

A large, stylized sun logo in the top right corner, composed of light blue and white segments.

MORAY EAST

OFFSHORE WINDFARM

Decorative wavy lines in shades of blue and teal, separating the title from the subtitle.

Pre-Construction Survey Campaign Summary Report

September 2019

Moray Offshore Windfarm (East) Limited

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List of Abbreviations

BGS	British Geological Survey
CfD	Contract for Difference
CPT	Cone Penetration Testing
CPTU	Piezo-Cone Penetration Testing
LAT	Lowest Astronomical Tide
MPV	Multi-Purpose Vessel
MW	Megawatt
MV	Motor Vessel
OFTI	Offshore Transmission Infrastructure
OSPs	Offshore Substation platforms
PCPT	Piezocone Cone Penetration Test
SPT	Standard Penetration Test
UHR	Ultra-High Resolution
UXO	Unexploded Ordnance
WTG	Wind Turbine Generator

Definitions

The following definitions have been used throughout this document with respect to the company, the consented wind farms and how these definitions have changed since submission of the Moray East Environmental Statement (ES) in 2012 and the Moray East Modified Transmission Infrastructure ES in 2014.

- **Moray Offshore Windfarm (East) Limited (formerly known as Moray Offshore Renewables Limited)** – the legal entity submitting this Pre-Construction Survey Campaign Summary Report;
- **Moray East Offshore Wind Farm** - the wind farm to be developed in the Moray East site (also referred as the Wind Farm);
- **The Moray East site** - the area in which the Moray East Offshore Wind Farm will be located. Section 36 Consents and associated Marine Licences to develop and operate up to three generating stations on the Moray East site were granted in March 2014. At that time the Moray East site was made up of three sites known as the Telford, Stevenson and MacColl offshore wind farm sites. The Section 36 Consents and Marine Licences were subsequently varied in March 2018;
- **Telford, Stevenson and MacColl wind farms** – these names refer to the three consented offshore wind farm sites located within the Moray East site;
- **Transmission Infrastructure (TI)** - includes both offshore and onshore electricity transmission infrastructure for the consented Telford, Stevenson and MacColl wind farms. Includes connection to the national electricity transmission system near New Deer in Aberdeenshire encompassing AC offshore substation platforms (OSPs), AC OSP interconnector cables, AC export cables offshore to landfall point at Inverboyndie continuing onshore to the AC collector station (onshore substation) and the additional regional Transmission Operator substation near New Deer. A Marine Licence for the offshore TI was granted in September 2014 and a further Marine Licence for two additional distributed OSPs was granted in September 2017. The onshore TI was awarded Planning Permission in Principle in September 2014 by Aberdeenshire Council and a Planning Permission in Principle under Section 42 in June 2015;
- **Offshore Transmission Infrastructure (OfTI)** – the offshore elements of the transmission infrastructure, comprising AC OSPs, OSP interconnector cables and AC export cables offshore to landfall (for the avoidance of doubts some elements of the OfTI will be installed in the Moray East site);
- **Moray East ES 2012** – The ES for the Telford, Stevenson and MacColl wind farms and Associated Transmission Infrastructure, submitted August 2012;
- **Moray East Modified TI ES 2014** – the ES for the TI works in respect to the Telford, Stevenson and MacColl wind farms, submitted June 2014;
- **The Development** – the Moray East Offshore Wind Farm and Offshore Transmission Infrastructure (OfTI);
- **Design Envelope** - the range of design parameters used to inform the assessment of impacts;
- **OfTI Corridor** – the export cable route corridor, i.e. the OfTI area as assessed in the Moray East Modified TI ES 2014 excluding the Moray East site; and
- **the Applications** – (1) the Application letter and ES submitted to the Scottish Ministers on behalf of Telford Offshore Windfarm Limited, on 2nd August 2012 and the Additional Ornithology Information submitted to the Scottish Ministers by Moray Offshore Renewables Limited on the 17th June 2013; (2) the Section 36 Consents Variation Application Report for

Telford, Stevenson and MacColl Offshore Wind Farms dated December 2017 and (3) the Marine Licence Applications and associated documents submitted for the OfTI Licences.

- **Moray East Offshore Wind Farm Consents** – are comprised of the following:

Section 36 Consents:

- Section 36 consent for the Telford Offshore Wind Farm (as varied) – consent under section 36 of the Electricity Act 1989 for the construction and operation of the Telford Offshore Wind Farm assigned to Moray East on 19 June 2018.
- Section 36 consent for the Stevenson Offshore Wind Farm (as varied) – consent under section 36 of the Electricity Act 1989 for the construction and operation of the Stevenson Offshore Wind Farm assigned to Moray East on 19 June 2018.
- Section 36 consent for the MacColl Offshore Wind Farm (as varied) – consent under section 36 of the Electricity Act 1989 for the construction and operation of the MacColl Offshore Wind Farm assigned to Moray East on 19 June 2018.

Marine Licences

- Marine Licence for the Telford Offshore Wind Farm (as varied) – Licence Number: 04629/19/0 – consent under the Marine (Scotland) Act 2010 & Marine and Coastal Access Act 2009, Part 4 marine licensing for marine renewables construction works and deposits of substances or objects in the Scottish Marine Area and the United Kingdom Marine Licensing Area transferred to Moray East on 19 July 2018.
- Marine Licence for the Stevenson Offshore Wind Farm (as varied) – Licence Number: 04627/19/0 – consent under the Marine (Scotland) Act 2010 & Marine and Coastal Access Act 2009, Part 4 marine licensing for marine renewables construction works and deposits of substances or objects in the Scottish Marine Area and the United Kingdom Marine Licensing Area transferred to Moray East on 19 July 2018.
- Marine Licence for the MacColl Offshore Wind Farm (as varied) – Licence Number: 04628/19/0 – consent under the Marine (Scotland) Act 2010 & Marine and Coastal Access Act 2009, Part 4 marine licensing for marine renewables construction works and deposits of substances or objects in the Scottish Marine Area and the United Kingdom Marine Licensing Area transferred to Moray East on 19 July 2018.

OfTI Licences – are comprised of the following:

- Marine Licence for the Offshore Transmission infrastructure – Licence Number 05340/19/0 – consent under the Marine (Scotland) Act 2010 & Marine and Coastal Access Act 2009, Part 4 marine licensing for marine renewables construction works and deposits of substances or objects in the Scottish Marine Area and the United Kingdom Marine Licensing Area (referred to as the “OfTI Marine Licence”)
- Marine Licence for two additional distributed OSPs – Licence Number 06347/19/0 – consent under the Marine (Scotland) Act 2010 & Marine and Coastal Access Act 2009, Part 4 marine licensing for marine renewables construction, operation and maintenance works and the deposit of substances or objects in the Scottish Marine Area and the United Kingdom Marine Licensing Area (referred to as the “OSP Marine Licence”)

1 Introduction

1.1 Background

Moray East Offshore Wind Farm (East) Limited (Moray East) is a joint venture partnership between EDP Renewables, Engie, Diamond Generating and China Three Gorges. Moray East is developing the Moray East Offshore Wind Farm, located within Moray East site in the outer Moray Firth (see Figure 1-1 below). Section 36 Consents were granted in March 2014 for the construction and operation of three offshore wind farms (Telford, Stevenson and MacColl) within the Moray East site. Marine Licences for the three offshore wind farms were granted in September 2014 (together the Section 36 Consents and Marine Licences for the Wind Farm are referred as the Moray East Offshore Wind Farm Consents). The Moray East Offshore Wind Farm Consents were varied in March 2018 and assigned to Moray East Offshore Wind Farm (East) Limited (Moray East) in June 2018 and the Marine Licence varied in July 2019.

Moray East was granted a Marine Licence for two Offshore Substation Platforms (OSPs) in September 2014 (offshore transmission infrastructure (OfTI) Marine Licence) and in 2017 a Marine Licence was granted for two additional distributed OSPs (OSP Marine Licence) (together these licences are referred to as the OfTI Licences). These Marine Licences were subsequently varied in July 2019.

This document is being provided in line with the commitment made within the Project Environmental Monitoring Plan (PEMP) (Moray East, 2018) where it is stated that a summary of the pre-construction surveys will be provided upon completion of the analysis of the full pre-construction survey campaign (Section 2.6). The results of the 2010 geophysical and geotechnical surveys have been included within the Moray East Environmental Statement (ES) 2012 and therefore are not referred here. The layout of this document will divide the surveys completed in both the Moray East site and OfTI Corridor for clear representation (see Figure 1-1 below).

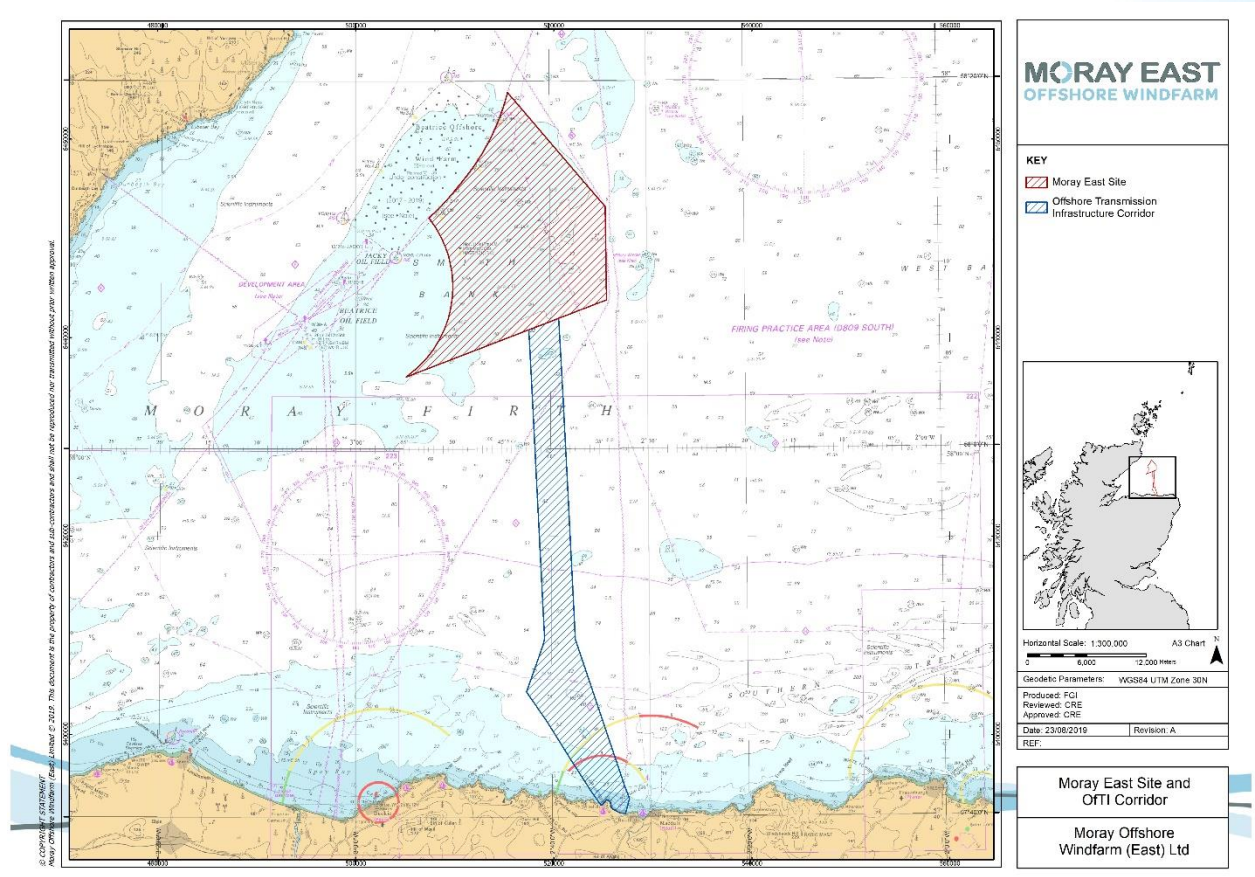


Figure 1-1: Moray East site and OfTI Corridor

2 Pre-Construction Survey Programme

2.1 Moray East site

Table 2-1 provides an overview of the surveys undertaken in the Moray East site referred in this document (Section **Error! Reference source not found.** to 3.1.7).

Table 2-1: Moray East site surveys summary

Survey	Survey Detail	Coverage	Date
Moray East site			
Geophysical Survey (Gardline)	Multi-Beam Echo Sounder, Side Scan Sonar, Sub-Bottom Profilers, Magnetometer/ Gradiometer.	50 m corridor along possible inter-array cable routes.	2014
Shallow Geotechnical Site Investigation (Gardline)	Vibrocores and Cone Penetration Testing (CPTs)	43 stations between possible WTG locations.	2014
Deep and Shallow Geotechnical Site Investigation (Calegeo)	Composite Boreholes and CPTs	26 boreholes and 75 CPTUs stations within and around possible WTGs locations.	2014
Geophysical Survey (Horizon)	Multi-Beam Echo Sounder, Side Scan Sonar, Sub-Bottom Profilers, Magnetometer	Infilling survey in the eastern part of the site, 3 lines going through WTG locations.	2017
Geotechnical Survey (Horizon/Fugro)	Sampling Boreholes, downhole CPT reading.	19 sampling boreholes, 88-92 downhole CPT readings across the Moray East site.	2017/2018
Geophysical Survey & Shallow Geotechnical Site Investigation	Multi-Beam Echo Sounder, Side Scan Sonar, Sub-Bottom Profilers, Magnetometer/ Gradiometer. Seabed CPTs and vibrocores.	100 m corridor along possible inter-array cable routes, shallow CPTs & vibrocores along inter-array cable routes.	2018
Unexploded Ordnance (UXO) Survey (Bibby HydroMap)	Multi-Beam Echo Sounder, Side Scan Sonar, Magnetometer/ Gradiometer, Sub- bottom profiler (limited scope with Bibby Tethra)	Moray East site.	2018/2019

2.2 Moray East Offshore Transmission Infrastructure (OfTI) Corridor

Table 2-2 provides an overview of the surveys undertaken in the Moray East OfTI Corridor and the surveys detailed in this document (Section 4.1.1 to 4.1.7).

Table 2-2: OfTI Corridor surveys summary

Survey	Survey Detail	Coverage	Date
Moray East OfTI Corridor			
Geophysical Survey (Gardline)	Multi-Beam Echo Sounder, Side Scan Sonar, Sub-Bottom Profilers, Magnetometer/Gradiometer.	1,000 m corridor along the export cable route.	2014
Shallow Geotechnical Site Investigation (Gardline)	Vibrocores and CPTUs.	68 stations along the export cable route.	2014
Topographic Beach Survey (Gardline)	-	Topographic coverage of an area around 250 m x 300 m.	2014
Nearshore Shallow Geotechnical Site Investigation (Gardline)	CPTs	21 CPTs along the cable route in the nearshore area.	2015
Nearshore Geophysical (Bibby HydroMap)	Multi-Beam Echo Sounder, Side Scan Sonar, Sub-Bottom Profilers, Magnetometer/ Gradiometer.	Coverage over an area of 800 m x 425 m	2017
Geophysical Survey & Shallow Geotechnical SI	Multi-Beam Echo Sounder, Side Scan Sonar, Sub-Bottom Profilers, Magnetometer/Gradiometer. Seabed CPTs and Vibrocores.	Infilling survey for part of the offshore export cable route, mainly inside the side boundaries.	2018
Nearshore Geotechnical Site Investigation	Deep geotechnical survey using jack-up vessel with a full complement of drilling and testing equipment. Boreholes including cable percussion methods, SPTs and rotary coring.	25 m target depth for a minimum of six offshore boreholes to encounter bed rock in the nearshore area. Furthest borehole location is to be approximately 1 km from shore following offshore export cable route.	2018
Unexploded Ordnance (UXO) Survey (Bibby HydroMap)	Multi-Beam Echo Sounder, Side Scan Sonar, Magnetometer/ Gradiometer.	50m- 100m width along Export Cable Routes and 470m x475m in the nearshore area	2018/2019

3 Pre-Construction Survey Summary Information

3.1.1 Geophysical Survey

Type of Survey: Geophysical Survey	Coverage: Moray East site Wind Turbine Generator (WTG) Preliminary Locations
Timescales: 6th May 2014 - 21st June 2014	
Contractor: Gardline	
<p>The geophysical survey for the Moray East site was undertaken between the 6th May 2014 and 21st June 2014 by the MV Vigilant. Survey operations followed primary lines which were designed to run through multiple WTG locations across the site. These survey lines extended 800 m beyond both ends, with wing lines offset 10 m and 20 m either side. This was specifically designed to cover the entirety of the Moray East site. To successfully complete the geophysical survey, the vessel utilised a quantity of varying equipment. This equipment included multi-beam echo sounder, single beam echo sounder, sub-bottom profiler, side scan sonar, magnetometer and velocity probes. Survey operations were undertaken in water depths ranging from 37.1 m Lowest Astronomical Tide (LAT) in the west to 54.2 m LAT in the east. The seabed was found to be generally flat, except for slight gradients along the edges of the sand accumulations. Bathymetric data also revealed the presence of two wrecks, with one being an unrecorded wreck and the other as the identified wreck of the Llanishen. In general, the water depth was greater in the east of the site.</p> <p>To detect the seabed features within the site, side scan sonar and multi-beam data was utilised. From this equipment, numerous sonar objects were found within the limits of the sonar data and divided into the following categories; boulders, debris and linear debris. The results highlighted considerable boulder presence, with over 9,000 within the Moray East site. The greatest boulder intensity with the Moray East site was in the northeast, southern, centre and west. Numerous magnetic anomalies were also detected within the Moray East site, commonly being associated with areas where numerous boulders are interpreted. Magnetic anomalies were detected after processing magnetometer data which indicated the presence of underlying geology or buried debris. This geophysical survey data was collected to provide additional information to assist WTG foundation design and inter-array routing.</p>	

3.1.2 Shallow Geotechnical Site Investigation

Type of Survey: Geotechnical Site Investigation	Coverage: Moray East site Inter-Array Cable Routing
Timescales: 9th June - 26th June 2014	
Contractor: Gardline	
<p>A shallow geotechnical survey of the Moray East site was undertaken to provide information for inter-array cable routing and to minimise cable installation risks. 43 vibrocore and CPT locations were sampled at pre-agree locations between each WTG. Geotechnical equipment consisted of a ROSON Dual Drive 55kN CPT and Aimers McLean 3 m Vibrocore. This survey was completed by the MV Ivero between the 9th June 2014 and 26th June 2014.</p> <p>The results of the site investigation concluded that the dominant seabed sediment varies throughout the Moray East site between sand and gravel. To interpret the seabed features, sediment composition was categorised and presented on either a micro or macro scale. On the micro scale, seabed sediments are either dominated by gravel with numerous sand accumulations or sand with numerous gravel patches. Sand accumulations occur as the mounds on the seabed and gravel patches are found in the elongate depressions. In other areas, there is evidence of boulder clay subcropping beneath a veneer of gravel, presented by the number of boulders present on the seabed at these locations. On the macro scale, more sand dominated seabed sediment occurs in topographic lows. In areas of bathymetric highs, the seabed sediments comprise a mixture of sand and gravel with occasional subcropping of boulder clay beneath a veneer of these sediments. The gravel dominated areas are more widespread throughout the Moray East site. Shallow geotechnical investigations also enabled dominant seabed sediments to be concluded for different areas of the site. In the northeast of the Moray East site, the dominant seabed sediment is boulder clay with a veneer of gravel. In the east and through the centre of the Moray East site, sand is interpreted to cover the majority of the seabed and the presence of gravel is interrupted to be sparse. The west section of the Moray East site, seabed sediments comprise sand and gravel with numerous sand accumulations. In the Southeast of the Moray</p>	

Type of Survey: Geotechnical Site Investigation	Coverage: Moray East site Inter-Array Cable Routing
Timescales: 9th June - 26th June 2014	
Contractor: Gardline	
East site, near the OfTI corridor, boulder clay is interrupted to subcrop beneath a veneer of gravel. In the southwest, most seabed sediments are interpreted to comprise sand.	

3.1.3 Deep and Shallow Geotechnical Site Investigation

Type of Survey: Geotechnical Site Investigation	Coverage: Moray East site Moray East site Seabed Geology
Timescales: 9th June 2014 – 9th August 2014	
Contractor: Calegeo	
<p>Geotechnical site investigations were completed between the 9th June 2014 and 9th August 2014 by the survey vessels MV Highland Spirit, MV Kommandor Calum and MV Greatship Manisha. Both the MV Highland Spirit and MV Greatship Manisha provided drill ship roles, whilst the MV Kommandor Calum was a single multi-purpose vessel. To complete the site investigations, the vessels were equipped with survey and drilling equipment. The MV highland spirit utilised a compensated marine drilling system for boreholes and a wireline PCPT system for Piezocone Penetration Test. The MV Kommandor Calum is predominantly equipped with survey equipment, alongside the capacity for downhole PCPT testing. A combination of survey equipment was operated from the MV Kommandor Calum to ensure drilling and CPT tests were completed using the correct methodology. Providing temporary replacement for the MV Highland Spirit, the MV Greatship Manisha provided the same equipment to continue operations. The results provided by the survey vessels during the site investigations enabled Moray East to acquire adequate geotechnical data to progress the design of a robust foundation solution.</p> <p>To complete the required scope, the site investigation work consisted of 24 50 m BSB composite boreholes, two 60m BSB composite boreholes and three continuous PCPT's to 15m BSB (20 m North, South and East) at each WTG location. Soil conditions encountered during the investigation were difficult to characterize consistently, showing variability across the site. The soils that were encountered across the site, consisted of a combination of sands and silts through to clay. 'Duality' in the behavioral characteristics of the soils was also identified, showing both granular and cohesive properties. Whilst the investigation also identified several samples which showed soils to have more strength and exhibited slight or weakly cemented properties. The soil properties identified by this site investigation are important when reviewing the soils for defining the lithological and engineering characteristics.</p>	

3.1.4 Geophysical Survey

Type of Survey: Geophysical Survey	Coverage: Moray East site
Timescales: 30th July 2017 – 10th August 2017	
Contractor: Horizon	
<p>Geophysical survey operations were completed between the 30th July 2017 and 10th August 2017 by the survey vessel DP2 Horizon Geobay, within water depth ranges of between 40-57 m. The survey identified and recorded possible debris (eight), boulders (14,437), areas of high-density boulders/cobbles (338), magnetic anomalies (561) and cables (one). An uneven seabed with a west to east sloping gradient containing three types of seafloor sediments was identified within the Moray East site. On the seabed, both features and obstructions were recorded. Features included trawl marks from fishing activities, with additional trench and sand ripples observed. Identified obstructions were divided between possible items of debris and boulder locations. Within the boulder survey obstructions, an area of high-density boulders was surveyed and separately located for identification and potential avoidance. Further seafloor surveying was targeted at identifying any existing infrastructures within the survey site. Survey results confirmed the absence of existing infrastructure, except an interpreted cable in the eastern limit of the Moray East site.</p> <p>As a further survey requirement, magnetic anomalies were recorded throughout the Moray East site. A total of 561 magnetic anomalies were observed, highlighting the potential presence of foreign objects in the seabed. For shallow</p>	

Type of Survey: Geophysical Survey	Coverage: Moray East site
Timescales: 30th July 2017 – 10th August 2017	
Contractor: Horizon	
<p>geology and stratigraphy results, a UHR seismic survey was conducted. This survey achieved an approximate 300 m sub-seabed penetration and observed geology comprised of very silty fine silica sand overlying very stiff to hard clay layers. Potential geohazards were also surveyed; however, no possible shallow gas accumulations were detected. The only geohazards recorded were a few prominent faults in the shallow depths and numerous small settlement faults.</p>	

3.1.5 Geotechnical Survey

Type of Survey: Geotechnical Survey	Coverage: Moray East site
Timescales: 7th July 2017 – 7th April 2018	
Contractor: Horizon/Fugro	
<p>The geotechnical survey operations were split into two phases. Horizon completed borehole work for both phases using Horizon’s DP2 drilling vessel Horizon Geobay, whilst Fugro completed CPT from the MV Larissa during the second phase. Horizon’s operations were completed between the 7th July 2017 and 16th September 2017 and Fugro completed operations between the 10th November 2017 and 21st November 2017. Phase two operations for the MV Larissa were performed between the 6th January and the 14th January 2018.</p> <p>In total, Horizon drilled 31 boreholes in two different tranches. During the initial tranche, 15 continuous sampling boreholes were drilled at eight locations. Three locations were drilled in a single attempt, four were drilled in two attempts and one was drilled in four attempts. During the second tranche, 16 continuous sampling boreholes were drilled at thirteen locations. Ten locations were drilled in a single attempt and three were drilled in two attempts. The ground conditions recorded were highly variable spatially both in terms of vertical and lateral extent. This made it difficult to identify soil and sediment characterisation between borehole locations. From the survey results, the soil types encountered were a combination of clays with varying degrees of secondary granular fraction, sands with varying fines and occasional much coarser layers containing gravels and in rare cases, cobbles to possibly small boulder sized constituents. Fugro carried out 65 CPT test locations in phase one and 22 in phase two on the MV Larissa. Several layers were found to contain significant number of beds of different soil types. The dominant soil type being sand, with many beds of clay. Dominant soil type was reviewed across all geotechnical logs for consistency in approach.</p>	

3.1.6 Geophysical Survey & Shallow Geotechnical Site Investigation

Type of Survey: Geophysical & Geotechnical	Coverage: Moray East site Inter-Array Cable Route
Timescales: 21st March 2018 – 20th June 2018	
Contractor: Gardline	
<p>The geophysical survey for the Moray East site was completed by the MV Ocean Observer vessel and focused on the inter-array cable routes. The wind farm was split into three sections to correspond to three different OSP locations, whilst between three and nine survey lines per corridor were completed to cover the inter-array cable positions. Cross lines were also surveyed approximately every 0.5 km to 1 km along the inter-array cable routes. Identification of seabed features within the Moray East site were conducted during this geophysical survey. Seabed features were identified by using side-scan sonar and multi-beam data, alongside, British Geological Survey (BGS) existing data. Numerous sonar objects were discovered within the survey data and for reporting purposes, these were grouped into; boulders, debris and linear debris. Bathymetric survey results identified common sand accumulations across the seabed site, with a gentle undulating seabed comprising numerous localised bathymetric lows. Sediment composition confirmed as a mixture of sand, sand with gravel patches and gravel with sand patches. Confirmed seabed features were identified as small depressions, surrounding boulders, likely caused by scour. Further seabed features were identified as magnetometer anomalies and debris items.</p>	

Type of Survey: Geophysical & Geotechnical	Coverage: Moray East site Inter-Array Cable Route
Timescales: 21st March 2018 – 20th June 2018	
Contractor: Gardline	
<p>The geotechnical site investigation was completed by the MV Ocean Vantage undertaking the CPT sampling of the geotechnical scope of work. 246 CPT tests were completed along inter-array sections. Water depth ranges for the geotechnical site investigations varied between 39.4 m and 53.9 m. Within inter-array section 1, most of the soil composition consisted of very loose to very dense locally gravelly silty sand. A presence of low becoming medium strength sandy clay was also recorded with the presence of occasional shell fragments. Interbedded layers of high to extremely high strength gravelly sand is present locally beneath the above described soil layering. On inspection of inter-array section 2, the soil composition was similar to that identified within inter-array section 1. Section 2 does have a difference with the presence of a structureless chalk bed, not identified within section 1. In comparison, both inter-array sections surveyed have similar soil composition. Minor differences in section 2 compared to section 1 are the added presence of the structureless chalk bed and greater composition of interbedded layers in section 2 than section 1. Section 3 of the inter arrays consists of fine to coarse sands of varying thickness with frequent gravel size shell fragments. Below this later are clays, with high strength clays occurring more frequently toward the Northeast of the wind farm area.</p>	

3.1.7 Unexploded Ordnance (UXO) Survey

Type of Survey: UXO and Boulder Surveys	Coverage: Moray East site OfTI Corridor
Timescales: 20th May 2018 – 8th January 2019	
Contractor: Bibby HydroMap	
<p>Bibby HydroMap was contracted by Moray East to carry out UXO and boulder surveys within the Moray East site and OfTI Corridor. This survey was initially undertaken by the MV Kommandor Stuart, with its survey operations completed between 20th May 2018 and 23rd September 2018. The Bibby Tethra was then assigned to complete additional surveys between 12th December 2018 and 8th January 2019. The MV Kommandor Stuart was equipped with Kongsberg EM2040 300 kHz multibeam echo sounder, iXblue GAPS USBL system and motion sensor, Edgetech 4200 MP dual frequency side scan sonar (300/900 kHz) and 8 x Geometrics G-882 magnetometers towed by 2 EIVA KATRIA ScanFish III. The survey plan consisted of a 270 m x 270 m survey box centered at each WTG and OSP location and a 50 m survey corridor was undertaken along each inter-array and interconnector cable. The combination of these surveys provided information on the presence of boulders, debris and magnetic data which would then be analysed with the aim of identifying potential UXOs. This survey data identified locations for further inspection and clearance activities if identified as a UXO target. Boulder survey data provided boulder positions on the seabed for accurate removal at a later stage by the boulder and debris clearance contractor.</p> <p>For the wind farm site, 63,172 boulders, 1762 sonar targets and 480 magnetic targets (110 of which were modelled as potential UXO and 20 Magnetic Masking Areas) were identified. Regarding the OfTI corridor, 20,800 boulders, 644 sonar targets, 480 magnetic targets (100 of which were modelled as potential UXO and 33 Magnetic Masking Areas) were recorded.</p>	

4 OfTI Corridor

4.1.1 Geophysical Survey

Type of Survey: Geophysical Survey	Coverage: OfTI Corridor
Timescales: 6th May 2014 – 26th June 2014	
Contractor: Gardline	
<p>The geophysical survey operations targeted a common offshore section and two possible landfall options of Sandend and Inverboyndie. Regarding the common offshore section, a seabed composition of predominantly sand was present in bathymetry of 94-47 m. A seabed obstruction identification campaign within 5 m of the route was completed, detecting a magnetic anomaly and two boulders. Shallow soil analysis to 5 m below the seabed was surveyed to confirm the dominance of sand throughout the common offshore section. Separate to geology, cable constraints and hazards were surveyed. Boulder density was recorded during the seabed obstruction survey. Further debris items were occasionally detected within the route alongside a well surveyed position from magnetometer data. The Sandend landfall option of the survey followed a similar dominant composition of sand in bathymetry of between 95-4.8 m. A seabed obstruction identification campaign detected a significant boulder area along the proposed route from KP50.880 to KP55.620 within 5 m of the proposed cable route. Further shallow soil penetration at 5 m into the seabed were detected and confirmed the dominance of sand in the results. Cable constraints and hazards confirmed the significant boulder presence and increased debris distribution from fishing activities at the inshore sections. The Inverboyndie landfall option followed the same sand composition in bathymetry of between 95-4.2 m. Similar seabed obstruction identification observed significant boulder density locations. Present only on this route, an in-service fibre optic cable was detected east of the route centreline. A shallow 5 m seabed penetration detected the reoccurring sand dominance consistently recorded across all routes. Pipeline constraints and hazards followed similarly to the Sandend landfall option with significant boulder presence and increased debris distribution from fishing activities at the inshore sections. A fibre optic cable was detected as a hazard at 503 m east of route centreline.</p>	

4.1.2 Shallow Geotechnical Site Investigation

Type of Survey: Geotechnical	Coverage: OfTI Corridor
Timescales: 9th June 2014 – 26th June 2014	
Contractor: Gardline	
<p>The shallow geotechnical investigation was completed by the vessel MV Ivero between 9th June 2014 and 26th June 2014. 68 seabed CPTU stations and 68 seabed vibrocore stations were undertaken in water depth between 28.2 m LAT and 94.8 m LAT. For sampling collection, the Gardline Aimers McLean 3 m vibrocore and ROSON dual drive CPT rig were equipped on the MV Ivero. Once the samples were collected, all samples were capped, sealed and labelled accordingly by the geotechnical crew. All samples were then returned to the Gardline onshore facility in Great Yarmouth for further laboratory testing. The analysis of the CPTU results and vibrocore results indicates that the soils encountered along the cable route are highly variable. Despite this variable soil composition, three generalised soil types dominate the collected samples. These soil types are sand, clay and gravel. Their composition was recorded along the cable route as either an individual presence or a mixture between the three. To analyse these results, classification tests were performed. Classification tests consisted of analysing samples for varying features such as moisture content, bulk and dry density, particle density, particle size distribution, plasticity, index shear strength testing and maximum and minimum density testing. Further triaxial, shearbox and thermal laboratory tests were completed as part of the overall classification tests. These tests enabled the contractor to confirm the soil classification of the surveyed site and produce geotechnical data from the samples obtained.</p> <p>Seabed CPTU operational test results were collected and categorized in different accuracy classes, with the majority of CPTUs carried out within accuracy classes 1 and 2 of the ISO 22476-1:2012 Geotechnical Investigation and Testing. Laboratory testing was then completed on the site soil samples to evaluate the physical and mechanical features of the soil. These laboratory tests enabled more accurate particle size analysis and confirmed the composition of the dominant sand, clay and gravel soil types. The exact laboratory tests also followed the same process as described for the classification tests above.</p>	

4.1.3 Topographic Beach Survey

Type of Survey: Topographic Beach Survey	Coverage: OfTI Corridor Landfall Area
Timescales: 10th May 2014 – 14th May 2014	
Contractor: Titan Environmental Surveys Ltd	
<p>A topographic beach survey of the two possible landfall beaches was undertaken by Titan Environmental Surveys Ltd. This survey was completed by the M.V. Titan Explorer as part of the inshore geophysical survey of the OfTI corridor, between the 10th May 2014 and 14th May 2014. The objective of this survey was to determine the topographical features that could impact on the satisfactory installation and trenching of the cable. Topographic surveys were completed at two possible landfall locations, Sandend and Inverboydie, as in 2014 an export cable route had not yet been confirmed. Within the topographic beach survey location, no bathymetry data was available. This absence of bathymetry data was replaced by the results of the topographic beach survey.</p> <p>At the Sandend Landfall option, the survey results of the topographic beach survey indicated beach sediments comprising sand until the route traverses beach defences comprising large concrete blocks. Similar recordings of beach sediments were identified at the Inverboyndie Landfall option, however, without beach defences. The end of the Inverboyndie option featured beach sediments comprising a pebble bank.</p> <p>Further restrictions on data gathering within the survey results from the inability to collect shallow profiler data, otherwise allowing the interpretation of shallow soils. With the topographic beach survey being completed as part of the inshore geophysical survey during a short time period of weather downtime, the survey results are limited.</p>	

4.1.4 Nearshore Shallow Geotechnical Site Investigation

Type of Survey: Shallow Geotechnical Investigation	Coverage: OfTI Corridor Nearshore Area
Timescales: 22nd May 2015 – 27th May 2015	
Contractor: Gardline	
<p>A nearshore shallow geotechnical site investigation was completed by the MV Green Isle vessel between the 22nd May 2015 and 27th May 2015, after mobilizing from Macduff harbour on the 21st May 2015. Thirty-six CPTUs were completed during the CPTU testing to collect geotechnical data on the ground suitability for export cable burial. Within the thirty-six CPTUs, twenty-three were tested with thirteen repeat tests carried out. Survey operations were performed using a 100 kN ROSON wheel driven rig in water depth ranging from a maximum 41.4 m LAT and a minimum 4.1 m LAT.</p> <p>All seabed CPTU locations had a target penetration of 3.0 m. Retests were completed where penetration failed to reach 70 % of the 3.0 m target, or otherwise 2.1 m. A total of two attempts were scheduled by Gardline at each location penetration failed to meet this target</p> <p>To enable conclusive results on the soil layering, results were based on the three factors of soil description, index shear measurements and the CPTU data. Results from the CPTU data indicated that the shallower water sediment consisted of medium dense sand overlying very dense gravelly sand. An indication of a hard layer, possibly bedrock, was also detected due to CPT tests terminating. In deeper waters, sediment composition consisted of medium dense to very dense sand with occasional gravel overlying a medium strength clay. Underlying this clay, a record of high to extremely high strength gravelly clay was sampled.</p>	

4.1.5 Nearshore Geophysical

Type of Survey: Nearshore Geophysical	Coverage: OfTI Corridor Nearshore [Inverboydie Bay]
Timescales: 17th August 2017 – 26th August 2017	
Contractor: Bibby HydroMap	
<p>A nearshore geophysical survey was completed at Inverboyndie beach between the 17th August 2017 and 26th August 2017, with a survey area approximately 1 km long from landfall at Inverboyndie beach and covering 430 m in width. Survey lines were operated in a north-east to south-west orientation at 20 m line separations and several 100 m crossline spacings. Bathymetry in the survey site had a minimum 2.4 m inshore range, to a maximum 9.0 m at the offshore data limit. Further bathymetry results indicated the seabed dips gently towards the north-northeast, with a small exception in the south-west, south and east of the survey site.</p> <p>Seabed sediments were surveyed and recorded, indicating a general sandy composition with areas of outcropping rock. Regarding seabed features, a total of 128 sonar contacts were recorded. These were formally identified as boulders; however, none were recorded within 20 m of the proposed cable centre line. Sonar equipment was also deployed to detect any linear seabed orientation for potential man-made objects. A linear orientation was detected; however, an absence of magnetic detection confirmed the absence of a foreign object. A total number of five magnetic anomalies were detected throughout the survey, with none detected within 2 m of the proposed centre line. Two are believed to be geological features and the other two relate to a fibre-optic telecommunications cable. A total absence of buried objects was detected on the sub-bottom data.</p> <p>A comparison with an earlier 2014 survey, indicated some changes in the data recorded. Located in the inshore section, data comparison has shown the seabed is deepening from 2 m to 3 m LAT. A recorded increase in the exposure of clay and rock has also been detected. Clay in the north east of the site and rock expansion in the northern survey section, extending further to the west. All sonar contacts identified during the 2014 survey were identified in the 2017 survey, except for a slight increase in boulder presence. Surface sediment thickness has not shown any noticeable difference since the 2014 survey.</p>	

4.1.6 Geophysical Survey & Shallow Geotechnical Site Investigation

Type of Survey: Geophysical & Geotechnical	Coverage: OfTI Corridor
Timescales: 21st March 2018 – 26th May 2018, 31st May- 20th June	
Contractor: Gardline	
<p>The geophysical survey and shallow geotechnical site investigation surveying was completed by the vessels MV Ocean Observer and MV Ocean Vantage. Surveying responsibilities were split between the two vessels, with the MV Ocean Observer responsible for the geophysical surveying and core sampling part of the geotechnical scope. The remaining CPT sampling of the geotechnical scope of work was completed by the MV Ocean Vantage. To complete the survey operations, these vessels were equipped with single beam and multi-beam echo sounder, side scan sonar, pinger, boomer, magnetometer, vibrocores and CPT equipment. These survey operations consisted of data collection along three proposed offshore export cable routes.</p> <p>To survey the proposed OfTI corridor, a 500 m surveying corridor along the proposed cable routes was established. Extending from nearshore 10 m LAT to the commencement of the 500 m surveying corridor south of the site boundary, a centreline and two wing lines along the cable route was surveyed. Additional cable route surveying was completed within a 100 m corridor, in addition to co-located CPT and vibrocore samples at designated sites.</p> <p>A side scan sonar was utilised to detect numerous seabed features as part of the geophysical survey and categorized into boulders, debris and linear debris. The magnetometer data were analysed with software Oasis Montaj, identifying numerous anomalies within the route corridor. This survey identified installation constraints and hazards, particularly regarding boulder fields. Seabed sedimentation along the routes comprised varying levels of mixed or single composition of sand, gravel, clay and outcrops of bedrock. Though sections of shallow soils of the cable route are identified as being highly variable, one of the four soil types listed are consistently dominant in a mixture or single composition.</p>	

4.1.7 Nearshore Geotechnical Site Investigation

Type of Survey: Geotechnical Site Investigation	Coverage: OfTI Corridor Nearshore Area
Timescales: 10 th November 2017 – 3 rd March 2018	
Contractor: Fugro GB Marine Limited	
<p>A nearshore geotechnical site investigation was completed to investigate soil composition data in assisting the development of the Moray East Offshore Wind Farm and OfTI. This investigation was completed by a variety of survey vessels at different deployment times. These survey vessels were the MV Larissa, MV Fugro Voyager, MV Fugro Scout and MV Gargano. A combination of both seabed and downhole CPTs were deployed, with the MV Larissa being the only vessel to operate seabed CPTs. The remaining three vessels provided downhole CPT operations. Each downhole borehole was deployed at a location where CPT had initially been completed, with a target depth for each downhole borehole location being 60 m below the seafloor. To collect operational data, CPTs were deployed using a 20 tonne Mk IV continuous drive system and downhole CPTs were performed using Fugro’s WISON MK IV system.</p> <p>Once the soil samples were obtained through CPT deployment, the Robertson (2009) classification method was used for soil classification purposes. Similarly, strength terms were only interpreted for main soil layers but not for sublayers as recommended by Lunne <i>et al</i> (1997). Results identified a mixture of several different beds; however, a dominance of sand and clay was clearly present. Through each sample analysed, the dominant soil type of sand and clay was reviewed across all geotechnical logs for consistency in approach. In some material tested, the material was classified as being borderline sand/clay. These soil composition samples could not be identified, and it was not possible to differentiate between slightly sand or sandy clay. This soil profile classification conclusion is presented from interpretation of geotechnical logs, which are based on an analysis of the CPT data obtained.</p>	

5 Bathymetry

The difference in bathymetry between the survey locations described above is demonstrated in Figure 5-1 below. Bathymetry is generally consistent throughout the Moray East site of approximately 50 m in depth (LAT), with slightly deeper locations towards the east of the site of 57 m in depth (LAT). The shallowest bathymetry can be found at the west of the site at 37m of depth (LAT). All WTG and OSP locations are situated within a bathymetry range of between 39 m and 54 m (LAT). This change in the bathymetry is highlighted in the change of colours in the figure below. Progressing along the OfTI corridor from the Moray East site, the depth changed from about 50 m (LAT) at the northern end of the OfTI corridor route, deepening to about 90 m in depth (LAT) before shallowing to 60 m (LAT). On the approach to the shoreline, the bathymetry decreases again to approximately 100 m (LAT) at its deepest point before the natural shallowing towards the cable landfall site. The figure also represents the three landfall options surveyed for during project definition, with the chosen landfall route at Inverboyndie being shown with the export cables present. As the OfTI corridor approaches Inverboyndie, clear shallowing is indicated with a progressive change in bathymetry until landfall. Overall, survey locations along the OfTI corridor were completed at more variable bathymetry whereas survey locations within the Moray East site had more consistent bathymetry.

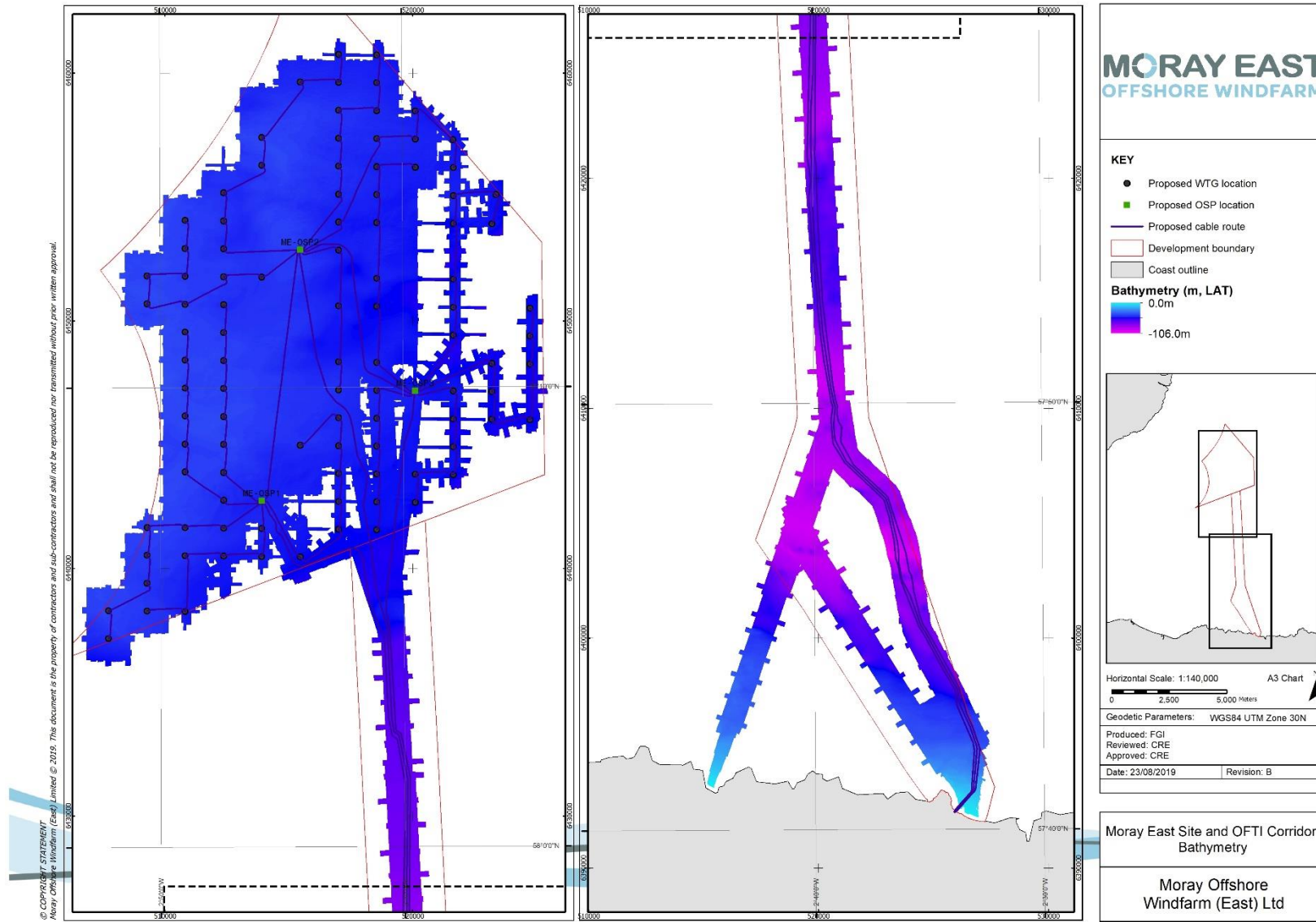


Figure 5-1: Moray East site and OfTI Corridor bathymetry



MORAY EAST

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