	Previously unrecorded wreck identified by all geophysical equipment. Structure is almost completely buried within an area of sand waves and is poorly defined on both side scan sonar and multibeam bathymetry data. Possibly the Vasco
SSS	No coverage of recorded target position. Adjacent lines within northern limits of AEZ show no features.
MBES	No data over recorded target position.
MAG	No data over the target position, though high amplitude anomalies are located directly north and to the south-west within the limits of the AEZ's outer extent.
Interpretation	**No new interpretation.**



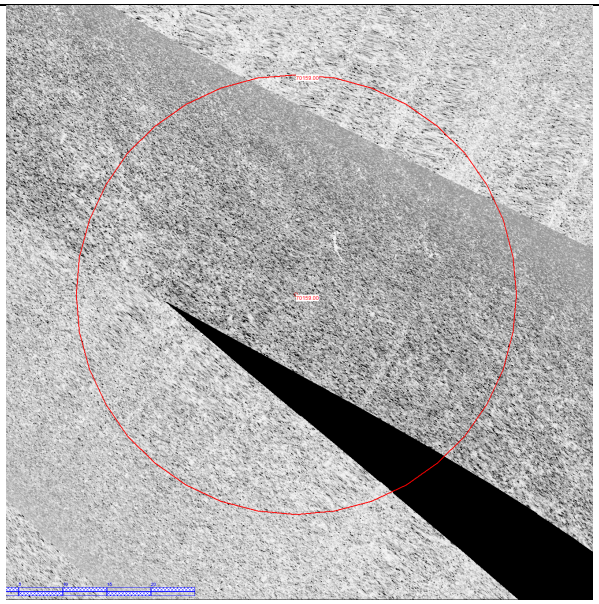
3.3.6 WA70157, 25m AEZ

ID	WA70157
2016 data coverage	c. 30% SSS, 10% MBES, 20% MAG, target missed, south of survey lines.
Survey block	Block 5
Original description	Isolated, high magnetic return indicating ferrous material.
SSS	No coverage of recorded target position. Adjacent lines within north-eastern limits of AEZ show no features.
MBES	No data over recorded target position
MAG	No data over recorded target position.
Interpretation	**No new interpretation.**



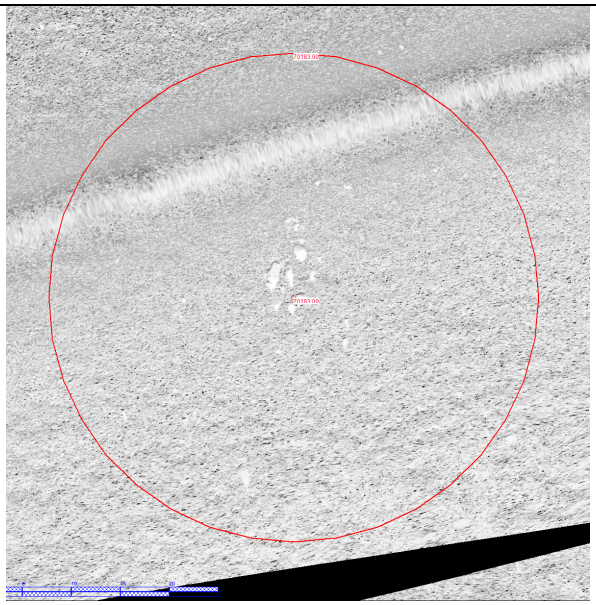
3.3.7 WA70159, 25m AEZ

ID	WA70159
2016 data coverage	c. 90% SSS, 30% MBES, 50% MAG.
Survey block	Block 5
Original description	Isolated, high magnetic return indicating ferrous material.
SSS	Small linear reflector located 5m north of the recorded position, 3.4 x 0.5 x 0.1 m.
MBES	No data over recorded target position
MAG	No identifiable anomaly in large area (500m+) of magnetic disturbance.
Interpretation	**No new interpretation.**



3.3.8 WA70183, 25m AEZ

ID	WA70183
2016 data coverage	100% SSS, c. 25% MBES, 30% MAG.
Survey block	Block 6
Original description	Area of irregular reflectors with associated shadows and scour. Probable anthropogenic material.
SSS	Scattered area of reflectors over 21 x 15 m area, fully contained within the centre of the AEZ.
MBES	No data over recorded target position
MAG	No data over recorded target position or anomaly seen in northern part of AEZ with coverage.
Interpretation	**No new interpretation.**



4. Mitigation Recommendations

Table 2 details the results of the data review and the recommended mitigation. The current list of all AEZs for Hornsea Project One following this review is provided in Appendix I and the full results for each AEZ reviewed by data type can be found in Appendix II.

Table 2: Mitigation recommendations for AEZ reviewed February 2017.

LOT Number (Location)	WA ID	Area	Recommendation	AEZ extent
3 (Export Cable)	70008	Block 1	Move AEZ 21.5m ESE, new position 307499, 5933758 (WGS84 UTM 31N).	50m radius
3 (Export Cable)	70045	Block 2	Maintain AEZ in current position.	50m radius
3 (Export Cable)	70088	Block 2	Maintain AEZ in current position.	50m radius
3 (Export Cable)	70116	Block 2	Maintain AEZ in current position.	50m radius
3 (Export Cable)	70122	Block 2	Maintain AEZ in current position.	110 x 150m
3 (Export Cable)	70157	Block 5	Maintain AEZ in current position.	25m radius
3 (Export Cable)	70159	Block 5	Maintain AEZ in current position.	25m radius
3 (Export Cable)	70183	Block 6	Maintain AEZ in current position.	25m radius
1&2 (AC)	70589	B51	Maintain AEZ in current position.	25m radius
1&2 (WTG)	70605	B066	Maintain AEZ in current position.	25m radius
1&2 (WTG)	71029	B110	Remove AEZ	25m radius
1&2 (WTG)	71035	B025	Maintain AEZ in current position.	150m radius

4.1 AEZs Amended

Mitigation for one feature has been amended following the review of 2016 geophysical and bathymetric data.

WA70008 is located at the nearshore area of the cable route, between the northern and central cable routes. Based on the orientation and distribution of the large spread of magnetic anomalies consistently observed but now clearly gridded to demonstrate the larger extent, it is recommended that the existing AEZ is moved east-south-east by 25 m and the size of 50 m radius maintained (Figure 2).

4.2 AEZs Removed

One AEZ is recommended for removal following the review of 2016 geophysical and bathymetric data.

WA71029 was identified in 2009 by EMU Ltd as the located of two reported obstructions. No evidence has been identified in any geophysical or bathymetric data reviewed in this area to date, including this latest assessment. It is therefore recommended that the existing AEZ be removed.

4.3 AEZs Unchanged

Mitigation recommendation for ten AEZs assessed using 2016 geophysical and bathymetric data remains unchanged.

Seven features were either not covered or were insufficiently covered by the new data in order to inform further interpretation and mitigation proposals as part of this review.

Four AEZs were identified in the original recorded positon. The interpretation and current mitigation were confirmed, with no potential to alter (move, enlarge, reduce, remove) being justified.

5. Discussion and Conclusions

The high quality data reviewed as part of this assessment enabled clear results and a high degree of certainty regarding the interpretation and mitigation proposals, where AEZs coincided with sufficient data coverage. Unfortunately, seven of the features reviewed were not sufficiently covered by one or more data sets of the survey.

Utilising similar monitoring data in the future, it may be possible to further revise and enhance the current mitigation proposals for these and other existing exclusion zones.

Further ground-truthing opportunities by divers or with ROVs during clearance operations prior to and during project construction may also enable these and other features to be reviewed and AEZs updated accordingly following formal archaeological assessment.

It should be noted that any seabed operations within established AEZs will require archaeological supervision and early input and are subject to prior agreement with Historic England.

Where anthropogenic material with any suspected archaeological potential are encountered beyond the limits of established AEZs, these should be reported using the *Protocol for Archaeological Discoveries*, as detailed in the archaeological WSI (Maritime Archaeology Ltd, 2016).

6. References

Bibby HydroMap, 2016. *Hornsea Zone - Geophysical Survey Lot 3, Volume 3 - Results Report*, Bibby HydroMap Project No. 2016-024, December 2016.

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7. Figures

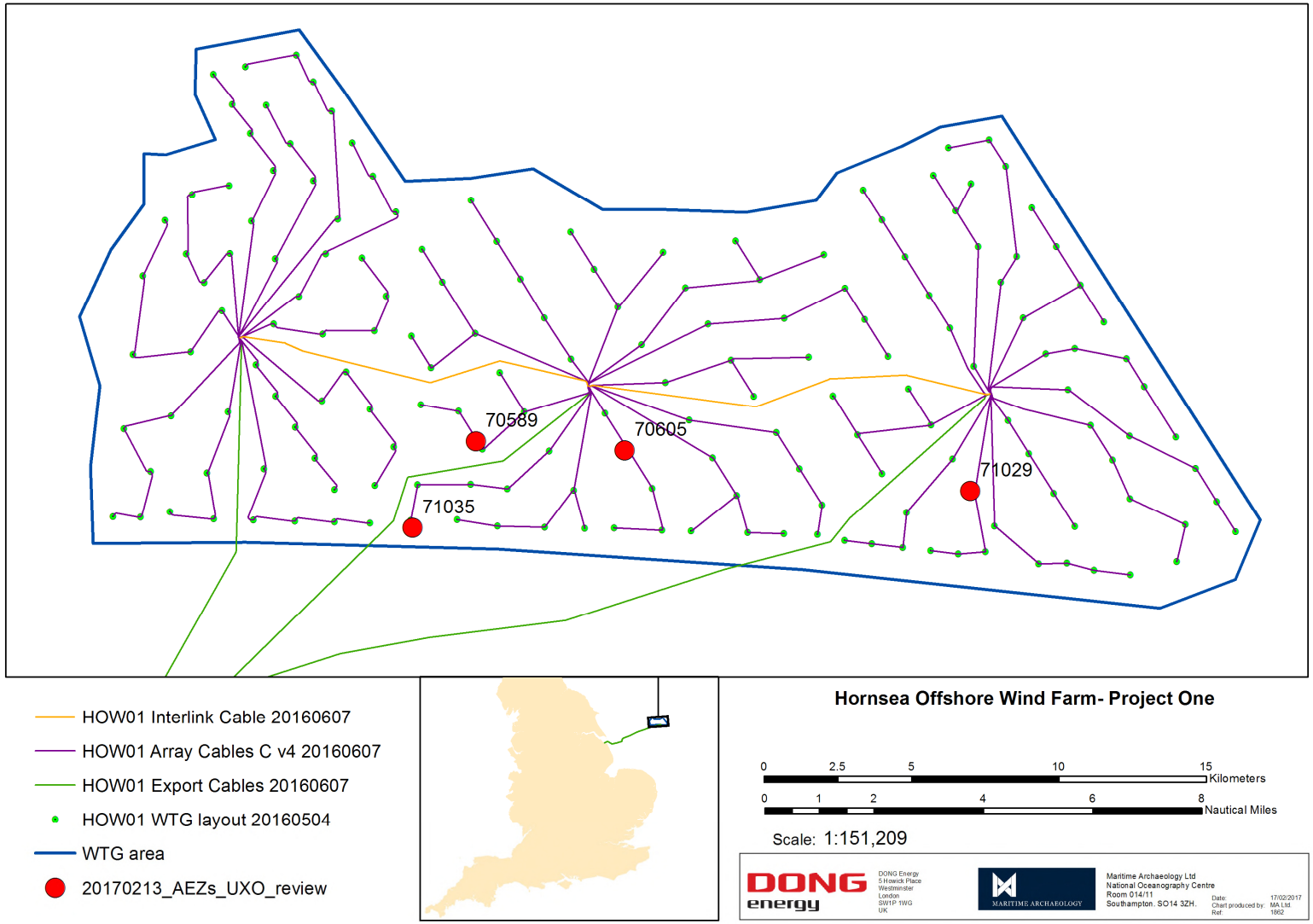

Figure 1: Positions for 4 AEZs reviewed within the WTG area (AEZs not scale).

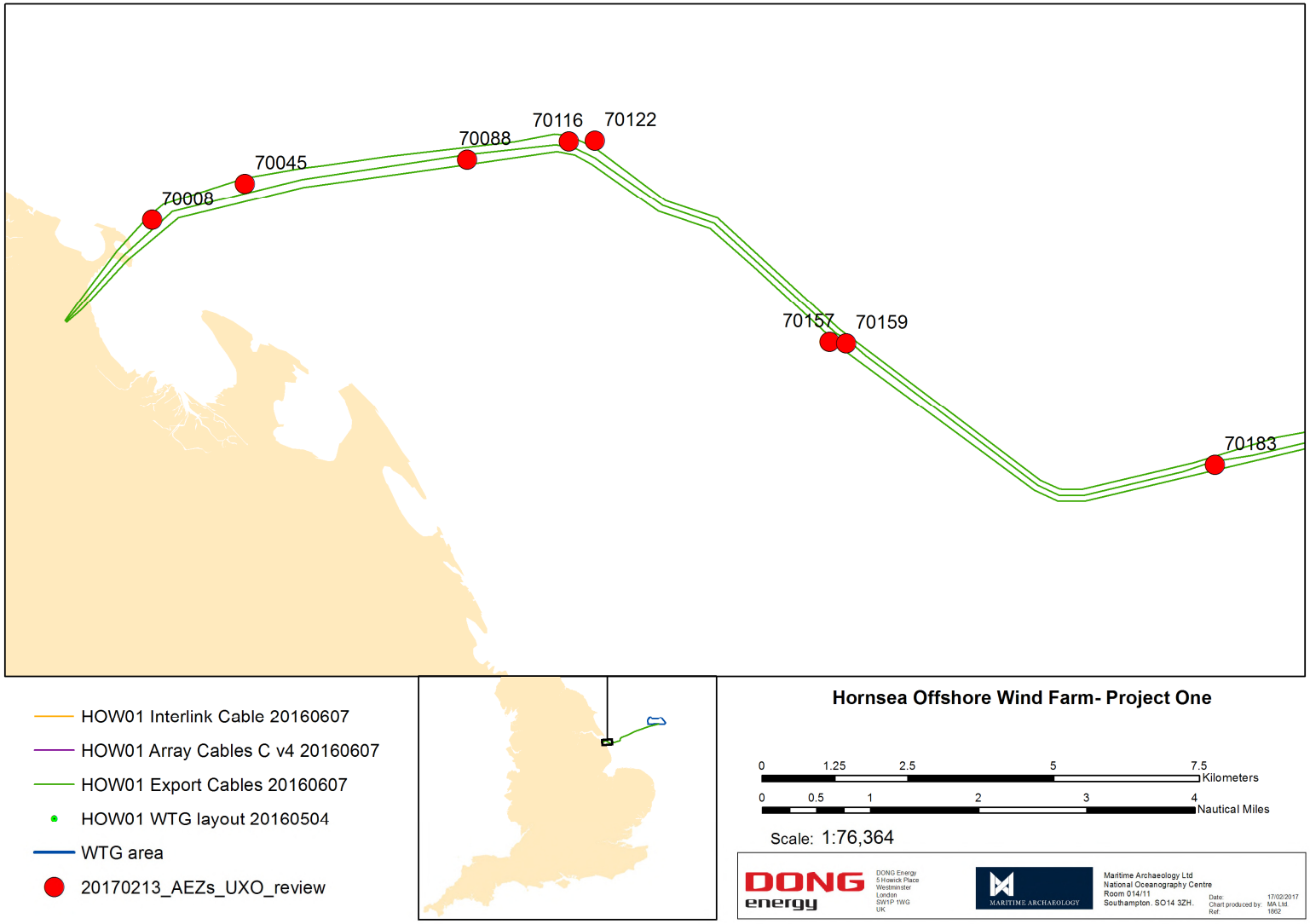

Figure 2: Positions for 8 AEZs located within the export cable route corridor (AEZs not to scale).

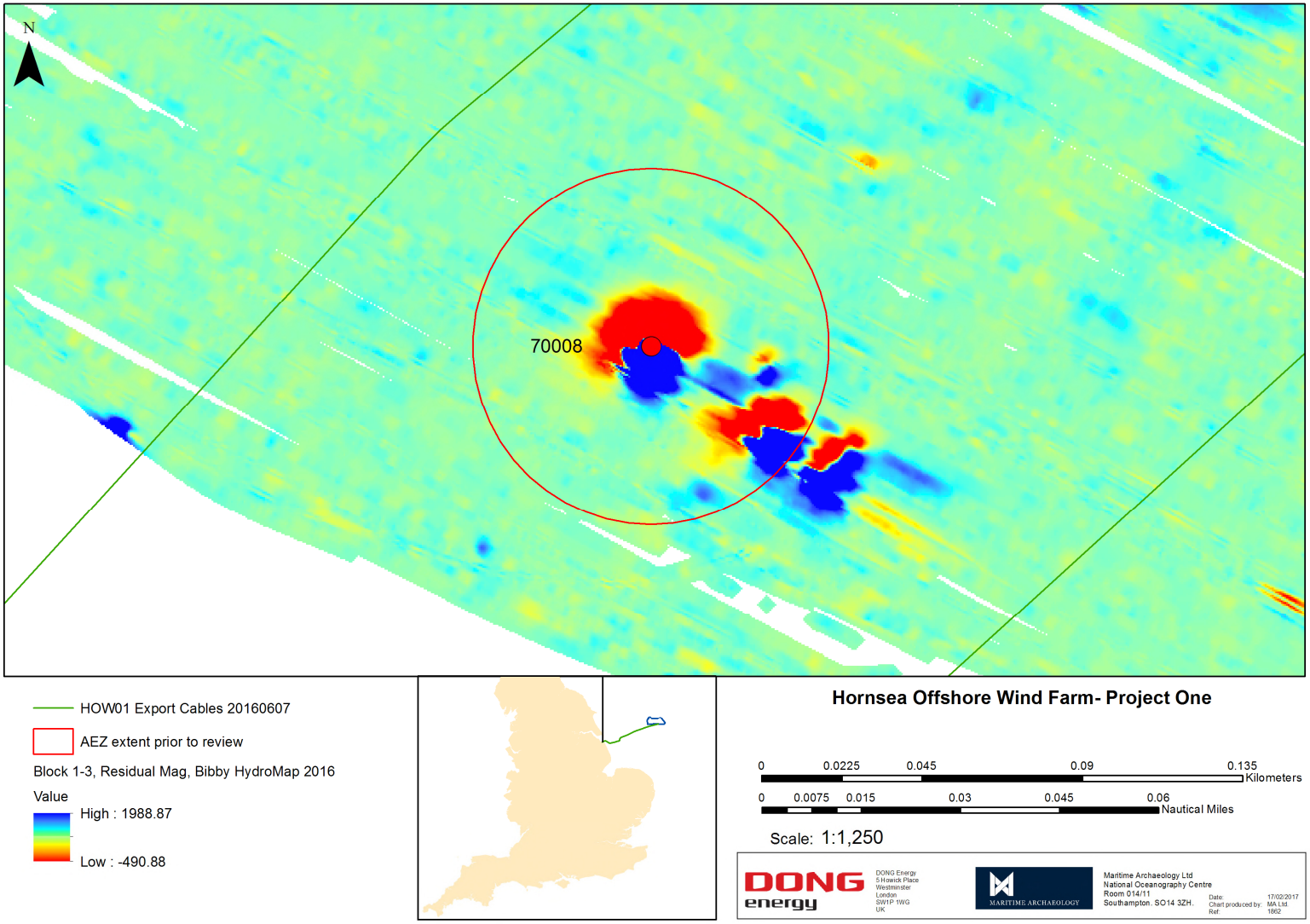

Figure 3: Position and extent of AEZ WA70008 prior to 2017 review (50m radius).

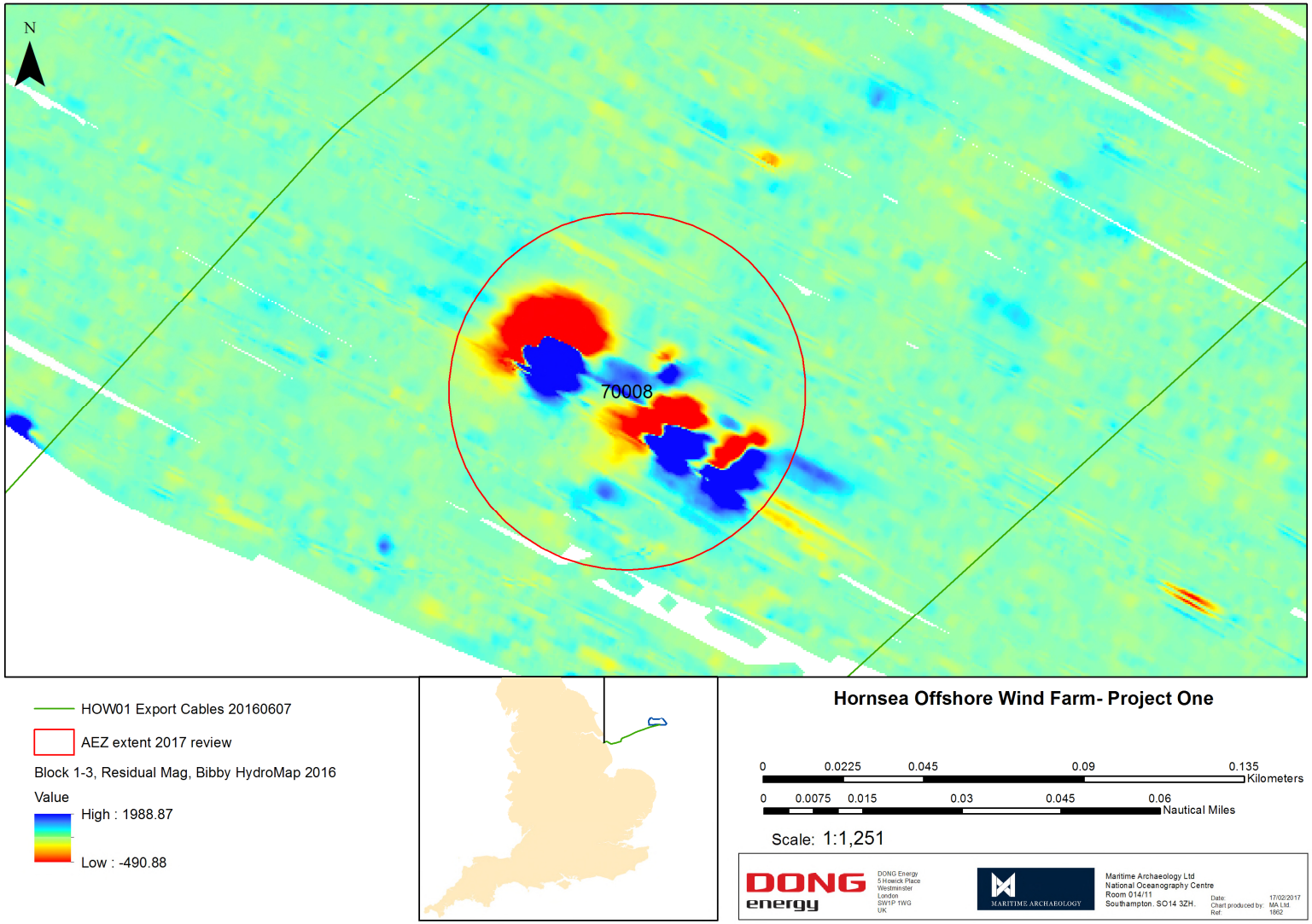

Figure 4: Position and extent of AEZ WA70008 after 2017 review, covering a group of at least four discrete anomalies (50m radius).

Appendix I – All Hornsea Project One AEZs (February 2017)

ID	Classification	Easting	Northing	Arch. potential	Length (m)	Width (m)	Height (m)	Magnetic (nT)	Description	AEZ	rea
70545	Wreck	418166	5968355	A1	16.4	10.7	0.4	0	Group of reflectors with height and parallel structure on the edge of a sediment wave. Possible wreck site	50	Wind Farm Site
70838	Wreck	443544	5966583	A1	29.5	8.7	0.9	0	Two elongated reflectors with a group of right-angular reflectors at one end suggest this may be a wreck structure, broken up and partially buried. Some localised scour. Likely to be a wreck site, though no wreck is previously recorded in this area.	50	Wind Farm Site
70965	Wreck	436282	5965805	A1	14.2	4.8	0.8	42	Two steep sided, proximal mounds likely to represent a metal wreck structure. Sidescan sonar imagery shows a structured, angular, anthropogenic object partially buried. Possible two ends of a shipwreck with centre buried and associated debris. Corresponds with known live wreck location. Magnetic anomaly suggests at least partial ferrous construction.	50	Wind Farm Site
71007	Wreck	441288	5976774	A1	36.7	124.8	2.5	0	Possible metal wreck, two points of height, steep sided protrusions above the seabed suggesting a broken up/partially buried wreck. Wreck appears broken into separate sections, minimal debris field. Corresponds with unknown recorded wreck location (UKHO 6928).	50	Wind Farm Site
71008	Wreck	439746	5973882	A1	35.0	15.0	1.2	96	A broken up wreck. Sidescan sonar indicates one end is significantly more intact and proud of the seabed. Strong angular reflectors amidships and curved stem visible. Magnetic anomaly suggests significant ferrous content of structure. Associated with previously recorded wreck location.	50	Wind Farm Site
71035	Wreck	421407	5965706	A1	105.7	18.6	4.0	2483	Distinct wreck site. Acoustic and magnetic signatures suggest this is a metal wreck with several large flat sections, some of which appear to be the result of outwards collapse. Associated with a recorded wreck site.	50	Wind Farm Site
71069	Wreck	414540	5981438	A1	23.5	12.9	0.4	308	Large structure identified in the sidescan sonar data. Strongly angular with flat, square sections. It has a corresponding magnetometer signature and bathymetric scouring suggesting this is a likely wreck site that is only partially exposed. No associated Seazone record, located approx. 260 m outside of the Subzone 1 boundary.	50	Wind Farm Site
71070	Wreck	411107	5965586	A1	22.9	6.5	2.5	2	Shipwreck, metal hulled, structure amidships, defined hull shape. Collapsed and broken at one end. Upright. Some debris field. Identified in sidescan sonar and multibeam bathymetry data sets. Coincides with a known wreck location believed to be the wreck of the Perseus, a trawler lost in 1915. Located approx. 390 m outside of the Subzone 1 boundary.	50	Wind Farm Site
71106	Wreck	444541	5962579	A1	19.2	8.3	0.4	0	Group of elongated and angular reflectors suggest this may be a structure. Unusual arrangement between sections, constant apparent heights and angles suggest possible wreck structure.	50	Wind Farm Site

ID	Classification	Easting	Northing	Arch. potential	Length (m)	Width (m)	Height (m)	Magnetic (nT)	Description	AEZ	rea
71107	Wreck	444729	5964023	A1	20.2	11.8	0.5	0	Potential anthropogenic debris, hard irregular reflector with shadow, possible wreck. Two adjacent anomalies recorded by EMU with same description, approx. 13m apart. Grouped by WA. Recorded as debris by EMU, but described as possible wreck.	50	Wind Farm Site
70926	Anthropogenic material	438570	5976469	1 (from A2)	25.24	10.25	1.65	0	Linear reflector with associated shadow. Probable anthropogenic material.	25	Wind Farm Site
70911	Anthropogenic material	439556	5974909	1 (from A2)	14.15	1.51	0.55	0	High magnetic return indicating ferrous material.	25	Wind Farm Site
71004	Anthropogenic material	440503	5968653	1 (from A2)				0	Irregular reflectors and shadows. Probable anthropogenic debris.	25	Wind Farm Site
70605	Anthropogenic material	428600	5968331	1 (from A2)	19.46			0	Linear reflector with associated shadow. Probable anthropogenic material.	25	Wind Farm Site
70591	Anthropogenic material	423415	5970338	1 (from A2)	17.15	0.39	1.55	0	Irregular reflector with associated shadow. Probable anthropogenic object.	25	Wind Farm Site
70589	Anthropogenic material	423551	5968626	1 (from A2)	25.65	1.95	0.66	0	Large irregular reflector. Probable anthropogenic material.	25	Wind Farm Site
70544	Anthropogenic material	417958	5972999	1 (from A2)	14.12	3.81		0	Area of irregular reflectors. Probable anthropogenic material.	25	Wind Farm Site
71018	Anthropogenic material	417035	5971830	1 (from A2)				0	Substantial reflector with associated shadow. Probable anthropogenic material.	25	Wind Farm Site
70008	Debris	307499	5933758	A1	4.2	1.6	0.6	691	Distinct elongate dark reflector with well-defined shadow located at the edge of a natural seabed feature. Associated with a large magnetic anomaly identified on a number of survey lines. Probable piece of ferrous debris. February 2017 review, MA Ltd, no SSS or MBES contact observed, but gridded mag data shows high amplitude feature over 70 m in length orientated wnw-ese, centred 25m ese of the recorded position. AEZ position amended in this record.	50	Cable Route
70045	Wreck	309073	5934394	A1	-	-	-	1143	Very large, distinct, but broad and complex magnetic anomaly identified on a number of survey lines. No associated sidescan sonar or multibeam bathymetry anomaly. Located approximately 40 m SE of a recorded obstruction, also recorded to be the location of the wreck of the Yacht HMS Gael, lost in 1940. Site possibly comprises scattered buried ferrous debris rather than a coherent structure.	50	Cable Route
70077	Wreck	312535	5934334	A1	-	-	-	1558	Very large, distinct, magnetic anomaly identified on a number of survey lines. No associated sidescan sonar or multibeam bathymetry contacts. Located approximately 35 m northeast of a recorded obstruction, also recorded to be the location of the wreck of the HMS Manx Prince, mined and lost in 1940. No visible debris on the seabed, but a significant amount of buried ferrous debris associated with this wreck could be present within the mobile seabed sediment.	50	Cable Route

ID	Classification	Easting	Northing	Arch. potential	Length (m)	Width (m)	Height (m)	Magnetic (nT)	Description	AEZ	rea
70088	Magnetic	312886	5934805	A1	-	-	-	129	Large, distinct magnetic anomaly without an associated side scan sonar or multibeam bathymetry contact, identified on more than one survey line. Possible large piece of buried ferrous debris.	50	Cable Route
70116	Magnetic	314595	5935130	A1	-	-	-	726	Large, distinct magnetic anomaly without an associated side scan sonar or multibeam bathymetry contact, possibly identified on two survey lines. Possible large piece of ferrous debris. Part of an area of approximately 11 similar magnetic anomalies.	50	Cable Route
70142	Magnetic	316705	5933599	A1	-	-	-	3840	Very large magnetic anomaly identified on a number of survey lines, but without an associated sidescan sonar or multibeam bathymetry contact. Indicates the presence of a significant amount of buried ferrous debris, possibly the remains of a wreck site though no previously recorded wrecks are located in the vicinity. Probably related to nearby similar feature 70144.	50	Cable Route
70144	Magnetic	316862	5933487	A1	-	-	-	3673	Very large magnetic anomaly identified on a number of survey lines and two sets of survey data, but without an associated sidescan sonar or multibeam bathymetry contact. Indicates the presence of a significant amount of buried ferrous debris, possibly the remains of a wreck site though no previously recorded wrecks are located in the vicinity. Probably related to nearby similar features 70142.	50	Cable Route
70122	Wreck	315075	5935126	A1	54.3	15.8	0.8	21233	Previously unrecorded wreck identified by all geophysical equipment. Structure is almost completely buried within an area of sand waves and is poorly defined on both sidescan sonar and multibeam bathymetry data. Because of the extent of burial the condition of the wreck is difficult to determine, though some possible structure is visible and the wreck seems contained to one relatively small area, suggesting a significant part of the structure may remain intact. A very large magnetic anomaly has been associated with the structure, suggesting a significant ferrous construction, though the anomaly is so large it is possibly over exaggerated. Although no known wreck is recorded in this location it is possibly the Vasco, the recorded position of which is approximately 345 m northwest though was not identified at this position.	50	Cable Route
70334	Wreck	370887	5947705	A1	33.1	14.4	2.7	849	Wreck identified by all geophysical equipment. Located approx 154 m southwest of a recorded unidentified wreck (including some other debris) and approximately 500 m east north-east of SS Nieuwland. A large, distinct magnetic anomaly suggesting a construction of ferrous material. Little structure identifiable from sidescan sonar indicated a significant proportion is buried. Location identifiable on multibeam bathymetry. Could be debris related to 70335, 70332 or individual small wreck.	50	Cable Route

ID	Classification	Easting	Northing	Arch. potential	Length (m)	Width (m)	Height (m)	Magnetic (nT)	Description	AEZ	rea
70335	Wreck	370945	5947842	A1	14.5	6.6	2.6	215	Wreck identified by all geophysical equipment. Located at recorded location of unidentified wreck and approximately 650 m eastnortheast from SS Nieuwland. Could be debris related to 70334 or individual small wreck. Minimal structure can be seen from the sidescan sonar but some height is identifiable. Large magnetic anomaly could indicate some buried structure. Location identifiable on multibeam bathymetry.	50	Cable Route
70439	Wreck	418774	5961246	A1	27.9	8.2	1.5	44	Area of seafloor disturbance identified by all geophysical systems located at the position of an unnamed recorded wreck. Feature is visible as a low, elongate mound on multibeam bathymetry data, and appears as an area of indistinct dark and bright reflectors on sidescan sonar data. Feature is unrecognisable as a vessel, but the association with a medium magnetic anomaly suggests this is the broken up and mostly buried remains of an at least partially ferrous vessel.	50	Cable Route
70454	Wreck	426180	5963601	A1	65.1	27.2	3.7	41	Wreck of an unidentified vessel, located on the edge of the geophysics coverage and tentatively identified by all of the geophysical equipment orientated approximately northnortheast-southsouthwest. The wreck appears as an elongate debris field unrecognisable as a vessel, and is characterised in the sidescan sonar data by two large dark reflectors with large shadows and accompanying smaller irregular dark and bright reflectors. The feature was poorly resolved in the multibeam bathymetry data, and only tentatively associated with a medium magnetic anomaly approximately 100 m away suggesting an amount of ferrous debris. The structure is badly broken up and likely mostly buried.	50	Cable Route
70194	Wreck	328072	5929813	A1	109.1	42.3	2.0	9070	Large wreck site visible in all geophysical data, identified orientated approximately northeast-southwest. Recorded by UKHO as possibly part of the wreck of the SS Ravonia, a British steam cargo ship lost in 1944 after collision with the HMT trawler Eroican. The other part of the wreck is reported to be located approximately 1,170 m north-northeast, outside of the area covered by the geophysics. The wreck is badly broken up and appears as a large, elongate mound of debris unrecognisable as a vessel. However, parallel ridges in numerous areas of the mound indicate individual pieces of intact structure still survive. The highest point of the structure is towards the centre, and the very high magnetic anomaly suggests a significant degree of surviving ferrous material.	50	Cable Route

ID	Classification	Easting	Northing	Arch. potential	Length (m)	Width (m)	Height (m)	Magnetic (nT)	Description	AEZ	rea
70332	Wreck	370438	5947503	A1	56.1	36.0	1.6	1991	Wreck identified by all geophysical equipment. Located approximately 46 m NW from the recorded location of the wreck of SS Nieuwland, a Dutch cargo ship mined and lost 3/10/1914. A very large distinct magnetic anomaly suggests a construction of ferrous material. Some structure can be identified by the sidescan sonar, though in generally the wreck appears fairly damaged and broken up. Possible associated with 70334 and/or 70335	50	Cable Route
70246	Recorded Wreck	345527	5936605	A3	-	-	-	0	LIVE Dangerous wreck, position accuracy is 13m. Initially found by echo sounder, indicating buried material. Wreck is marked on chart.	50	Cable Route
70317	Recorded Obstruction	364016	5944387	A3	-	-	-	0	LIVE foul ground possibly FV Rebono Low archaeological Significance. Marked on Chart Reported sinking and detected in 1983 as debris 50x15m. Accuracy reported as 25m. A possible FV Rebono has also been located 18 km away where a wreck after a fishing trawler with one boiler has been confirmed by divers.	50	Cable Route
70023	Anthropogenic material	308173	5933412.5	1 (from A2)	0.00	0.00	0.00	97.79	Isolated, high magnetic return indicating ferrous material.	25	Cable Route
70027	Anthropogenic material	308353.84	933290.75	1 (from A2)	0.00	0.00	0.00	519	Isolated, high magnetic return indicating ferrous material.	25	Cable Route
70041	Anthropogenic material	308772.17	5933087.5	1 (from A2)	0.00	0.00	0.00	104.19	Isolated, high magnetic return indicating ferrous material.	25	Cable Route
70057	Anthropogenic material	310355	310355	1 (from A2)	0.00	0.00	0.00	135.64	Isolated, high magnetic return indicating ferrous material.	25	Cable Route
70067	Anthropogenic material	310424.67	933259.25	1 (from A2)	0.00	0.00	0.00	113.69	Isolated, high magnetic return indicating ferrous material.	25	Cable Route
70076	Anthropogenic material	312856.34	5933975	1 (from A2)	0.00	0.00	0.00	113.13	Isolated, high magnetic return indicating ferrous material.	25	Cable Route
70091	Anthropogenic material	313276	313276	1 (from A2)	0.00	0.00	0.00	201.48	Isolated, high magnetic return indicating ferrous material.	25	Cable Route
70157	Anthropogenic material	319103.84	5931679	1 (from A2)	0.00	0.00	0.00	149.0	Isolated, high magnetic return indicating ferrous material.	25	Cable Route
70159	Anthropogenic material	319383	5931650	1 (from A2)	0.00	0.00	0.00	188.94	Isolated, high magnetic return indicating ferrous material.	25	Cable Route
70183	Anthropogenic material	325713	5929572	1 (from A2)	11.84	18.71	0.00	0	Area of irregular reflectors with associated shadows and scour. Probable anthropogenic material.	25	Cable Route
70227	Anthropogenic material	343899	5933099	1 (from A2)	31.64	31.74	0.00	0	Area of irregular reflectors with associated shadows and scour. Probable anthropogenic material.	25	Cable Route
70264	Anthropogenic material	350552	5940870	1 (from A2)	0.00	0.00	0.00	286.40	Magnetic target (286.4nT) in area of seabed disturbance. Probable buried material.	25	Cable Route

Appendix II – Archaeological Review of Specific AEZs

WA ID	Area	WA Interp	AEZ extent	Actual Coverage	SSS	MBES	MAG	Recommendation
70008	Block 1	Distinct elongate dark reflector with well-defined shadow located at the edge of a natural seabed feature. Associated with a large magnetic anomaly identified on a number of survey lines. Probable piece of ferrous debris.	50m radius	100% SSS, c. 10% MBES, 100% MAG.	No anomaly observed across nine lines of overlapping data. Data is of good quality. Flat sand.	No data over recorded target position	High amplitude anomaly within original AEZ, though new data shows that the feature extends further ESE over a 70m long area.	Move AEZ 25m ESE, new position 307499, 5933758 (WGS84 UTM 31N).
70045	Block 2	Very large, distinct, bur broad and complex magnetic anomaly identified on a number of survey lines. No associated sidescan sonar or multibeam bathymetry anomaly. Located approximately 40m SE of a recorded obstruction, also recorded to be the location	50m radius	c. 30% SSS, 10% MBES, 15% MAG, target missed, south of survey.	No coverage of recorded target position. Adjacent lines within northern limits of AEZ show no features.	No data over recorded target position.	No data over recorded target position	Maintain AEZ in current position.
70088	Block 2	Large, distinct magnetic anomaly without an associated sidescan sonar or multibeam bathymetry contact, identified on more than one survey line. Possible large piece of buried ferrous debris.	50m radius	c. 60% SSS, 10% MBES, 30% MAG, target missed, between lines.	No coverage of recorded target position. Adjacent lines north and south within limits of AEZ demonstrate sand wave migration.	No data over recorded target position.	No data over the target position, though high amplitude anomalies are located directly north and south within the limits of the AEZ's outer extent.	Maintain AEZ in current position.
70116	Block 2	Large, distinct magnetic anomaly without an associated sidescan sonar or multibeam bathymetry contact, possibly identified on two survey lines. Possible large piece of ferrous debris. Part of an area of approximately 11 similar magnetic anomalies.	50m radius	c. 15% SSS, 5% MBES, 15% MAG, target missed, east of survey.	No coverage of recorded target position.	No data over recorded target position.	No data over recorded target position.	Maintain AEZ in current position.
70122	Block 2	Previously unrecorded wreck identified by all geophysical equipment. Structure is almost completely buried within an area of sand waves and is poorly defined on both sidescan sonar and multibeam bathymetry data. Possibly the Vasco	110 x 150m	c. 40% SSS, 5% MBES, 15% MAG, target missed, south of survey.	No coverage of recorded target position. Adjacent lines within northern limits of AEZ show no features.	No data over recorded target position.	No data over the target position, though high amplitude anomalies are located directly north and to the south-west within the limits of the AEZ's outer extent.	Maintain AEZ in current position.
70157	Block 5	Isolated, high magnetic return indicating ferrous material.	25m radius	c. 30% SSS, 10% MBES, 20% MAG, target missed, south of survey lines.	No coverage of recorded target position. Adjacent lines within north-eastern limits of AEZ show no features.	No data over recorded target position.	No data over recorded target position.	Maintain AEZ in current position.
70159	Block 5	Isolated, high magnetic return indicating	25m	c. 90% SSS,	Small linear reflector	No data over	No identifiable	Maintain AEZ in

WA ID	Area	WA Interp	AEZ extent	Actual Coverage	SSS	MBES	MAG	Recommendation
		ferrous material.	radius	30% MBES, 50% MAG.	located 5m north of the recorded position, 3.4 x 0.5 x 0.1 m.	recorded target position.	anomaly in large area (500m+) of magnetic disturbance.	current position.
70183	Block 6	Area of irregular reflectors with associated shadows and scour. Probable anthropogenic material.	25m radius	100% SSS, c. 25% MBES, 30% MAG.	Scattered are of reflectors over 21 x 15 m area, fully contained within the centre of the AEZ.	No data over recorded target position.	No data over recorded target position or anomaly seen in northern part of AEZ with coverage.	Maintain AEZ in current position.
71035	B025	Distinct wreck site. Acoustic and magnetic signatures suggest this is a metal wreck with several large flat sections, some of which appear to be the result of outwards collapse. Associated with a recorded wreck site.	150m radius	c. 25% SSS, 20% MBES, 20% MAG, target missed, south of survey lines.	No coverage of recorded target position.	No data over recorded target position.	No data over recorded target position.	Maintain AEZ in current position.
71029	B110	Location of two recorded obstruction, approx. 10m apart and possibly referring to the same object. Not identified by Emu in their geophysical data.	25m radius	100% all data.	Nothing observed on five sonar lines at this location. Small boulder, 17m N and 41m WNW, < less than 0.5m.	No contact observed, area of raised sand waves.	No magnetic anomaly.	Remove AEZ
70605	B066	Linear reflector with associated shadow. Probable anthropogenic material.	25m radius	100% all data.	Contact located 2.85m from AEZ centre, clearly observed on all three coincident survey lines. Curvi-linear hard reflector, probable anthropogenic origin. 4.1 x 1.3 x 0.5m. AEZ also covers smaller possibly related feature 23m N.	Raised object in slight circular scour feature c. 5m in diameter, 0.1m deep scour.	Amplitude 18.3 nT monopole anomaly.	Maintain AEZ in current position.
70589	B51	Large irregular reflector. Probable anthropogenic material.	25m radius	100% all data.	Linear hard reflector measuring 2 x 1 x 0.9 m, standing well proud of the seabed.	Matching contact, 5m diameter scour, 0.2m deep.	No magnetic anomaly.	Maintain AEZ in current position.