Wind Farm Cable Plan

Moray East Offshore Wind Farm

March 2019

Moray Offshore Windfarm (East) Limited

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List of Abbreviations

AC	Alternating Current
AtoN	Aids to Navigation
BOWL	Beatrice Offshore Wind Ltd.
CAA	Civil Aviation Authority
CaP	Cable Plan
CBRA	Cable Burial Risk Assessment
cm	Centimetre
CMB	Cable Marker Board
CMS	Construction Method Statement
CoP	Construction Programme
CPS	Cable Protection System
CPT	Cone Penetration Test
DECC	Department of Energy and Climate Change
DGC	Defence Geographic Centre
DGPS	Digital Geographic Positioning System
DIO	Defence Infrastructure Organisation
DP	Dynamic Positioning
DSLP	Development Specification and Layout Plan
EMF	Electromagnetic Field
EMP	Environmental Management Plan
EPCI	Engineering Procurement Construction and Installation
ERCoP	Emergency Response Cooperation Plan
ES	Environmental Statement
Fl	Flashing
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
IPS	Intermediate Peripheral Structure
JNCC	Joint Nature Conservation Committee
LAT	Lowest Astronomical Tide
m	Metre
MCA	Maritime and Coastguard Agency
Met Mast	Meteorological Mast
MGN	Marine Guidance Note
MHWS	Mean High Water Springs
ml	Millimetre
MOD	Ministry of Defence
Moray East	Moray Offshore Windfarm (East) Limited

MVAC	Medium Voltage Alternating Current
MW	Megawatt
NLB	National Lighthouse Board
nm	Nautical mile
NOTAM	Notice to Airmen
NVIS	Night Vision Imaging System
O&M	Operation and Maintenance
OFCOM	Office of Communications
OfTI	Offshore Transmission Infrastructure
OFTO	Offshore Transmission Owners
OMP	Operation and Maintenance Programme
OREI	Offshore Renewable Energy Installation
OSP	Offshore Substation Platform
Q	Quick
ROV	Remotely Operated Vehicle
S	Second
SAR	Search and Rescue
SNH	Scottish Natural Heritage
SPS	Significant Peripheral Structure
SSC	Suspended Sediment Concentrations
PEMP	Project Environmental Monitoring Programme
PLGR	Pre lay grapnel run
TI	Transmission Infrastructure
UK	United Kingdom
UKHO	United Kingdom Hydrographic Office
UXO	Unexploded Ordnance
V	Very
VMP	Vessel Management Plan
W	White
WTG	Wind Turbine Generator
Y	Yellow

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 Wind Farm Cable Plan (CaP);
- **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 known as the "Eastern Development Area" and 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;
- **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;

- **Inter-array cables** – network of AC subsea cables connecting the wind turbine generators (WTGs) and the OSPs within the Moray East site;
- **OSP interconnector cables** – AC subsea cables connecting the OSPs within the Moray East site; and
- **Export cables (offshore and onshore)** – AC cables connecting the OSPs within the Moray East site to the transition joint bays at the cable landfall site and onward to the AC collector station (onshore substation) near New Deer.
- **Moray East Offshore Wind Farm Consents** – are comprised of the following:

  <u>Section 36 Consents:</u>

  - 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.

  <u>Marine Licences</u>

  - Marine Licence for the Telford Offshore Wind Farm (as varied) – Licence Number: 04629/18/1 – 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 the 19 July 2018.
  - Marine Licence for the Stevenson Offshore Wind Farm (as varied) – Licence Number: 04627/18/1 – 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 the 19 July 2018.
  - Marine Licence for the MacColl Offshore Wind Farm (as varied) – Licence Number: 04628/18/2 - 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 the 19 July 2018.
- **OfTI Licences** – are comprised of the following:
  - Marine Licence for the Offshore Transmission infrastructure – Licence Number 05340/14/0 – 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 06347/17/1 – 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”)

Executive Summary

This Wind Farm CaP has been prepared to address the specific requirements of the relevant conditions attached to the Section 36 Consents and where applicable for the interconnector cables the OfTI Licences issued to Moray Offshore Windfarm (East) Limited (Moray East).

The Wind Farm CaP addresses each condition as set out in Section 1.2 and provides supporting specifications, engineering, planning and construction details to confirm alignment with the original application.

1 Introduction and Consents Conditions

1.1 Background

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 to as the Moray East Offshore Wind Farm Consents). Moray East was granted a Marine Licence for two Offshore Substation Platforms (OSPs) in September 2014 (OfTI Marine Licence). This Wind Farm CaP is submitted in accordance with the Section 36 Consents and the OfTI Marine Licence.

Moray East is a joint venture partnership between EDP Renewables, Engie and Diamond Generating and China Three Gorges and has been established to develop, finance, construct, operate, maintain and decommission the Moray East Offshore Wind Farm.

1.2 Objectives of this Document

The Section 36 and OfTI Marine Licence contain a variety of conditions that must be discharged through approval by the Scottish Ministers prior to the commencement of offshore construction. One such requirement is the approval of a cable plan, referred in this document as the Wind Farm CaP.

The relevant conditions setting out the requirements for a CaP for approval are set out in full in Table 1-1 below.

This document is intended to satisfy the requirements of the Section 36 Consents and OfTI Marine Licence conditions by providing a Wind Farm CaP that can be practically implemented during the construction and operation phases of the Development. This Wind Farm CaP covers the inter-array cables together with, to a more limited extent, the OSP interconnector cables and a separate OfTI CaP has been produced to cover the offshore export cables (Moray East, 2018a). The OSP interconnector cables have been included within this Wind Farm CaP on the basis that that a single contractor has been selected for the engineering and installation of the inter-array and OSP interconnector cables (with a consistent approach for the design and installation of the cables within the Moray East site).

The objective of the document is to provide supporting descriptions, data and evidence that the planning for the installation and operation of inter -array and OSP interconnector cables with the Moray East site are in accordance with the required consent conditions.

Table 1-1: Consent conditions to be discharged and reference sections

Consent Document	Condition Reference	Condition Text	Reference in this Cable Plan
Section 36 Consents	18	The Company must, no later than 6 months prior to the Commencement of the Development, submit a Cable Plan ("CaP"), in writing, to the Scottish Ministers for their written approval. Such approval may only be granted following consultation by the Scottish Ministers with the JNCC, SNH, MCA and any such other advisors or organisations as may be required at the discretion of the Scottish Ministers. The CaP must be in accordance with the ES. The Development must, at all times, be constructed and operated in accordance with the approved CaP (as updated and amended from time to time by the Company). Any updates or amendments made to the CaP by the Company must be submitted, in writing, by the Company to the Scottish Ministers for their	This document sets out the Wind Farm CaP for approval by the Scottish Ministers.

Consent Document	Condition Reference	Condition Text	Reference in this Cable Plan
		written approval. The CaP must include the following:	
		a. Details of the location and cable laying techniques for the inter -array cables;	Section 7 and 11
		b. The results of survey work (including geophysical, geotechnical and benthic surveys) which will help inform cable routing;	Section 8
		c. Technical specification of inter -array cables, including a desk based assessment of attenuation of electro-magnetic field strengths and shielding;	Section 7
		d. A burial risk assessment to ascertain if burial depths can be achieved. In locations where this is not possible then suitable protection measures must be provided;	Section 10
		e. Methodologies for over trawl surveys of the inter -array cables through the operational life of the wind farm where mechanical protection of cables laid on the sea bed is deployed; and	Section 13
		f. Measures to address exposure of inter -array cables	Section 12
OfTI Marine Licence	3.2.2.10	The Licensee must, no later than 6 months prior to the Commencement of the Works, submit a CaP, in writing, to the Licensing Authority for their written approval. Such approval may only be granted following consultation by the Licensing Authority with the JNCC, SNH, MCA, and the SFF and any such other advisors or organisations as may be required at the discretion of the Licensing Authority. The CaP must be in accordance with the Application. The CaP must include the following:	This document sets out the OSP interconnector CaP for approval by the Scottish Ministers.
		a. Details of the location and cable laying techniques for the cables;	Relevant details for the OSP interconnector cables included within Section 3 and 11
		b. The results of survey work (including geophysical, geotechnical and benthic surveys) which will help inform cable routing;	Relevant details for the OSP interconnector cables included within Section 8
		c. A pre-construction survey for Annex 1 habitat and priority marine features to inform cable micro-siting and installation methods in consultation with the Licensing Authority and their advisors;	Relevant details for the OSP interconnector cables included within Section 8
		d. Technical specification of all cables, including a desk based assessment of attenuation of electro-magnetic field strengths and shielding;	Relevant details for the OSP interconnector cables included within Section 7

Consent Document	Condition Reference	Condition Text	Reference in this Cable Plan
		e. A burial risk assessment to ascertain if burial depths can be achieved. In locations where this is not possible then suitable protection measures must be provided;	Relevant details for the OSP interconnector cables included within Section 10
		f. Methodologies for over trawl surveys of the cables through the operational life of the Works where mechanical protection of cables laid on the sea bed is deployed; and	Relevant details for the OSP interconnector cables included within Section 13
		g. Measures to address exposure of any cables.	Relevant details for the OSP interconnector cables included within Section 12

1.3 Cable Plan Scope

This Wind Farm CaP covers the following areas, in line with the requirements of the Section 36 Consents condition 18 and OfTI Marine Licence condition 3.2.2.10:

- Inter-array and OSP interconnector cable layout and cable routing description;
- The technical specification of inter -array and OSP interconnector cables and overall cable system including the thermal and electromagnetic field impact;
- The results of survey work including geophysical, geotechnical, Unexploded Ordnance (UXO) and benthic surveys which will help inform cable routing;
- Pre-cable installation enabling, and route preparation works;
- Cable laying techniques for the inter -array and OSP interconnector cables;
- The method of cable burial and/or protection;
- The cable burial risk assessment results and measures to provide cable protection;
- Measures which will be employed to monitor, and address potentially exposed inter -array or OSP interconnector cable throughout the life of the Wind Farm.

As highlighted in Section 1.2 above, the offshore export cables are covered under the OfTI CaP.

1.4 Cable Plan Document Structure

In response to the specific requirements of the Section 36 Consents condition 18 and OfTI Marine Licence condition 3.2.2.10, this Wind Farm CaP has been structured to clearly set out how each part of the specific requirements has been met and that the relevant information to allow the Scottish Ministers to approve the Wind Farm CaP has been provided. The document structure is set out in Table 1-2 below.

Table 1-2 Document Structure

Section		Summary of Contents
1	Introduction and Consent Conditions	Sets out the background, objectives and aims of the Wind Farm CaP, including the consent conditions related to the Wind Farm CaP.
2	Statements of Compliance	Sets out the statements of compliance in relation to the Wind Farm CaP consent conditions and the broader construction process.
3	Project Overview	Provides an overview of the whole project as background.
4	Timing of Construction Works	Sets out the key construction milestones.
5	Overall Construction Management	Sets out the manner of offshore construction management, coordination, operation and control.
6	Inter -array and OSP Interconnector Cable Supply and Installation Contractors	Identifies the key contractors and subcontractors for the inter -array and OSP interconnector cable installation.
7	Inter -array and OSP Interconnector Cable Specifications	Provides details of the cable specifications and the results of external electromagnetic field assessment.
8	Site Investigations	Details of survey work, including geophysical, geotechnical and benthic surveys conducted to inform cable routing.
9	Cable Routing and Constraints	Details the key constraints considered within route engineering.
10	Cable Burial Risk Assessment	Provides details of the cable burial risk assessment conducted to determine the burial targets.
11	Cable Installation and Protection	Briefly summarises the inter -array and OSP interconnector cable installation methods.
12	Cable Monitoring and Exposure Planning	Sets out the operation and maintenance programme and remedial procedures in the event that the cables become exposed, damaged or fail.
13	Over Trawl Surveys	Provides the rationale for evaluating the requirement for over trawl surveys.
14	Compliance with the Application	Sets out the requirement for compliance with the application. A detailed comparison of the approach set out in the Wind Farm CaP and how it compares with the application is provided within Appendix 1.
15	Updated Cable Trenching Methodology	Provides a comparison of the cable trenching assessment carried out as part of the Moray East ES 2012 and the proposed trenching methodology provided within this Wind Farm CaP.
16	References	Details all references used to develop this Wind Farm CaP.

1.5 Linkages with other Consent Plans

The consent conditions that require the development of a CaP do not explicitly identify linkages between this and other consent plans. However, other conditions require that several consent condition plans be consistent with the Wind Farm CaP; these plans are identified in Table 1-3 below.

Table 1-3: Cable Plan consistency and links to other consent plans

Condition	Consent Plan	Consistency with and linkage to Wind Farm CaP
Section 36 Condition 10; OfTI Licences Condition 3.2.2.4	Construction Method Statement (CMS)	The purpose of the CMS is to detail the methods that will be implemented during the construction of the Development. The cable installation and burial methods detailed are consistent with the Wind Farm CaP.
Section 36 Condition 26; OfTI Licences Condition 3.2.1.1	Project Environmental Monitoring Programme (PEMP)	Provides an overview of seabed scour and local sediment deposition monitoring this shall be consistent with the Wind Farm CaP.
Section 36 Condition 12; OfTI Marine Licence Condition 3.2.2.6 and OSP Marine Licence Condition 3.2.2.7	Design Specification and Layout Plan (DSLP)	The details provided on the length and proposed arrangements of the inter-array cable network shall be consistent with the Wind Farm CaP.
Section 36 Condition 16; OfTI Marine Licence Condition 3.2.1.2 and OSP Marine Licence Condition 3.2.3.11	Operation and Maintenance Programme (OMP)	The OMP sets out the procedures and good working practices for the operational and maintenance (O&M) phase of the Development. The OMP must be consistent with the Wind Farm CaP.
OfTI Marine Licence Condition 3.2.2.10	OfTI CaP	The OfTI CaP sets out evidence that the installation and operation of the offshore export cables and interconnector cables are in accordance with the required consent conditions.

2 Statements of Compliance

The following statements re-affirm the Moray East commitment to ensuring that the Development is constructed and operated in such a manner as to meet the relevant legislative requirements set out by the Section 36 Consents and OfTI Marine Licence as well as broader legislative requirements.

2.1 Statements of Compliance

Moray East in undertaking the construction and operation of the Development will ensure compliance with this Wind Farm CaP as approved by the Scottish Ministers (and as updated or amended if required).

Where significant updates or amendments to this Wind Farm CaP are required, Moray East will ensure the Scottish Ministers (and relevant stakeholders) are informed as soon as reasonably practicable and where necessary the Wind Farm CaP will be updated and amended.

Moray East in undertaking the construction and operation of the Development will require compliance with other relevant consent condition plans as approved by the Scottish Ministers and identified in Section 1.5 above.

Moray East in undertaking the construction and operation of the Development will ensure compliance with the limits defined by the original Applications (including the project descriptions defined in the Moray East ES 2012 and Modified TI ES 2014) referred to in Annex 1 of the Section 36 Consents and Part 2 of the OfTI Marine Licence and in so far as they apply to this Wind Farm CaP (unless otherwise approved in advance by the Scottish Ministers).

Moray East will, in undertaking the design and construction of the Development, require compliance with the approved Wind Farm CaP (and all other relevant, approved Consent Plans) by the key contractors and subcontractors through condition of contract and by an appropriate auditing process.

2.2 Management of Change to the Cable Plan

Should there be a reason to modify methodologies brought about during the engineering stages of the project, such changes will be made to this document and resubmitted following the same review process as described in the Environmental Management Plan (EMP) (Moray East, 2018b).

As required by the Section 36 and OfTI Marine Licence conditions, any updates or amendments made by the Licensee, will be submitted, in writing, by the Licensee to the Licensing Authority for their written approval.

3 Project Overview

The Section 36 Consents require that the Wind Farm CaP includes the following:

"Details of the location and cable laying techniques for the cables."

A similar requirement is also included within the OfTI Marine Licence as detailed in Table 1-1 above.

This section provides a brief overview of the Development relevant to the Wind Farm CaP, including details of the location, and sets out the main roles and responsibilities in relation to Moray East and the key contractors. Details of the cable laying techniques are provided in Section 11 below.

3.1 Development Overview

The Development will consist of the following main components:

- A total generating capacity of approximately 950 MW, however the total generation capacity will be constrained by the Development's grid connection transmission entry capacity of 900 MW (further details provided within the DSLP (Moray East, 2019));
- Up to a 100 WTGs of no greater than 10 MW (further details provided in the DSLP);
- Jacket substructures each installed on three pile foundations driven into the seabed;
- Three AC OSPs to collect the generated electricity and transform the electricity for transmission to shore;
- A network of buried or (if burying is not possible) mechanically protected, subsea inter -array cables to connect strings of turbines together and to connect the turbines to the OSPs;
- Two buried or (if burying is not possible) mechanically protected subsea OSP interconnector cable circuits that link the OSPs to one another (as defined in the OfTI CaP (Moray East, 2018a));
- Three buried or (if burying is not possible) mechanically protected subsea export cable circuits, to transmit the electricity from the OSPs to the landfall at Inverboyndie Bay and connecting to the onshore buried export cable circuits for transmission to the onshore substation and connection to the national electricity transmission system (as defined in the OfTI CaP); and
- Minor ancillary works such as the deployment of met buoys and permanent navigational marks as defined in this Wind Farm CaP.

3.2 Project Location and Layout

The location of the Development in the Moray Firth is shown in Figure 3-1 below.

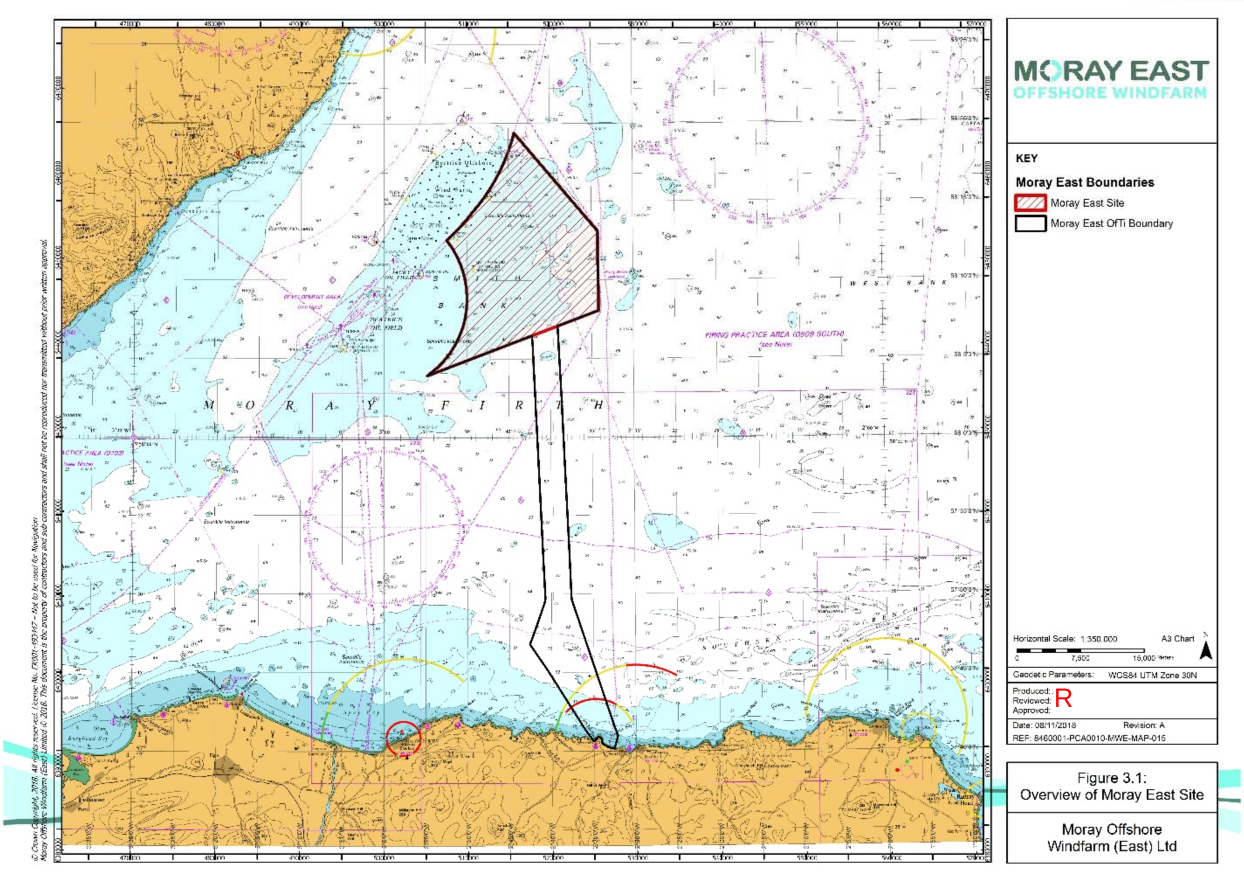

Figure 3-1: Overview of the Development Boundary

Figure 3-2 below shows the WTG and OSP layout across the Moray East site, subject to confirmation through final project design and engineering work, upon which this Wind Farm CaP is based. Further information on the layout of the Moray East site, including the specifications of the WTGs and OSPs and the location coordinates of each structure, is provided in the DSLP. Note that Figure 3-2 includes up to seven spare locations (as per DSLP dated March 2019). As detailed within Section 2.1 above this Wind Farm CaP will be updated as relevant.

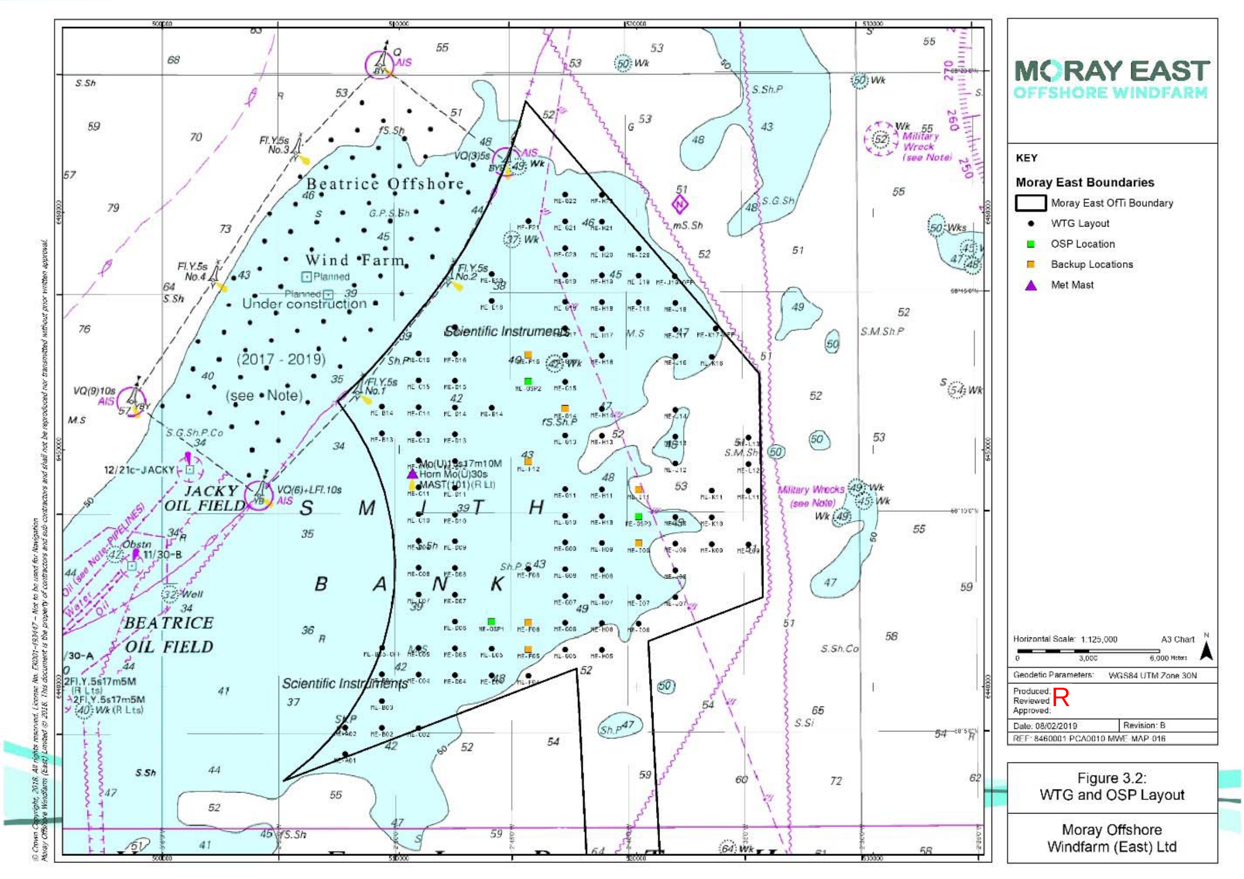

Figure 3-2: WTG and OSP Locations

4 Timing of Construction Works

This section provides an overview of the Moray East Offshore Wind Farm development (as consented under the Section 36 Consents and OfTI Marine Licence) and presents the key milestone dates for the commencement of works, the main construction activity and the commissioning of the Wind Farm.

Table 4-1 below identifies the key activities related to the inter -array and OSP interconnector cable construction. These are indicative and subject to change throughout the project. There is a planned six week break in activities from January 2021 to mid-February 2021. Full details of the construction programme are provided in the Construction Programme (CoP) and Construction Method Statement (CMS) document (Moray East, 2018c)[1].

Table 4-1: Indicative Construction Timeline (inter -array and OSP interconnector cables)

Activity	Forecast Start Date	Forecast End Date [including winter break]
Boulder Clearance / PLGR	June 2020	August 2020
Pre-lay Survey	July 2020	-
Cable Loadout	Sept 2020	Feb 2021
Cable Lay	Oct 2020	April 2021
Cable Burial	Oct 2020	May 2021
Termination and Testing	Nov 2020	June 2021
Remedial Protection	April 2020	September 2021

[1] Please note that the programme included within Table 4-1 represents the inter-array and OSP interconnector installation programme as of October 2018 (updated from that referred within the CoP & CMS document dated September 2018). Further revisions of the CoP & CMS document (and of the Wind Farm CaP) will reflect updates to the installation programme as relevant.

5 Overall Construction Management

The overarching offshore construction management of the inter -array and OSP interconnector cable installation works will be coordinated under a centralised Moray East Marine Co-ordination function. Moray East will be responsible for the co-ordination of vessel movements, marine operations and work permitting within the Development and will provide 24-hour coverage during the construction phase of the project.

The daily work planning and sequencing of offshore operations, vessels, crew transfer, equipment movement, and permit applications as well as applicable safe systems of work is the responsibility of the inter -array and OSP interconnector cable key contractor.

Moray East will appoint a Company Fisheries Liaison Officer (CFLO) and Fisheries Liaison Officers (FLOs) to support Moray East through the construction phase. The CFLO will be the primary point of contact for the fishing industry and will ensure timely provision of information regarding the development to the local fishing industry. The role of the CFLO is detailed within the FLOWW Best Practice Guidance for Offshore Renewables Developments: Recommendations for Fisheries Liaison (January 2014). The role of the FLOs will be to act as an intermediate communication point between Moray East's contractors and the fishing industry on site during offshore construction works and as such much of the FLO's roles will be based on construction vessels.

6 Inter-Array and OSP Interconnector Cable Supply and Installation Contractors

6.1 Key Contractor

The inter -array and OSP interconnector cable supply, installation and completion works will be carried out under an Engineering Procurement Construction and Installation (EPCI) contract between Moray East and Boskalis Subsea Cables & Flexibles (formally VBMS). Boskalis is a leading installation, dredging and marine contractor with significant experience in the offshore wind market. Past inter -array cable projects include; Blyth Offshore Demonstrator, Dudgeon, Aberdeen Bay, Galloper, Nordsee Ost, Butendiek Offshore Wind Farms. Boskalis comes with significant inter -array cable experience as well as general company-wide resources and planning for marine and subsea construction operations.

The CoP and CMS document provides an overview of the key Wind Farm and OfTI contractors.

6.1.1 Key Subcontractors

The supply of the 66kV cable and accessories will be undertaken by JDR UK Ltd. The cables will be manufactured and loaded out from the JDR Hartlepool Facility.

The inter-array and OSP interconnector cable installation and burial activities will be carried out by Boskalis.

Examples of other services that may need to be subcontracted include support vessels, guard vessels, survey services, transport services, supply of minor components, waste services, vessel provisioning and bunkering services, and provision of equipment to be used in the construction works.

7 Inter-Array and OSP Interconnector Cable Specifications

The Section 36 Consents require that the Wind Farm CaP includes the following:

"Technical specification of inter-array cables, including a desk based assessment of attenuation of electro-magnetic field strengths and shielding."

A similar requirement is also included for the OfTI Marine Licence as detailed in Table 1-1 above.

The following section provides information relating to the specification and design of the inter-array and OSP interconnector cables.

7.1 Inter-Array and Interconnector Cable Field Layout

The inter-array and OSP interconnector cable layout provides connection between all WTGs (100) and OSPs (three). The cable connecting between WTG and the final connection to the OSP are defined as inter-array cables, whilst the cables connecting between the three OSPs are defined as OSP interconnector cables.

The inter-array cable layout is based on the WTG locations, with the position numbers following a grid system from A to J (West to East) and 01 to 22 (South to North). The OSP interconnectors are named as OSP1_OSP2 (10.3km) and OSP2_OSP3 (9.2km). Further detail is presented in Figure 7-1 below. The full layout map is provided in Appendix 2.

The layout is of a radial design with a single cable connecting each WTG in series back to the closest OSP. Up to eight WTGs are connected in 15 circuits (strings) back to each OSP.

At each WTG or OSP connection the cable and associated cable protection system (CPS) will be pulled into and through a steel J-tube mounted to the structure.

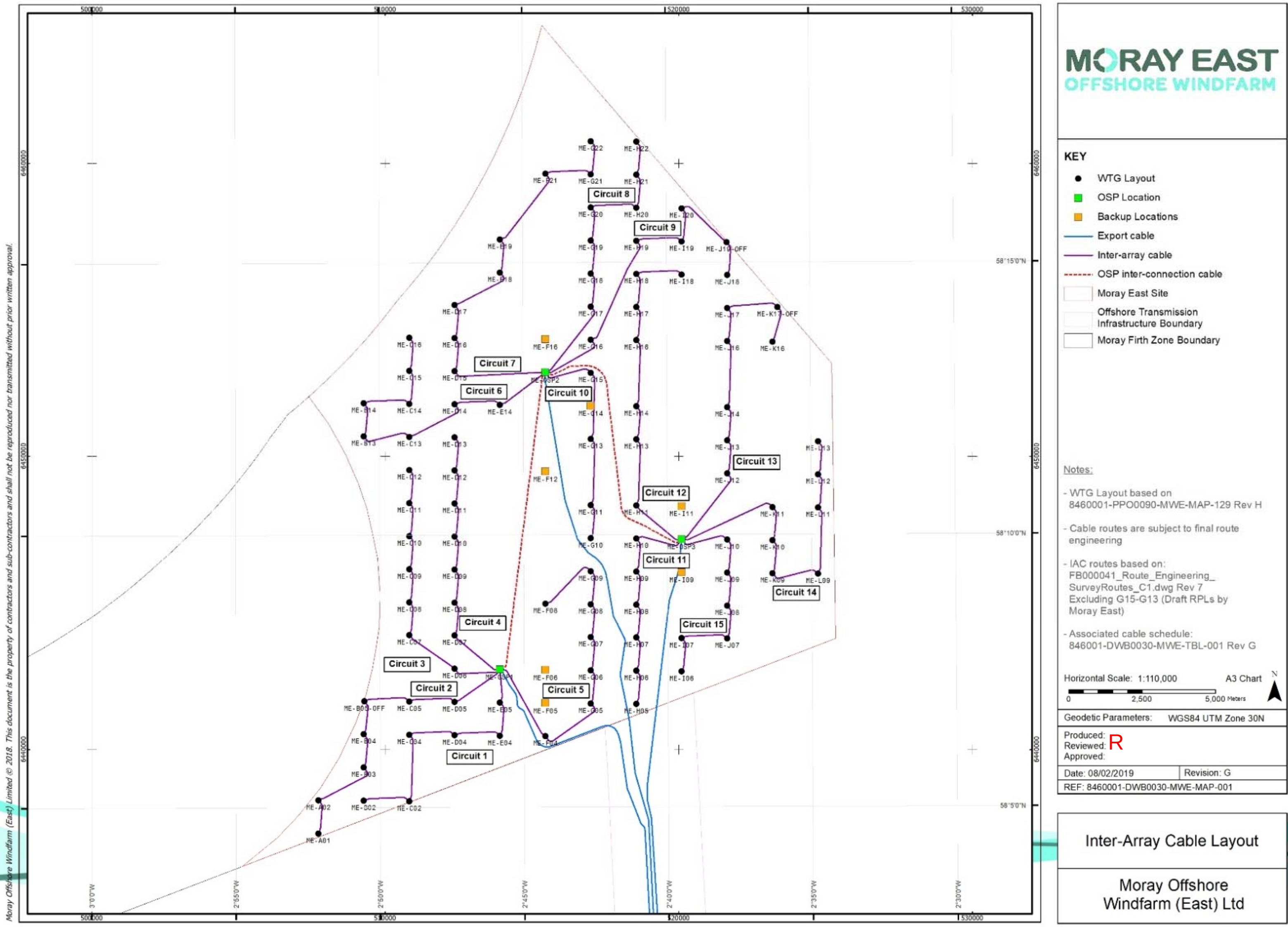

Figure 7-1: Inter -array and OSP interconnector cable routing.

7.1.1 Key Cable Data

Table 7-1 below provides pertinent data for the inter-array and OSP interconnector cables.

Table 7-1: Key cable data

Parameter	240 mm^2 size	630 mm^2 size	500 mm^2 size	Unit
Cable Outer Diameter	130	156	143	mm
Conductor Material	Aluminum	Aluminum	Copper	
No. of individual cable	60	40	2	
Total Installed Seabed Cable Length [inter -array]	85.7	70.4		km
Inter Connector Total Installed Seabed Cable Length			19.6	km
Weight / m (in air)	21.2	30.15	34,98	Kg/m
Weight / m (in seawater)	9.78	13.36	21.02	Kg/m

7.2 Inter-Array and Interconnector Cable Design and Construction

It is expected that three cable conductor cross sectional area sizes will be required; 240mm^2 and 630mm^2 aluminium types for the inter -array cables, and 500 mm^2 copper type for the two Interconnector cables.

The cable design is a high voltage alternating current (HVAC) for 66kV, with aluminium or copper stranded conductors (three phases) and XLPE insulation. The constructed cable will contain the associated metallic screens, sheaths, fillers and fibre optic elements and is encased by a single layer of helically applied steel armour wires (Figure 7-2 below).

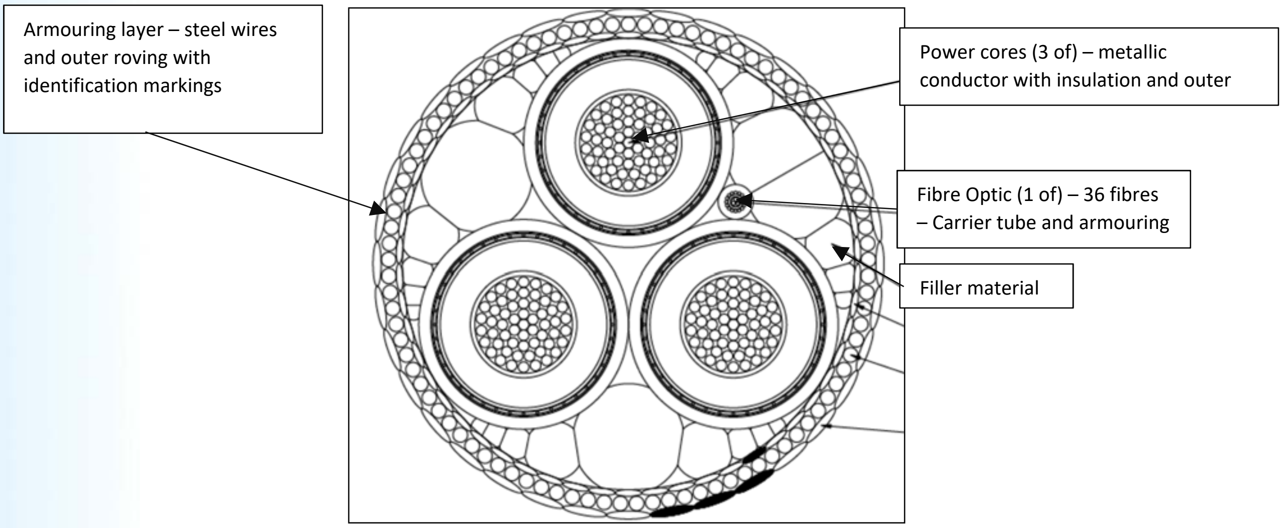

Figure 7-2: Inter -array and interconnector cable cross section – detailed components

The complete cable has three key elements to its construction, as detailed in Sections 7.2.1 to 7.2.3 below.

7.2.1 Power Cores

The three single power cores are used to transmit power in the three separate electrical phases between the WTGs and back to the OSP. The power core has a stranded aluminium or copper conductor, with a water-resistant insulation (cross linked polyethylene - XLPE) material. A copper wire screen and a final outer sheath with aluminium foil barrier is it fitted to provide insulation from the environment.

7.2.2 Fibre Optic Cable

The fibre optic cable contains single and multimode fibres are the primary method for communication between and control of the WTGs. These elements are contained in a stainless steel carrier tube and are protected with a mechanical armouring and outer sheath.

7.2.3 Armour Wires and Outer Roving

The outer cable layer consists of steel armouring wire with covering rovings. The armouring wires provide mechanical protection and the required structural capacity to handle and install the cables. The rovings provide environmental to the steel wire as well as providing identification of the cable type by coloured stripes.

7.3 Electromagnetic Field Assessment

This section summarises the results of a desk based assessment undertaken on behalf of Moray East analysing the attenuation of the electromagnetic fields (EMF) associated with the inter -array and OSP interconnector cables. Details of the electromagnetic field assessment associated with the interconnector cables are presented in the OfTI CaP.

The analysis calculated the EMF strength, measured in micro Teslas (µT) at a range of depths of lowering and measurement distances.

EMF attenuation from the inter-array cables measured at the seabed surface for a range of depths of lowering are shown in Figure 7-3 to Figure 7-6 below. The x-axis shows horizontal distance from the cable centre (metres) and the y-axis shows the EMF strength (µT). It was observed that the magnetic field decreases with (horizontal and vertical) distance from the cable.

As an example, when the depth of lowering is 0.5 m:

- For the 66 kV 240 mm² cable carrying a load of 350 A, the maximum EMF strength above the cable at the seabed surface is 13.91 µT
- For the 66 kV 630 mm² cable carrying a load of 700 A, the maximum EMF strength above the cable at the seabed surface is 32.76 µT

For context, a reference magnitude of the earth's magnetic field can be estimated from models available in the public domain[2]. Across the Moray East site and from sea level to maximum water depth the geomagnetic total field is estimated as 50.4±0.1 µT.

The geomagnetic field is largely stationary, although it can have some time variations. The magnitude of the variations is typically measured in µT, for example the total field in the vicinity of the Moray East site is estimated to be increasing at a rate of approximately 0.020 µT/year.

Considering the recommended minimum depth of lowering of 0.6 m stated in Section 10.7 below and review of the EMF values for the 0.5 m depth of lowering cases the anticipated cable burial depth depths will ensure the seabed surface EMF is within the acceptable limits. In all cases, the calculated magnetic

[2] https://www.ngdc.noaa.gov/geomag/

field associated with the inter -array cables at the seabed surface is expected to be lower than the earth's magnetic field.

The calculations are conservative in that they do not include the shielding effects of armour wire or helical cable core twisting. The EMF values presented are higher than would be calculated if armour wires were incorporated in the calculations. The ferromagnetic armour wires are generally understood to offer a level of mitigation and this is supported by published results of experiments[3].

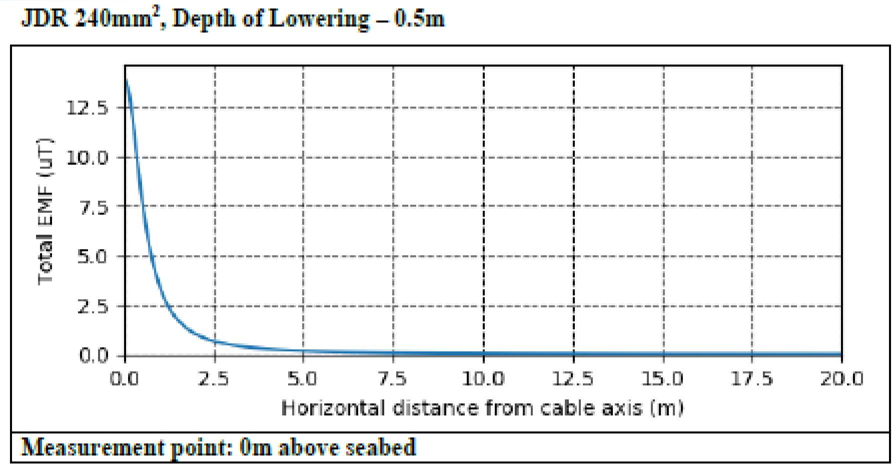

Figure 7-3: 66kV Inter -array cable 240 mm², Depth of Lowering - 0.5 m

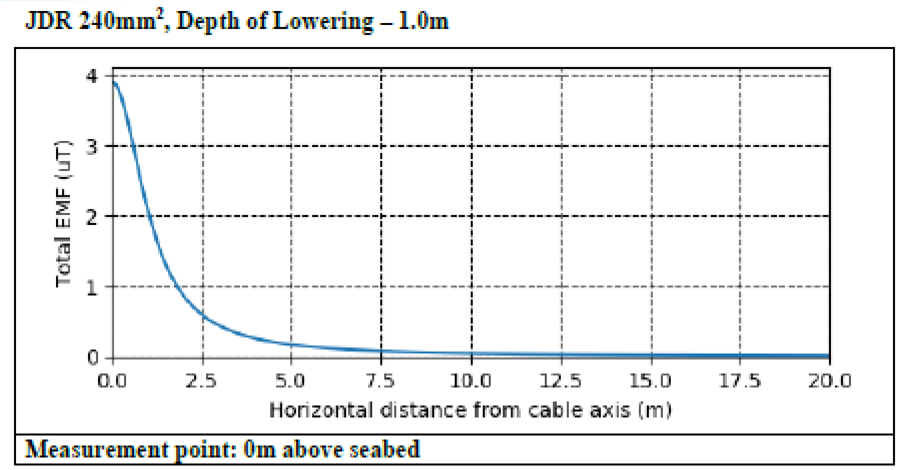

Figure 7-4: 66kV Inter -array cable 240 mm², Depth of Lowering - 1.0 m

[3] References include 'Comparison of losses in an armoured and unarmoured three phase cable', T. Ebdrup et al., paper B2-2, 9th International Conference on Insulated Power Cables (Jicable '15); 'Measurements of losses on three-core submarine cables', W. Frelin et al., paper B3.7, Jicable '15; 'Armour loss in three-core submarine XLPE cables', D. Palmgren et al., paper A.7.3, 8th International Conference on Insulated Power Cables (Jicable '11).

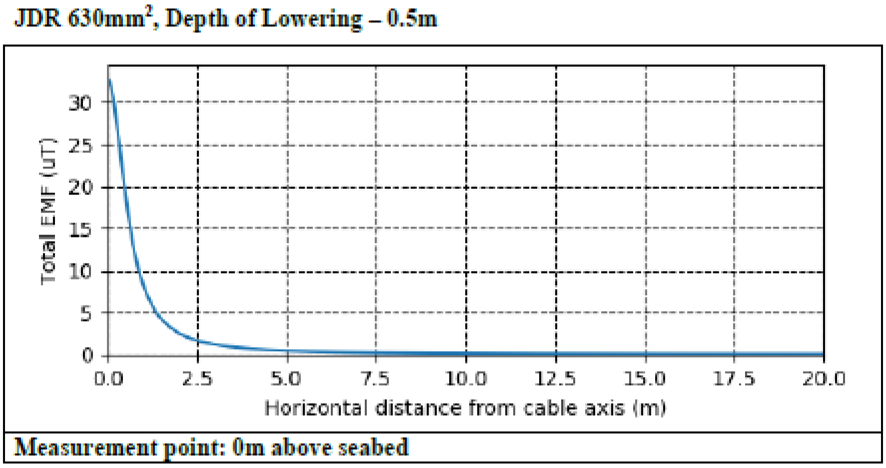

Figure 7-5: 66kV Inter -array cable 630 mm², Depth of Lowering - 0.5 m

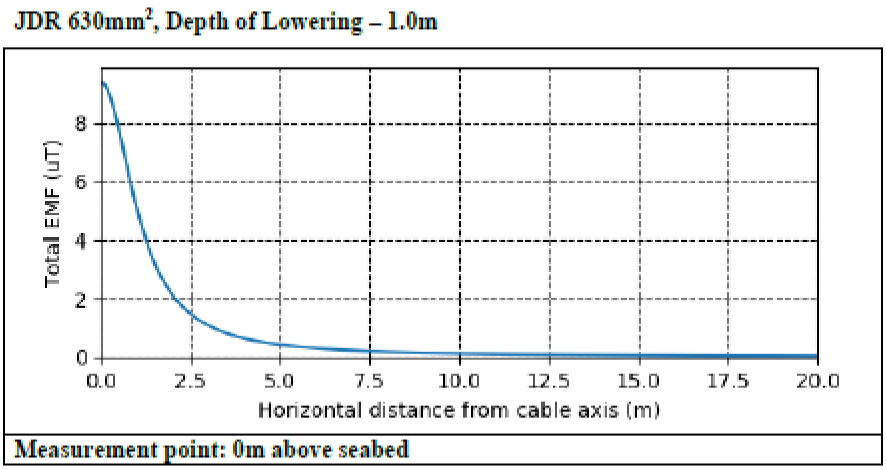

Figure 7-6: 66kV Inter -array cable 630 mm², Depth of Lowering - 1.0 m

7.4 Cable Protection System Specification

A cable protection system (CPS) will be designed, procured and installed on each cable end. Its purpose is to protect the cable where it is in a free span zone, from the structure cable entry point and into burial. In this zone, the cable is affected by dynamic environmental loads (waves and current). The CPS protects the cable from these loads and also provides impact protection. The design consists of polyurethane, cast iron, and polymer elements (Figure 7-7 below).

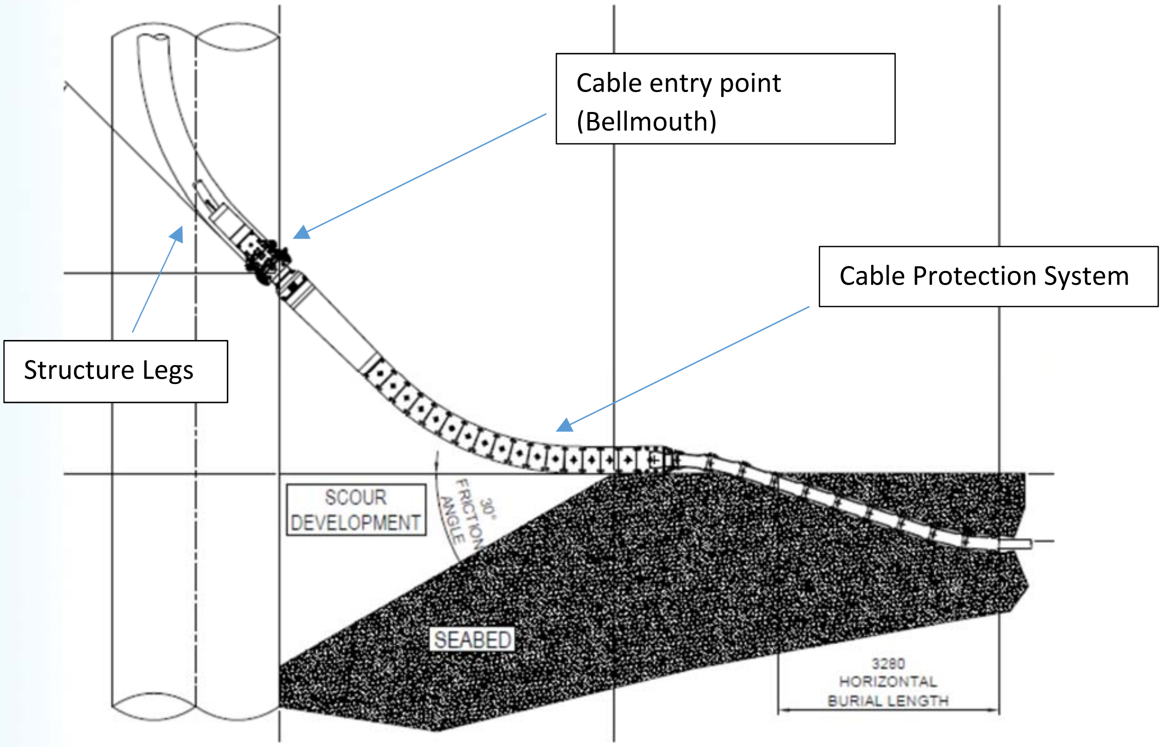

Figure 7-7: Cable Protection System

8 Site Investigations

The Section 36 Consents require that the Wind Farm CaP includes the following:

"The results of survey work (including geophysical, geotechnical and benthic surveys) which will help inform cable routing."

A similar requirement is also included for the OfTI Marine Licence as detailed in Table 1-1 above.

In order to support the route engineering and cable burial plan, Moray East has completed detailed geophysical and geotechnical surveys of the preliminary cable routes. The survey results provide the required soil and seabed condition information to allow the selection and specification of the burial tooling. The survey results also identify debris, wrecks or boulders which pose a hazard to trenching operations, as well as potential UXO within the defined survey corridors.

The following information is provided regarding the survey activities and the use of the acquired data in the engineering, route design and installation of the inter-array and OSP interconnector cables. Section 9 below provides information on key constraints identified through the surveys.

8.1 Development Surveys

A number of surveys have been undertaken between 2010 and 2018 to inform engineering and decision making regarding the inter -array and OSP interconnector cable layout and installation.

Table 8-1 below has been adapted from the Moray East Project Environmental Monitoring Programme (PEMP) (Moray East, 2018e), and represents all relevant documents and data files utilised in the process of developing the cables routes and burial requirements for the inter -array and OSP interconnector cables.

Table 8-1: Moray East site surveys

Survey	Survey Detail	Coverage	Date
Moray East site			
Geophysical Survey (Osiris Projects)	Multi-Beam Echo Sounder, Side Scan Sonar, Sub- Bottom Profilers, Magnetometer / Gradiometer.	100 % of the Moray East site.	2010
Deep Geotechnical Site Investigation (Fugro)	Composite boreholes.	19 Boreholes across the Moray East site.	2010
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

Survey	Survey Detail	Coverage	Date
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	Moray East site.	2018/2019

8.2 Benthic Surveys

In order to inform the Environmental Impact Assessment (EIA), a considerable amount of benthic ecological data have been collected from the Moray East site. These data were collected both from literature review and site-specific survey, involving grab and scientific trawl sampling and seabed video surveillance. The results of the sampling and analyses, as detailed in the Moray East ES 2012, were consistent with those of previous studies and showed that dominant seabed sediment habitat type was slightly gravelly sand with patches of shelly gravelly sand, sandy gravel and gravel. Levels of sediment contaminants were below guideline levels at all locations sampled. The benthic communities associated with these seabed habitat types were found to be rich and diverse and were characterised by polychaete worms (e.g. *S. bombyx*, *Notomastus* spp. *Lumbrineris gracilis* and *Chone* sp.), the burrowing urchin (*Echinocyamus pusillus*) and the bivalve *Cochlodesma praetenue*. Other commonly recorded species included the calcareous tube dwelling keel worm (*Pomatoceros triqueter*), soft corals, barnacles, sea firs (hydroids) and sea mats (bryozoans). Assemblages of more mobile epifauna, such as crab, fish, shrimps and starfish recorded include the common starfish *Asterias rubens*, burrowing starfish *Astropecten irregularis*, and sea urchins *Echinus* spp., crustaceans (e.g. *Aequipecten opercularis, Crangon allmanni*, *Pagurus bernhardus*, *Anapagurus laevis* and *H. coarctatus*) and the gastropod *Neptunea antiqua*.

The biotopes found within the Moray East site included closely related circalittoral (deep water) and offshore sand biotopes typical of central and northern North Sea areas. None of the habitats were considered to be geographically restricted or rare and were well represented within and around the study area. No rare or protected species with respect to the EC Habitats Directive 92/43/EEC and/or the Wildlife & Countryside Act 1981 were found within the boundaries of the Moray East site.

As a result, additional targeted pre-, during or post-construction benthic surveys within the Moray East site are not considered necessary. However, data collected as part of scour monitoring will also be analysed by an environmental specialist in the context of benthic monitoring (to confirm that no changes to benthic communities have occurred) as detailed within the PEMP. The rationale for this approach also takes into account the monitoring proposals of the adjacent Beatrice Offshore Wind Farm and the outcome of literature reviews on benthic monitoring at offshore wind farms.

8.3 Geophysical Survey (2018)

A specific site investigation survey was conducted by Gardline during Q2 and Q3 of 2018 (Figure 8-1 below). The data acquisition programme was carried out by two vessels. M.V. Ocean Observer undertook the geophysical part of the survey scope along with the core sampling part of the geotechnical scope, with M.V. Ocean Vantage undertaking the CPT sampling part of the geotechnical scope of work (see Section 8.4 below). The geophysical survey was undertaken using single beam and multi-beam echo sounder, side scan sonar, pinger, boomer and magnetometer.

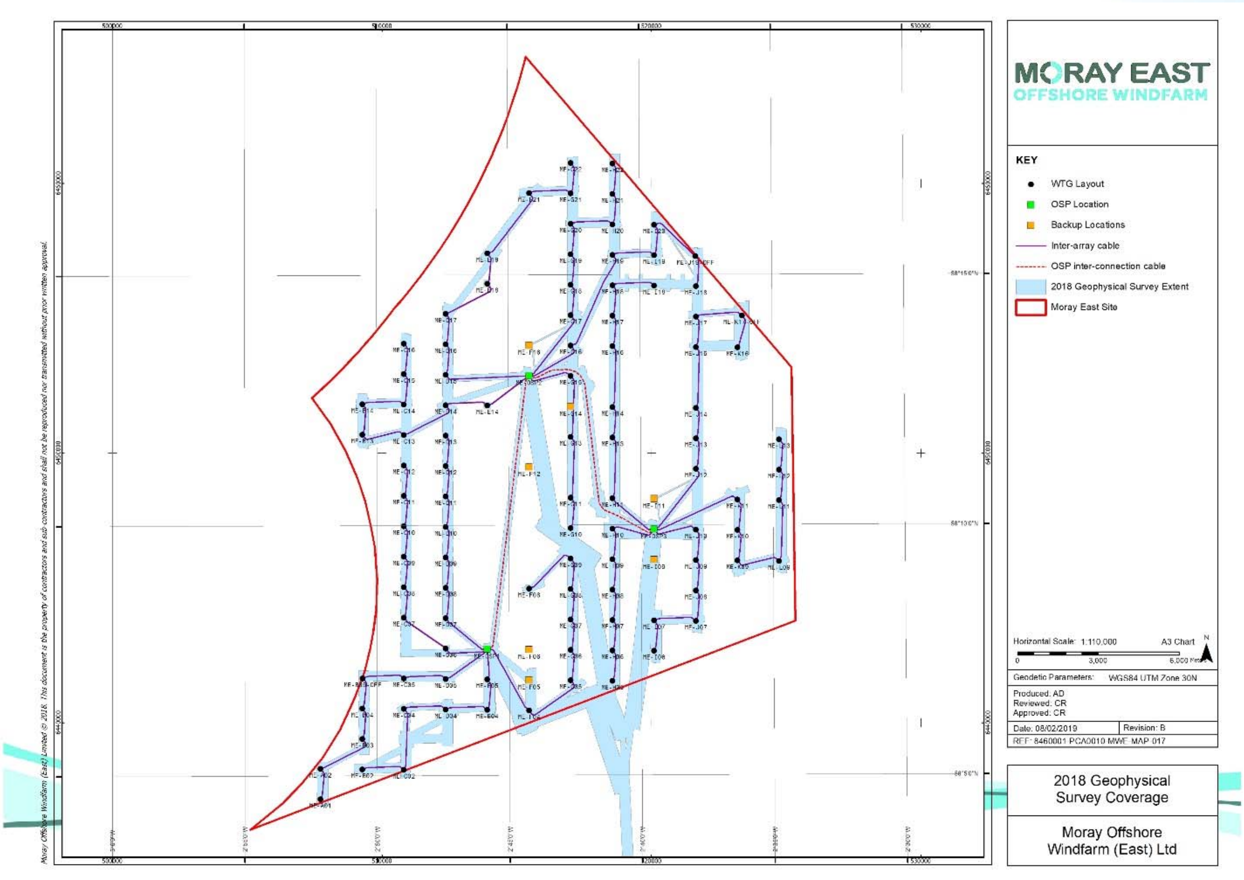

Figure 8-1: 2018 Geophysical Survey extents.

8.3.1 Bathymetry and Surface Features

The geophysical survey bathymetry results from the proposed cable routes range between 35 m to 65 m below LAT. Survey results show gentle undulating seabed comprising numerous localised bathymetric lows. Accumulations of sand, less than 1 m thick, are common across the seabed. There are localised east-west orientated channel features / linear depressions, up to 0.5 m deep. Seabed gradient on the flanks of these channels reach 3°, although gradients are generally <3°. This provides for good operating conditions for cable burial tools that will be used as part of the installation process. Seabed surface sediments comprise of a mix of sand, sand with gravel patches, gravel with sand patches and clay.

8.4 Geotechnical Survey (2018)

An inter-array and OSP interconnector cable specific geotechnical survey was undertaken in Q3 2018 (Figure 8-2 below). This was undertaken using a combination of Cone Penetration Tests and acquiring core sample of the soils up to a depth 3 m across the proposed Wind Farm cable routes. Further engineering and laboratory testing along with collated results from the geophysical surveys (see Section 8.3 below) provides insight into the soil types present across the site.

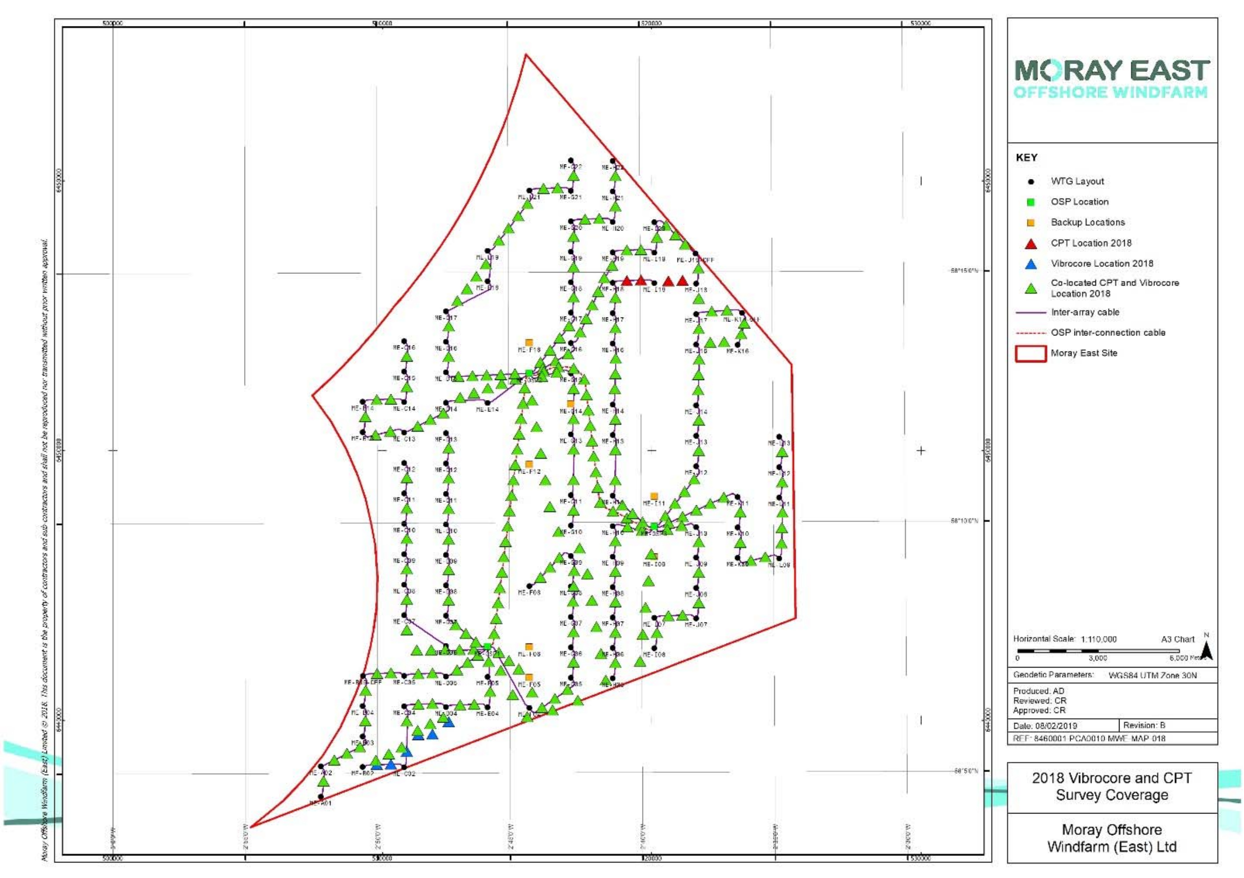

Figure 8-2: Geotechnical locations.

8.4.1 Shallow Geology

The geotechnical survey indicated that shallow soils (>3 m) across the site are generally characterised by a top layer of medium to very dense locally silty sand with occasional gravel / shell, occasionally interbedded with low to medium strength clay. Some deeper layers of medium to high strength clays are present.

It is anticipated that a large number of subsurface boulders will be present based on the level of surface boulders identified in the geophysical bathymetric and side scan sonar survey results.

8.5 UXO Survey and Clearance

As part of the 2018 site investigation a survey using multi-beam echo sounder, side scan sonar, and magnetometer was conducted to identify any potential UXO targets on the Moray East site. The preliminary cable routes have been surveyed and any potential UXO identified during the survey will be further investigated. If required, these will be removed from the inter -array and OSP interconnector cable routing corridors prior to commencement of construction under a separate Marine Licence.

8.6 Survey Results

The initial review of results from the surveys described in Sections 8.3, 8.4 and 8.5 above does not indicate a requirement for significant deviations to the cable routing across the site, either due to anticipated burial performance of the selected tools, or due to seabed or surface features. Preliminary assessment of the soil types shows the selected burial method and tooling has high potential to achieve the required minimum depth of lowering. Further site surveys may be required as dictated by engineering works and based on layout refinement.

9 Cable Routing and Constraints

The general key principles for cable route design considered by Moray East and the cable installation contractor can be identified as follows:

- The shortest or most efficient path between different offshore assets (WTGs and the OSPs);
- Avoidance of all identified exclusion zones and infrastructure;
- Consideration of all the constraints that bound the cable route such as the UXO clearance corridor, anomalies identified by geophysical and geotechnical surveys, large debris;
- Avoidance of shipping anchorages (if identified);
- Reduction in the number of alter courses (curves in route) to reduce installation time, and cable damage risk;
- Operation consideration of minimum cable straight distance (150 m) from the structure exit positions before any route alter courses;
- Consideration of constraints regarding operational limitations of trenching equipment (slope, offset distance, turning radius);
- Achieving target depth of lowering and minimise the amount of mechanical protection required; and
- Consideration of fishing activities and methods in the wind farm site including a review of historical data (section 10.3).

9.1 Routing Constraints

The cable route design is generally constrained by the defined consented boundaries of the Moray East Offshore Wind Farm consents. All cable routes are contained in this area. The western boundary of the Moray East site abuts the Moray West development area and proximity to potential WTG positions here is considered. On the eastern site boundary, the Caithness-Moray High Voltage Cable and SHEFA-2 cables run approximately North South. Whilst these cables sit outside the Moray East site, due consideration has been made in the routing of the closest inter -array cables.

The Beatrice Offshore Wind Farm to the North of the Moray East site is a considered constraint.

Constraints regarding the proximity to the offshore export cable (three) routes from the offshore substation platforms (OSPs) towards shore are also considered and adequate spacing to prevent impact during construction and operation is considered. The offshore export cable routes are detailed in the OfTI CaP.

9.2 Exclusion Zones

Following site survey, several locations of archaeological interest have been identified and archaeological exclusion zones (100 m and 50 m) have been applied and considered in cable routing (see Marine Archaeology Reporting Protocol (MARP) and Written Scheme of Investigation (WSI) Report for further details (Moray East, 2018d)).

There are several identified disused (plugged and abandoned) oil and gas wellheads located in the Moray East site. These have been considered and avoided during cable route design (further details provided within the DSLP (Moray East, 2019).

9.3 Route Engineered Locations

The planned cable route positions are identified in Figure 7-1 above. The finalised cable routes will be provided prior to construction to Marine Scotland and also as a part of the Notice to Mariners. Upon the outcome of further engineering works and surveys, minor modifications to the Route Position List (RPL) and protection of the inter -array and OSP interconnector cables may be proposed; however, these are not likely to result in significant changes to this Wind Farm CaP. As described within Section 2.2 above, this Wind Farm CaP will be reviewed in case of significant changes in the information provided. The final as built cable route details for the inter-array and OSP interconnector cables will be provided to Marine Scotland in line with the Wind Farm Marine Licences condition 3.2.3.2 (inter-array cables) and the OfTI Marine Licence condition 3.2.4.5 (OSP interconnector cables).

9.4 Route Deviations

During construction, unforeseen circumstances or previously unidentified hazards could result in minor route deviations, these would typically be within the cable survey and UXO clearance corridors. As such, large deviations (+/- 25m) from the planned routes are not foreseen.

10 Cable Burial Risk Assessment

The Section 36 Consents requires that the Wind Farm CaP includes the following:

"A burial risk assessment to ascertain if burial depths can be achieved. In locations where this is not possible then suitable protection measures must be provided."

A similar requirement is also included for the OfTI Marine Licence as detailed in Table 1-1 above.

The primary means of protecting the cables from hazards will be achieved by lowering of the cable into the seabed (burial). Secondary measures of protection which may be required are also detailed in this report, and consist of the use of rock armour, mattresses and CPS. Refer to Section 11 below for details.

This section of the Wind Farm CaP provides the information available to date. Should significant changes arise from the results of the engineering analysis then the Wind Farm CaP will be updated accordingly.

A cable burial risk assessment has been undertaken to assess the site specific human (primarily fishing and shipping), and natural hazards to the cables over the life of field. The recommended level of cable protection and depth of lowering is then defined for individual cable routes and soil conditions. The cable burial risk assessment has been completed by Cathie's Associates and is based on upon the 2018 site survey data (Cathie Associates, 2018a)).

10.1 Outline and Method

There are a wide range of processes and seabed users which can present a hazard to subsea cables, including fishing, dredging and seabed mobility. The aim of a Cable Burial Risk Assessment (CBRA) is to evaluate potential risks to the cable and provide recommendations as to the most efficient risk mitigation strategy.

The basis of a risk assessment for the inter -array and OSP interconnector cables relies on identifying the potential hazards, associated risks and evaluating the level of protection that may be afforded to the cable by its armouring (internal and/or external), cable burial beneath the seabed, and any other means, such as rock protection or concrete mattressing.

The methodology used will be in line with the industry guidance documents: "Cable Burial Risk Assessment Methodology, Guidance for the Preparation of Cable Burial Depth of Lowering Specification" (Carbon Trust (2015).

The general process is as follows:

- Seabed conditions and soils are assessed;
- All potential threats/hazards are identified and assessed for both the cable and seabed users; and
- Identified risks to cables are assessed in more detail and the burial or protection depths are determined (Figure 10-1 below).

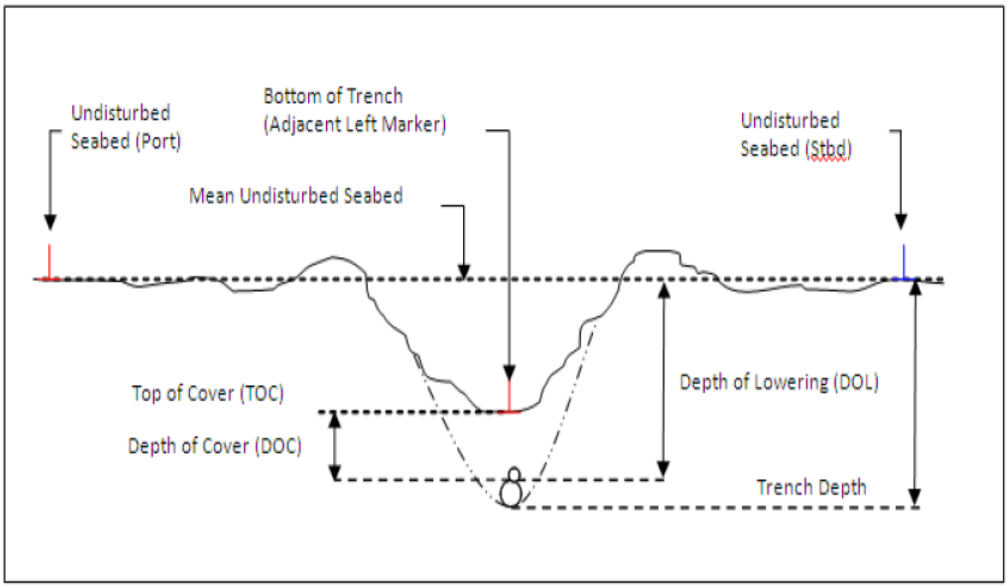

Figure 10-1: Depth of Lowering reference chart

10.2 Risk Register

The risks identified are primarily from fishing activities including scallop dredging and trawling, which provides the most frequent and likely risk. In addition, higher impact risks from anchor strike or drag by cargo vessels, larger fishing, or construction vessels operating or transiting across the Moray East site, are considered.

The summary of the key areas of the risk register is provide below:

- Post construction shipping;
- Fishing activities; and
- Seabed mobility and scour development.

As part of the CBRA all risks are quantified, and the level of mitigation required to achieve a tolerable treat level is determined.

10.3 Fishing Activities

As part of the CBRA an assessment was made on the level and type of fishing activities in the Moray East site. AIS vessel data (Cathie Associates, 2018b) was used to provide an indication as to activities in the area. An example area of the Moray East is given in (Figure 10-2 below). Refer to Cathie Associates (2018a) for more detailed charts.

A detailed fishing study was undertaken as part of the Moray East ES 2012 and the Moray East Modified TI ES 2012 was also considered.

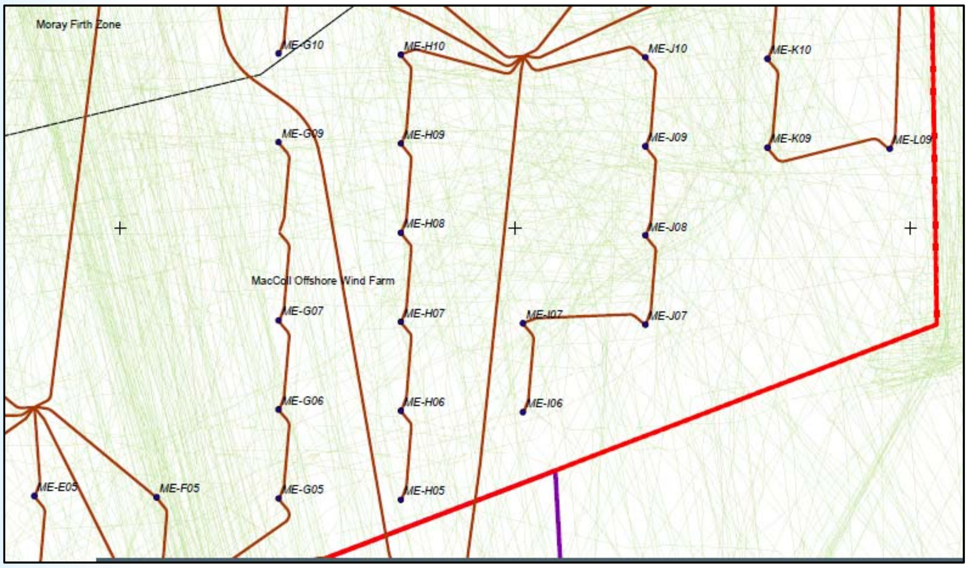

Figure 10-2: Example South East Sector of the Moray East Site - Fishing activity within the Moray East site (green is vessel tracking)

As part of the CBRA typical fishing gear types identified as used in the Moray East site were considered including; demersal trawling (otter trawling) and scallop dredging. An assessment of the penetration depth of fishing gear for the soils identified in the Moray East site is provided in Table 10-1 below (Carbon Trust, 2015 and Cathie Associates, 2018a).

Table 10-1: Maximum fishing gear penetration depths

Seabed Substrate	Clay < 40 kPa	Sand or Clay ≥40 kPa
Maximum penetration depth (m)	0.3	0.2

10.4 Commercial Shipping

Consideration of the risk associated with commercial shipping and anchor strike has been assessed using AIS shipping data (2013-2018) (Cathie Associates, 2018b) or transits across the site and vessel weight classification. Post-construction assumptions were made regarding the avoidance of the Moray East site by larger vessels, which allows a probabilistic assessment to determine the likelihood of an anchor strike (Cathie Associates, 2018a). This is a key input into the depth of lowering recommendation (Section 10.6 below).

10.5 Seabed Mobility and Erosion

The level of seabed erosion or movement of sandwaves, ripples or other mobile features across the Moray East site, is determined by comparison of the seabed topography from historical surveys (see Section 8 above; Figure 10-3 below).

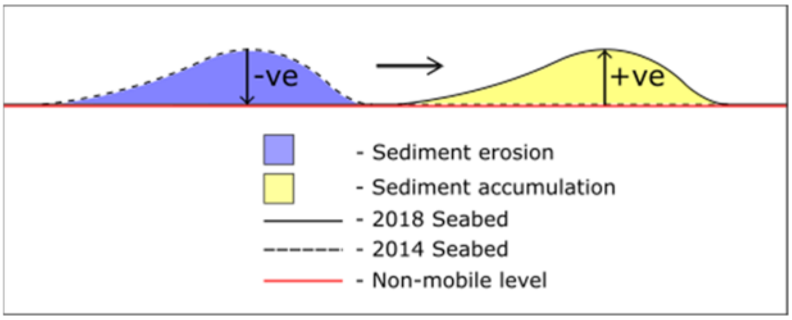

Figure 10-3: Seabed mobility schematic

To provide adequate protection against the future exposure of the inter-array and OSP interconnector cables over the life of the Development, 0.4 m is applied to the overall recommended depth of lowering value.

10.6 Recommended Depth of Lowering

The CBRA has been conducted in accordance with the "Cable Burial Risk Assessment Methodology, Guidance for the Preparation of Cable Burial Depth of Lowering Specification" (Carbon Trust, 2015). The following recommendation is made on the minimum depth of lowering which is required to protect the inter -array and OSP interconnector cables. This is the minimum depth of lowering values which the project will adhere to.

Table 10-2: Recommended Minimum Depth of Lowering

Seabed Substrate	Clay < 40 kPa	Sand or Clay ≥40 kPa
Minimum Depth of Lowering (m)	0.7	0.6

The CBRA has concluded that minimum depth of lowering values are what is required to ensure the safe operation of the cables and to avoid any interactions with other users of the seabed, this includes fishing activities. The installation contractor's minimum target depth of lowering for all inter-array and OSP interconnector cables across the Moray East site is 1 m. This is greater than the recommended minimum depth of lowering presented in Table 10-2. A target depth of 1 m was considered within the Moray East ES 2012 as detailed within Appendix 1.

10.7 Protection and Burial Assessment

The methods for burial and cable protection are provided in Section 11.6 below. The burial tooling and methodology as proposed by the installation contractor and assessed against the soil types and geotechnical information provided in the surveys (Section 8 above) gives confidence that the minimum depth of lowering indicated in Table 10-2 above should be met across the Moray East site. In instances where the unforeseen soil conditions affect the burial performance of the proposed tooling then alternative means of cable protection including rock placement as detailed in Sections 11.6.2 and 11.6.3below may be employed.

11 Cable Installation and Protection

The Section 36 Consents require that the Wind Farm CaP includes the following:

"*Details of the location and cable laying techniques for the inter-array cables.*"

A similar requirement is also included for the OfTI Marine Licence as detailed in Table 1-1 above.

The cable installation methodology is largely covered within the CoP and CMS document; however, this section outlines the key methodologies to be utilised for the inter -array and OSP interconnector cables.

11.1 Outline

The cable installation, burial and completion activities rely on multiple vessels and activities taking place simultaneously and with interlinking activities. A strict regime of permitting and marine co-ordination by a centralised project lead marine co-ordination function will be in place for the entirety of the construction phase.

11.2 Route Clearance

The Moray East site contains many boulders, and in high density on some of the cable routes. The boulders which are large enough to pose a threat to the cable lay or trenching operations will be relocated. A route clearance campaign will be completed ahead of the cable installation and burial activities. Two methods will be employed depending on the number of boulders present on each route: boulder clearance plough or boulder grab.

11.2.1 Boulder Plough

For routes with a large number of boulders, a towed plough unit will be used to clear the route (Figure 11-1 below). The plough has the capacity to handle boulders (up to ~2 m in diameter) for a corridor up to 15 m wide in one pass. The plough is deployed from an anchor handling vessel over a stern roller and therefore does not require an A-frame for launch and recovery. The plough is towed over the seabed and pushes boulders or debris to either side of the cable route.

The positioning of the plough is maintained by mounted acoustic beacon and coupled with the vessel survey positioning system. A remotely operated vehicle (ROV) is available to support the operations particularly during launch and recovery.

A post clearance survey shall be completed to verify the position of the cleared route and the final seabed condition.

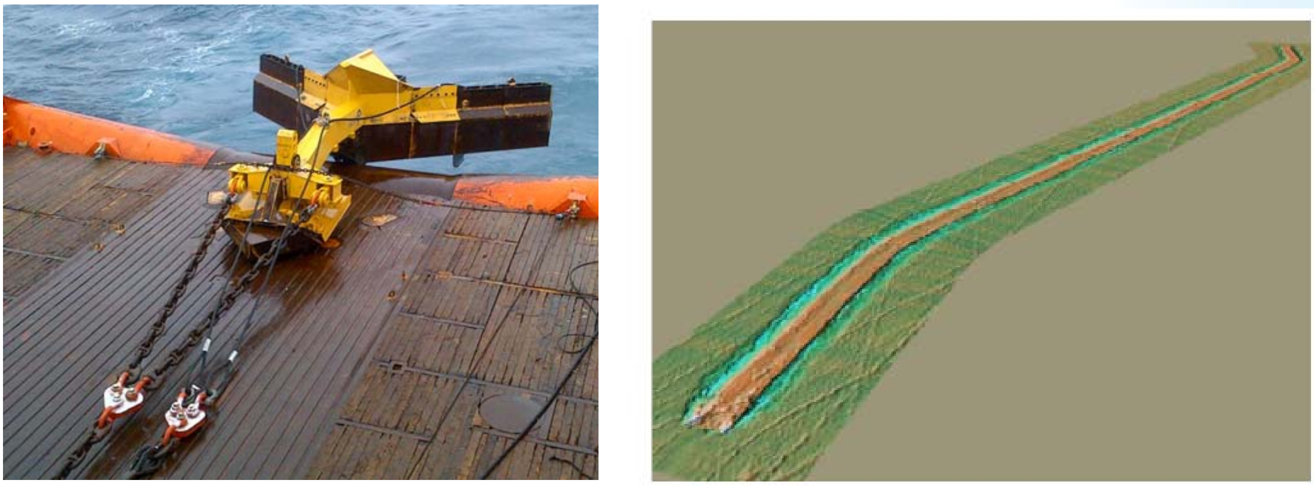

Figure 11-1: boulder clearance plough (left) and typical seabed result (right)

11.2.2 Boulder Grab

For routes with fewer boulders present, individual relocation is more efficient. A boulder grab will be positioned over the approximate object location using the vessel dynamic positioning (DP) system. Using a combination of positioning and cameras (or acoustic devices depending on the visibility) the operator will locate the target and move the boulder grab into position above it. The boulder grab is then lowered onto the target and the grab is closed. The boulder grab will be lifted up to clear the sea floor, the vessel will move to a safe location off the immediate route where the boulder / debris will be lowered to the seabed and released. Where cleared, boulders will be moved outside the cable route, within close proximity to the cables.

11.2.3 Pre-lay Grapnel Run

The removal of out of service cables, fishing nets, wire and other debris which will affect cable installation and burial will be undertaken by clearing the routes with a grapnel train (Figure 11-2 below).

A suitable vessel will deploy a ‘train’ of grapnels and hooks that will penetrate up to 0.5 m into the seabed to hook surface debris. The grapnel train is towed over the stern roller of the tow vessel and is equipped with a tension line monitor. During the grapnel run operations the tension is monitored and constant increases in tension indicate that debris or an out of service cable is hooked into the grapnel. The debris is recovered to surface, cut, or moved to a safe location off the cable route.

Figure 11-2: Typical Grapnel Train

11.3 Preparatory Works and Pre-Lay Survey

Prior to cable installation operations an Installation Support Vessel will mobilise and enter the Moray East site. This is a walk to work vessel using an actively compensated mobile gangway to allow pull-in and preparation personnel access to the WTG foundations or the OSPs. The preparatory work will include:

- Foundation inspection and pull-in equipment set-up including; winches, rigging and monitoring equipment;
- A pre-construction survey of each cable route by ROV to identify hazards to cable installation and burial activities.

11.4 Cable Loadout and Transportation

The Boskalis cable installation vessel mobilise for cable transpool and cable load out operations and transit to the agreed cable manufacturers' load out site. The cable loadout site and quayside will be equipped with storage carousels, cable handling rollers, cranes, tensioners, and chutes.

The cable lay vessel will be configured to receive and pack cable into the on-deck carousel (Figure 11-3 below).

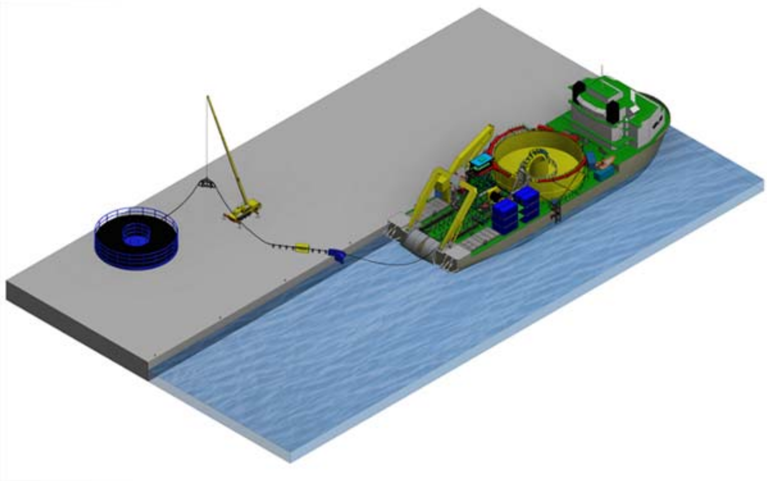

Figure 11-3: Cable Lay Vessel – Quayside set-up cable load out

The Cable lay vessel is a DP Class II cable installation and burial vessel and is equipped with a 26 m diameter 5000 Te capacity on deck carousel.

Two load outs are required to complete all the inter-array and OSP interconnector cables across the Moray East site. The load out sequence and manufactured cable lengths shall be engineered and pre-agreed with the manufacturer.

The transpool operations are controlled by the offshore shift supervisor (vessel) and quayside foreman (cable manufacturer) carefully monitoring the spooling speeds of both carousels, as well as a cable catenary in the water. The differing sizes of cables are packed into separate partitions of the carousel to allow increased volume of cable and better flexibility in lay operations (Figure 11-4 below).

Figure 11-4: Partitioned carousel with cable loading

11.5 Inter -Array and OSP Interconnector Cable Installation

The installation sequence of the inter -array and OSP interconnector cables will be completed on a circuit by circuit basis with cable installation following on the last cable toward or out from the OSP. For example, OSP1 to C06 then C06 to C07 (please see Figure 7-1 above for the inter-array and OSP interconnector layout). The installation support vessel will work ahead of the cable lay vessel and the pull-in teams, who will set-up the pull-in equipment and prepare each WTG foundation structure or OSP for cable installation.

11.5.1 First End Pull In

The cable lay vessel will set-up stern to the foundation. The pull-in wire is transferred from the foundation to the cable lay vessel deck and the pull-in winch is brought to deck and connected to the cable first end, including the CPS. The cable end is overboarded and pulled into the foundation entry point. The CPS will dock into the foundation entry point, the cable is then pulled up into the foundation cable deck. A clamp is fitted to secure the cable end. The vessel will move off from the structure and lay cable on the seabed. (Figure 11-5 below).

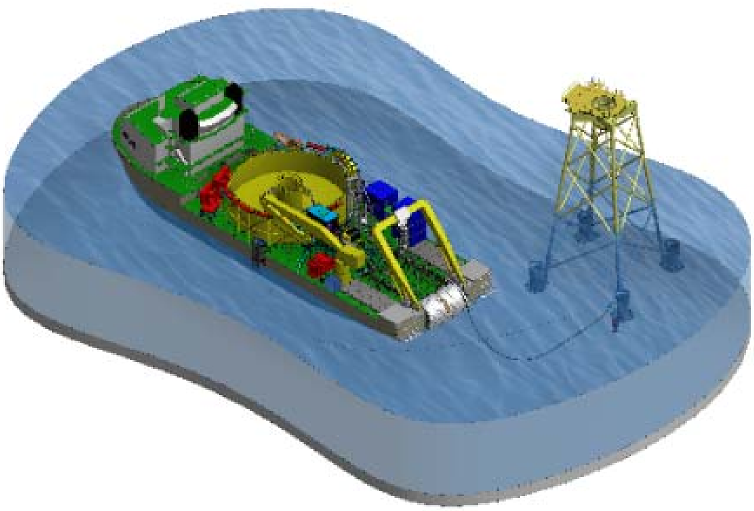

Figure 11-5: First end cable pull-in and vessel laying away

11.5.2 Cable Lay

The cable will be laid along the defined cable design route with the cable shape and tension monitored throughout by ROV and the deck tensioner read out (Figure 11-6 below). Normal cable lay speed is around 400-600 m/hr.

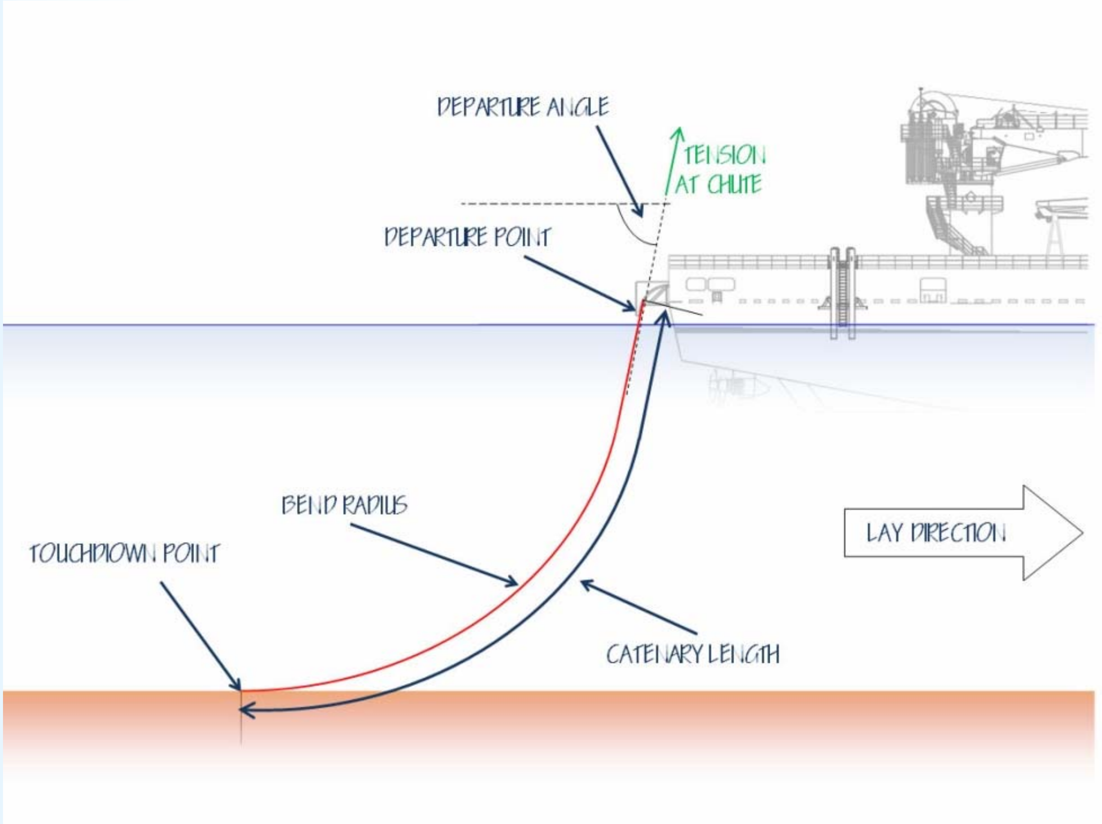

Figure 11-6: Cable Lay parameters

11.5.3 Second End Pull-In

On approach to the second foundation, the CPS will be assembled on the cable lay vessel deck. The pull-in teams will be transferred onto the WTG or OSP foundation and pull-in winch set-up and preparations shall be completed. The key operations are:

- Calculate the required remaining cable length;
- Position the vessel at ~90° to the cable approach into the foundation (Figure 11-7 below);
- Cut and seal the cable end;
- Transfer the pull-in winch wire to the vessel deck;
- Move the cable down the deck and overboard using the vessel crane (Figure 11-8 below);
- Pull in the cable into the foundation whilst lowering the cable to the seabed (Figure 11-9 below);
- Complete the docking of the CPS into the foundation entry point and pull the cable up to the foundation deck;
- Secure the cable in the hang off clamp; and
- Prepare the cable for termination and testing.

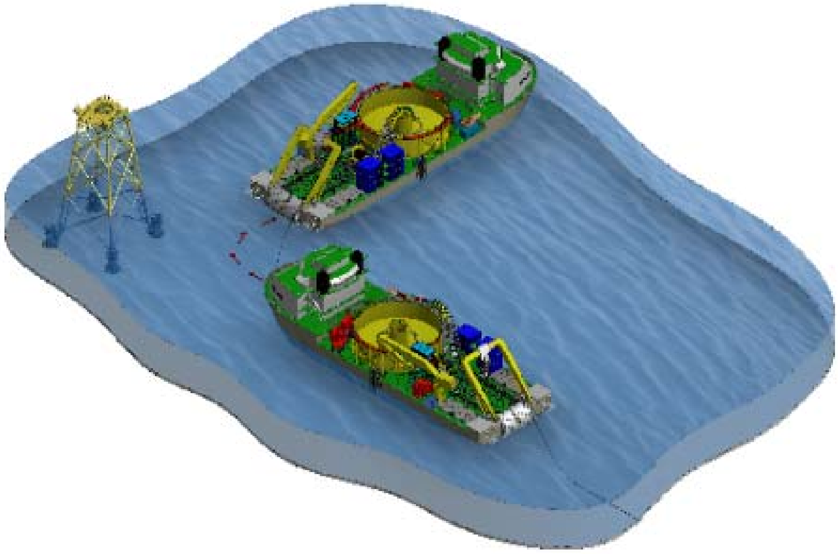

Figure 11-7: Lay vessel second end approach to structure

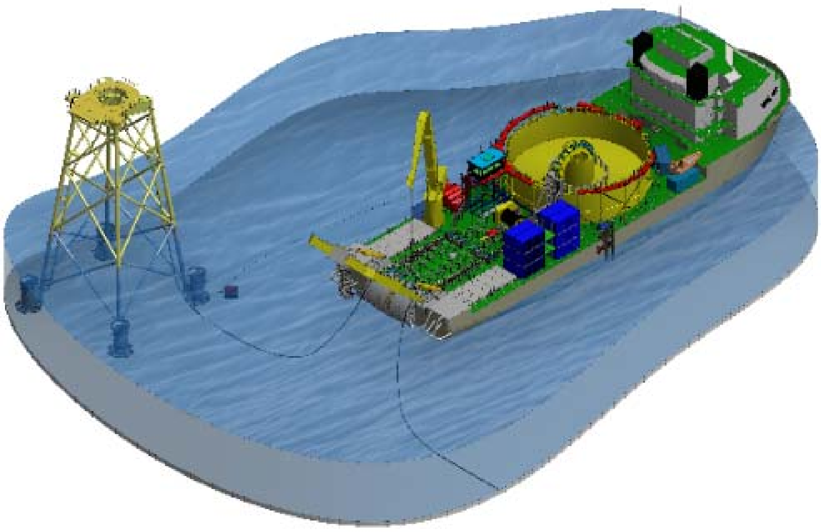

Figure 11-8: 2nd End pull-in and cable quadrant overboarding

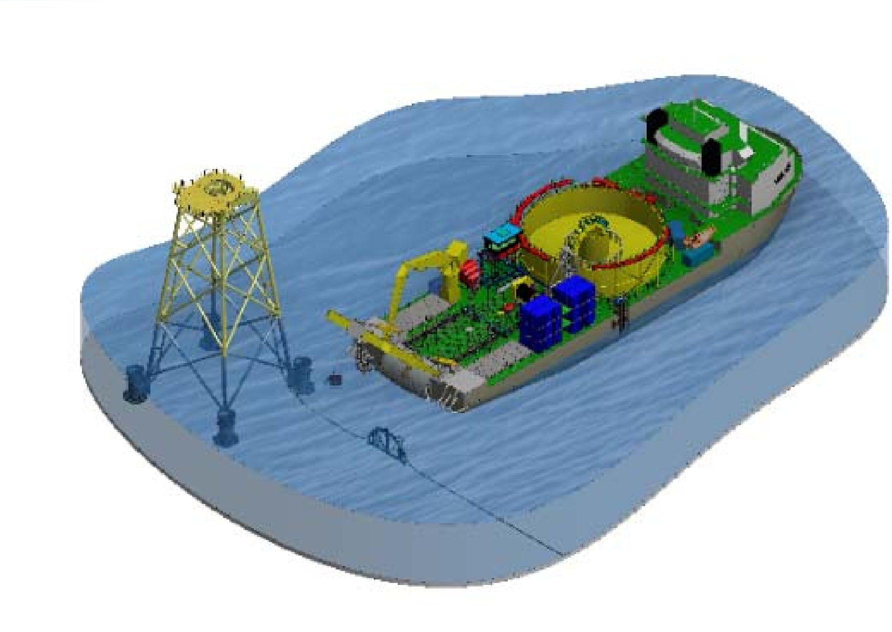

Figure 11-9: Cable and Cable Handling quadrant lowered to seabed prior to release

11.6 Cable Burial and Protection

The overall strategy for the protection of the cables is comprised of two elements as detailed in Figure 11-10 below.

Protection of the cable from the exit point of the structure is provided by the CPS (details provided in Section 7.4 above). The CPS is partially buried to the required depth by the post lay burial method using cutting and / or jetting burial tools. The cable is then buried to the required depth of lowering for the remainder of the cable route.

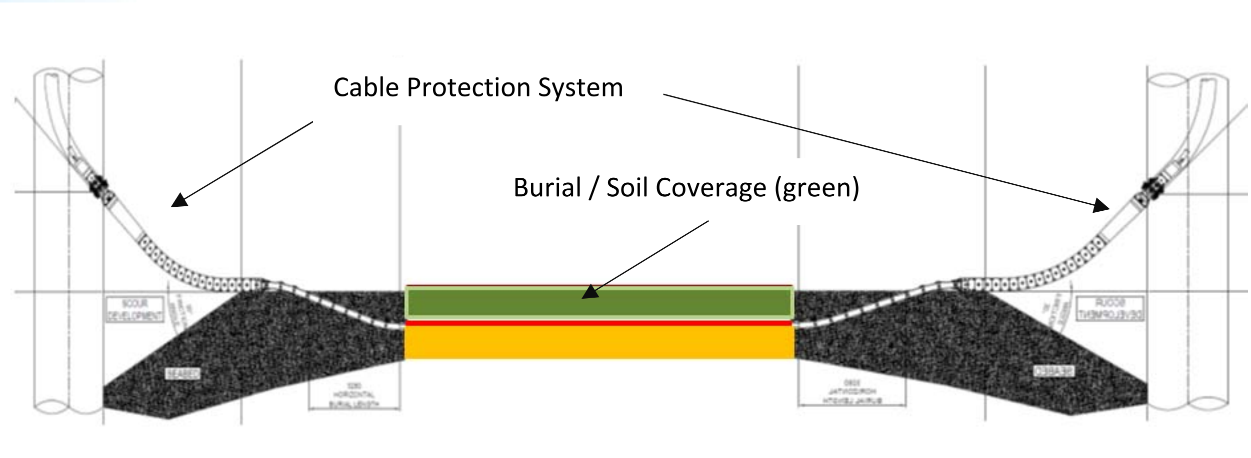

Figure 11-10: Typical cable protection strategy

11.6.1 Post Lay Burial Method

The installed cables will primarily be protected by burial. The depth of lowering of each cable route will be based on the soil conditions and the CBRA; however, a nominal target trench depth in excess of the CBRA recommendations of 1.0 m is planned across the site (Section 10.6 above). A DP II class trenching support vessel will be mobilised with the trenching tools and a survey ROV. The trenching units are launched and recovered with dedicated lifting frames.

The burial tools employed will be tracked vehicles with cutting, cutting and jetting, and jetting only capabilities. The cutter unit uses a chain cutter with mounted cutting picks to break up and clear a defined trench through hard clays, chalks, and peaty soil types (Figure 11-11 below).

Figure 11-11: The Cutting tracked burial tool - During launch

The jet trenching unit will be employed in the sands, silts and softer clay type soils (Figure 11-12 below). The tool uses high pressure jet nozzles (jet swords) and large water volumes to liquefy the soil, and allow the cable self-weight to lower the cable into the seabed.

Figure 11-12: Jetting Trenching Tool (Note Jetting nozzle arms at the rear)

A combination of the trenching tools can be used along a single route. The jetting trencher can be used for second passes where the cable has not reached the required minimum depth of lowering.

A post burial survey of the cable will be completed by the survey ROV with a mounted cable tracker unit. This survey will provide the achieved depth of lowering and identify if further trenching or cable protection is required (e.g. rock dump or concrete mattresses).

11.6.2 Rock Placement Protection

Where trenching of the cable is not practical, or the seabed soil conditions do not allow the cable to achieve the required level of protection by the burial method, the installation of rock placement on the cable may be required (

Figure 11-13 below). This is mostly likely to occur at the cable ends and will be in conjunction with the CPS (Section 7.4 above).

The rock will be loaded out into the rock placement vessel. The vessel is a dynamically positioned fall pipe vessel. This allows accurate placement of the rock from the fall pipe exit onto the cable. The rock berm height and slope angles will be designed to provide the correct level of protection, and must also be designed for long term stability for the site's current and wave conditions. The design will take the potential impacts on relevant commercial fisheries into account.

The surveyed 'as-built' level of cover by the burial method will be provided, and the final required level of cable protection by rock placement can be assessed.

The use of rock placement will be reduced to as low as reasonably practical. Where remedial protection has to be employed, rock placement will be the primary consideration. Other methods of cable protection that may also be considered, where the required depth of lowering protection is not achieved by burial, are described in (Section 11.6.3 below).

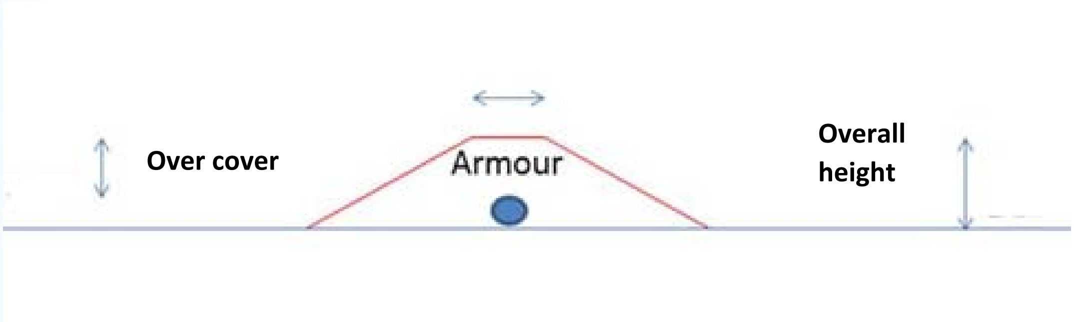

Figure 11-13: Typical Rock Placement Protection Design

Where rock protection has to be applied in locations where fishing activity is likely, Moray East and the installation contractor will engage with Marine Scotland and other stakeholders to ensure the rock berm design is suitable.

11.6.3 Alternative Protection Measures

In some instances, rock protection may not be suitable. For sections of cables which do not meet the minimum depth of lowering alternative protection measures may be used. These alternative measures are described below.

Mass Flow Excavation

The mass flow method directs a pumped flow of seawater toward the seabed which displaces seabed material allowing the cable to lower and achieve protection (Figure 11.14 below).

This is only suitable in some soil types identified in the Moray East site, however in some cases the cable can be lowered to give an adequate protection without the need for mechanical protection or rock dump protection. This would require further engineering assessment.

Figure 11-14: Mass Flow Tooling

Concrete Mattresses or Rock Bags

An alternative means of protection is by mechanically shielding exposed cable with concrete mattress, or rocks contained in a netted bag.

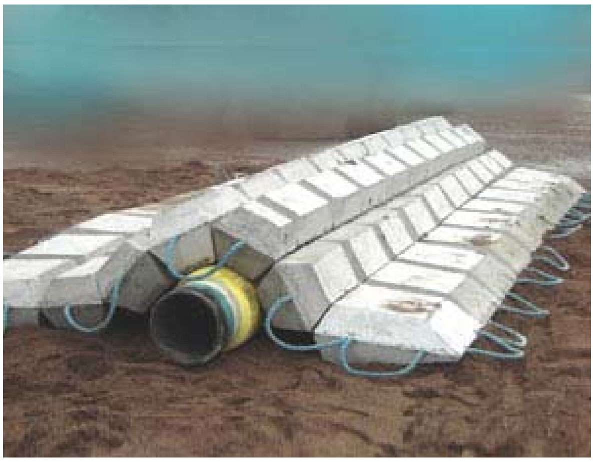

Figure 11-15: Typical Concrete Mattress

11.7 Trial Cable Lay and Burial

Prior to the main cable installation activities, a short trial section (300-400 m) of inter-array cable may be installed onto the seabed by the cable lay vessel. The trial cable would be located adjacent to a confirmed cable route and within the +/-25 m cable lay corridor. If a trial is undertaken, the location will be selected based on the most challenging soil conditions likely to be encountered on the Moray East site.

The purpose of the trial cable is to trial and test the burial performance of the proposed burial tools which will be employed as part of the construction. The trial will inform the final configuration of the tooling and aims to reduce the likelihood of poor burial performance and hence the requirement for remedial protection. The trial cable will be buried in accordance with the depth of lowering requirements given in Section 10.6 above and will be left in situ post construction with its position identified along with the finalised cable route positions. Section 11.5 above provides details of the installation methods employed.

11.8 Termination and Testing

Post installation, the cable pulled into the structure will be stripped back. The three-phase individual cable power cores and the fibre optic bundle are split out. The permanent hang off assembly is fitted to the J-tube top flange and cable armour wires are secured to the structure to support the cable weight.

The individual cable cores are then routed through the foundation and terminated with a connector into the electrical switch gear. All accessories and cable elements, are earthed to the foundation where required.

After termination, post installation electrical and optical testing is completed to verify there are no defects or damage in the cable system.

The complete inter -array and OSP interconnector cable system is then handed over for energisation of the cable network.

12 Cable Monitoring and Exposure Planning

The Section 36 Consents require that the Wind Farm CaP includes the following:

"Methodologies for over trawl surveys of the inter -array cables through the operational life of the wind farm where mechanical protection of cables laid on the seabed is deployed."

"Measures to address exposure of inter -array cables."

A similar requirement is also included for the OfTI Marine Licence as detailed in Table 1-1 above.

The following section provides information relating to post-installation surveys and potential remedial actions to be taken should cable exposure occur.

12.1 Mitigation

Engineering and planning will provide the following mitigations to reduce the chance of inter -array cable exposure over the life of the Wind Farm.

12.1.1 High risk scour locations

Where scour development is anticipated to occur, rock placement shall be installed at the base of WTG or OSP foundations. This shall prevent the development of scour pits at these locations and hence the chance of cable exposure over time.

12.1.2 Specification of the CPS

The design of the CPS includes weighed cast iron sections at all cable ends. This assists in lowering the cable into protective seabed cover and prevents movement of the cable and the adjacent soils.

12.1.3 Allowance for Erosion and Mobility of Seabed Features

An assessment of the mobility and erosion of the seabed over time has been made (see Section 10.5) and this is considered in the required depth of lowering specified. This ensures the prevention of cable exposure over time.

12.2 Survey and Monitoring

Monitoring of the cables will be carried out as part of the overall operations and maintenance programme for the Wind Farm. The following is being considered.

- Annual Bathymetric Survey along all routes (year 1 and 2) – timing/period of later surveys based on initial findings
- Survey at structure foundations (most likely location for scour/ erosion near cables)
- Survey comparison against as built post construction survey and burial depth
- Level of scour or seabed erosion determined, cable exposure or development rates determined.

12.3 Treatment

In the event that cables become exposed over time either by environmental or human activities a full assessment of the risk posed by the exposed cables will be carried out. Some of the following remedial activities would be considered:

- At the cable ends, rock bags or rock placement
- Midline mass flow or a campaign to rebury the cables if large sections are exposed
- Rock placement midline is considered a last resort and not anticipated at this time.

13 Over Trawl Surveys

As detailed within Section 8.6 above, it is currently envisaged that the minimum depth of lowering will be achieved during the installation of the inter -array and OSP interconnector cables (excluding where cables approach the WTGs and OSPs where a CPS will be installed as detailed in Section 7.4 above). However, if rock placement or mechanical overprotection is used as part of the cable protection measures and this is determined to pose a hazard to fishing activities, over trawl surveys could be employed. Any requirement for over trawl surveys and the appropriate methodologies will be discussed with the local fishing industry and agreed with Marine Scotland Licensing Operations Team.

14 Compliance with the Application

14.1 Introduction

As presented in Table 1-1, Condition 18 of the Section 36 Consents states the following:

"The CaP must be in accordance with the application."

Section 14.2 below sets out information from the Moray East ES 2012 with regard to compliance with the inter -array cable installation and burial proposals assessed.

A similar requirement is also included for the OfTI Marine Licence (as detailed in Table 1-1 above). The OfTI CaP presents compliance approach with regards to the OSP interconnector and export cables.

14.2 Compliance with the Moray East ES 2012

The Moray East ES 2012 described a range of specification and layout options that could be applied during the construction of the Development. This took the form of a broad 'Rochdale Envelope' incorporating a variety of options. The ES defined likely cable installation specifications for the Development, based upon these broad options.

Since the Moray East Offshore Wind Farm Consents were granted, the cable installation details have been substantially refined as detailed in this document. In order to demonstrate continued compliance of this refined design, Appendix 1 provides a tabulated comparison of cable specifications as presented in the ES and this Wind Farm CaP.

15 Updated Cable Trenching Methodology

Since publication of the Moray East ES in 2012 a significant amount of cable design engineering has been carried out as detailed within this Wind Farm CaP. A number of tools have been selected by the inter-array contractor as likely to be used during the installation of the inter-array and OSP interconnector cables. The following provides a comparison of the Moray East ES 2012 assessment and the worst case scenario (WCS) assessment resulting from the proposed inter-array cable installation tools for the Moray East Offshore Wind Farm. This comparison has been undertaken by Royal HaskoningDHV.

The dimensions of the proposed cable trencher and area of seabed disturbed during the cable installation and how these compare to the consented parameters are shown in Table 15-1 below. Although the same cable trencher will be used for the OSP interconnector, the changes in OSP interconnector trench are considered in the OfTI CaP as the original assessment of the OSP interconnector cables was carried out jointly with the export cables assessment as part of the Moray East Modified TI ES 2014.

Table 15-1 Parameters relevant to the cable trenching methodology

Relevant Parameter	Consented Parameters	Proposed Trencher Parameters
Trench depth	1 m (3m WCS)	1.5 m
Trench affected width[4]	6 m trench	6 m trench
Trench width	1m	1m
Vehicle tracks	Not considered during the original ES as information was not available.	2 m for each track (4 m combined width)
Cable length (all cables, including export)	Inter-array cable length = 572 km (OSP interconnector cables and export cable length within Moray East site = 70 km; overall Development cable length = approximately 850 km)	Inter-array cable length = 156 km (OSP interconnector cables and export cable length within Moray East site = 43 km; overall Development cable length = approximately 352 km)[5]
Trench profile	'U' shape	'U' shape

The proposed trencher has a smaller depth than the WCS assessed in the Moray East 2012 ES, meaning less sediment will be removed per metre of trench in comparison to the consented trencher. However, the proposed trencher has vehicle tracks on either side of the trench affected width, meaning there is up to 10 m (up to 6 m trench affected width with up to 4 m trencher tracks) of potential seabed disturbance.

Due to the change in parameters of the proposed trencher there is a requirement to assess the potential impacts of the seabed disturbance caused by the proposed trencher.

In order to assess the impacts of seabed disturbance from the proposed trencher the quantity of SSC expected to arise has been calculated (Section 15.1.2 below) and disturbance from the trencher tracks has been assessed (Section 15.1.4 below).

The outputs have been used to assess the impacts to the relevant environmental receptors, specifically:

[4] Described in the Moray East 2012 ES (Appendix 3-4-C) as a wider area of seabed (up to 6 m centred on the trench route) might be affected by some contact with the burial machine, but is not considered to contribute to the displacement of sediments.
[5] Please see OfTI CaP for details on export cable length.

- Benthic ecology;
- Fish and shellfish ecology; and
- Archaeology.

The results of the impact assessment are provided in Sections 15.3 to Section 15.5 below.

15.1 Suspended Sediment Concentrations

A worst-case scenario for sediment release was calculated within the Moray East 2012 ES, expressed as per metre of trench sediment. The assessment was completed by ABPmer (Moray East 2012 ES, Appendix 4-3-C) using the methodology / assumptions set out below.

- The total mass of sediment (6,360 kg) is re-suspended evenly up to a (variable) ejection height;
- The time required for sediment to settle (at 0.05 m/s or 0.0001 m/s) through the total height of ejection is calculated to yield the duration of the effect;
- The length scale of the effect is the furthest distance travelled by the plume (in a downstream direction) and is the product of the ambient current speed (0.25 m/s) and the duration of the effect;
- The estimate of mean SSC is estimated by dividing the total dry mass of sediment by the volume of the triangular wedge of water through which the sediment will settle (ejection height multiplied by downstream distance divided by two); and
- The average thickness of any resulting sea bed deposit is estimated by dividing the total volume of sediment by the footprint (length scale of the effect multiplied by 1 m).

The outcome of the calculations for the consented trencher is set out in Section 15.1.1 and the calculations for the proposed trencher are provided in Section 15.1.2 below.

15.1.1 Consented Cable Trencher

The worst-case scenario for sediment release, expressed as per metre of trench length for the consented trencher for the inter-array cables in the Moray East 2012 ES is:

- The maximum trench dimension is 1 m wide x 3 m deep with a ‘U’ shaped profile = 3 m^3/m sediment disturbance, all of which is released into the water column;
- The porosity of the material is conservatively estimated as 20 % void = 2.4 m^3/m sediment release;
- The sediment is assumed to be quartz with a density of 2,650 kg/m^3 = 6,360 kg/m dry mass sediment release;
- All the sediment is released as a fully fluidised mixture. The cable route consists of mixed sands and gravels, with a low fines content, becoming progressively finer in deeper water along the route; and
- A wider area of sea bed (trench affected width, up to 6m centred on the trench route) might be affected by some contact with the trencher, but is not considered to contribute to the displacement of sediments.

The range of possible effects on SSC and deposition for a cable trench of this dimension are provided in Table 15-2 below, which quantifies the total effect per metre of trench length dug (from Moray East 2012 ES Appendix 3-4-C). The assessment shows that a lower height of ejection will result in a greater SSC and thickness of deposition, but with a smaller footprint of effect, and *vice versa*.

Table 15-2 Extent and magnitude of effect of cable trenching in medium sands (top) and fine sediments (bottom) for the original trenching method assessed in the EIA (Moray East, 2012)

Ejection Height (m)	Duration of Effect (s)	Length of Scale of Effect (m)	Indicative Mean SSC (mg/l)	Average Thickness of Deposit (m)
Medium Sands – Settling Velocity 0.05 m/s				
1	20	5	2,544,000	0.600
5	100	25	101,760	0.120
10	200	50	25,440	0.060
25	500	125	4,070	0.024
Fine Sediments - Settling Velocity 0.0001 m/s				
1	10,000	2,500	5,088	0.001200
5	50,000	12,500	204	0.000240
10	100,000	25,000	51	0.000120
25	250,000	62,500	8	0.000048

According to the ABPmer assessment (Moray East 2012 ES, Appendix 3-4-C), a critical thickness of sediment deposition for medium sands with relevance to benthic ecology is 0.05 m. The maximum possible distance from the trench over which displaced sediment of any type might deposit to a thickness of 0.05 m is 71 m (affecting an area of 71 m^2 per metre of trench installed).

For fine sediments, the ABPmer assessment concluded that the effect of cable trenching on SSC would initially have a magnitude potentially more than the natural range of variability. However, the effect will be localised and temporary. Deposition would be followed by re-suspension, and sediments would disperse further throughout the water column with the result that SSC and the thickness of any subsequent deposits would be very small and within the range of natural variability.

15.1.2 Proposed Trencher

To assess the significance of the volume of disturbance from the proposed trencher, the method adopted by ABPmer (Moray East 2012 ES, Appendix 3-4-C) has been replicated. The worst-case scenario for sediment release (using the dimensions of the proposed trencher) for the inter-array cable is:

- The maximum trench dimension is 1 m wide x 1.5 m deep with a 'U' shaped profile = 1.5 m^3/m sediment disturbance, all of which is released into the water column;
- The porosity of the material is conservatively estimated as 20 % void = 1.2 m^3/m sediment material release
- The sediment is assumed to be quartz with a density of 2,650 kg/m^3 = 3,180 kg/m sediment release;
- A wider area of sea bed (trench affected width, up to 6 m centred on the trench route) might be affected by some contact with the trencher, but is not considered to contribute to the displacement of sediments. The proposed trencher method also has contact on either side of the trench due to trench tracks, which were not assessed in the Moray East 2012 ES. The disturbance due to the trench tracks has been considered in Section 15.2 below.

Applying the same method as ABPmer (Moray East 2012 ES, Appendix 3-4-C), the range of possible effects on SSC and deposition for the proposed trencher are provided in Table 15-3 below.

Table 15-3 Extent and magnitude of effect of cable trenching in medium sands (top) and fine sediments (bottom) for the proposed trencher.

Ejection Height (m)	Duration of Effect (s)	Length of Scale of Effect (m)	Indicative Mean SSC (mg/l)	Average Thickness of Deposit (m)
Medium Sands – Settling Velocity 0.05m/s				
1	20	5	1272000	0.3000
5	100	25	50880	0.0600
10	200	50	12720	0.0300
25	500	125	2035	0.0120
Fine Sediments - Settling Velocity 0.0001m/s				
1	10,000	2,500	2544	0.0006000
5	50,000	12,500	102	0.0001200
10	100,000	25,000	25	0.0000600
25	250,000	62,500	4	0.0000240

In the method adopted by ABPmer (Moray East 2012 ES, Appendix 3-4-C), the ejection height, duration of effect and length of scale of effect are kept constant regardless of volume of sediment released. Given these parameters are constant, but the volume of sediment released decreases, the estimated indicative mean SSC for the proposed trencher compared to the original trenching method is estimated to be 50 % smaller.

The average thickness of the deposit also decreases by 50 % to mirror the decrease in SSC, meaning the absolute estimates of thickness are very small. For the proposed trencher, the maximum thickness is estimated to be only 0.6 mm compared to 1.2 mm for the original trenching method.

The maximum possible distance from the trench over which displaced sediment of any type might deposit to a thickness of 0.05m is 33m compared to 71m for the original method.

15.1.3 Summary of Disturbance of Proposed Trencher

The following conclusions can be drawn from the comparative analysis on the two trenching methods:

- SSC is estimated to decrease by 50 % for the proposed trencher method compared to the original trenching method;
    - o This does not affect the outcome of the original assessment because, for both the original and proposed trencher methods, they would eventually reduce to be within the range of natural variability, through continued deposition and re-suspension (although it quicker for the proposed trencher,).
- The average thickness of the deposit is also estimated to decreased by 50 % for the proposed trencher method compared to the original trenching method;
    - o This does not affect the outcome of the original assessment because the absolute estimates of thickness are smaller for the proposed trencher, decreasing from a maximum of only 1.2 mm for the original method to a maximum of only 0.6 mm for the proposed trencher.

In both methods there will be disturbance of the seabed during trenching activities. The original assessment indicated that this disturbance (up to 6 m centred on the trench route) would not result in significant disturbance and release of sediments. The proposed trencher method also considers a disturbance due to trenching activities of up to 6 m with no significant change in the SSC assessment presented within the Moray East ES 2012 (as highlighted above). However an additional temporary disturbance of vehicle (trencher) tracks is now being considered for the proposed trencher (not previously included in the Moray East ES 2012). The disturbance due to the trencher tracks has been considered in Section 15.1.4 below.

15.1.4 Trencher Tracks

The effect of vehicle tracks on the seabed, created by the cable installation equipment, was not considered as part of the Moray East ES 2012 assessment due to lack of information on the trencher at the time of writing. However, the proposed trencher to be used for installation of the inter-array cables will roll along the sea bed on tracks that will be 2 m wide on either side of the trench. An assessment is therefore required to determine whether this change in the project description is significant compared to the consented project description (i.e. no trencher tracks).

There is potential for the tracks of proposed trencher used during the installation of the inter-array cable to directly impact the seabed. Where the trencher moves over the seabed, there is potential for the seabed to be compressed vertically downwards and displaced laterally. An indentation will be created, the same size as the dimensions of the trencher tracks (i.e. two times 2 m = 4 m wide). It is estimated that an indentation would be created that is a maximum of 0.2 m deep compared to the surrounding sea bed. On either side of the tracks there is the potential for the seabed to be slightly raised in a series of linear pressure ridges. After the trencher has passed, some of the slightly raised sediment would return to the track indentation via slumping under gravity until a stable slope angle is achieved. Over the longer term (months), the track indentation would become shallower, less distinct and return to its original profile, due to infilling with mobile seabed sediments.

In addition, the creation of the track indentations will release a negligible volume of sediment into the water column compared to the creation of the trench itself. Hence, the effects of the proposed trencher on suspended sediment concentrations and sediment deposition would be the same as those for the original consented assessment.

Given the small magnitude of the track indentation, its short-term nature (i.e. the seabed will recover over months), and the negligible changes in SSC and sediment deposition due to the tracks, the original consented assessment remains valid for the proposed trencher.

In addition, the consented length of the inter-array cables is 572 km, whereas the inter-array cable length to be installed is only 156 km, as set out in Table 15.1 above. The length of cable to be installed is less than half the consented length. Hence, any increase in seabed disturbance caused by use of the proposed trencher tracks, as highlighted above, is minimal and would be expected to recover within months. In addition, this would be compensated by the reduction in the length of cable the trencher would be operated over and by the reduction in SSC from the proposed trencher compared to the consented trencher.

An assessment of the seabed disturbance from the updated trenching methodology on the relevant environmental receptors is provided in Sections 15.3 to 15.5 below.

15.2 Benthic Ecology

As highlighted in Table 15-1 above, the proposed trencher has a smaller depth than the WCS assessed in the Moray East 2012 ES, meaning less sediment will be removed per metre of trench in comparison to the consented trencher. However, the proposed trencher has vehicle tracks on either side of the trench affected width, meaning there is up to 10 m of potential seabed disturbance.

The impact of the proposed trencher has been assessed in relation to benthic ecology. The only impact of relevance to the new trenching method is increased SSC and seabed disturbance. With regards to SSC, the inter-array trench affected width is still 6 m as per the original consented trench but the overall length of the trench has reduced from the consented 572 km to 156 km, meaning the total footprint of temporary habitat loss due to trenching has reduced. Therefore, temporary habitat loss during the construction phase due to the trench footprint has not been considered further.

The Moray East ES 2012 showed that as a result of trenching activities for the inter-array cable increased SSCs may potentially occur above the range of natural variation but that this will be highly localised around the point of disturbance (up to 25 to 50 m) and will be of short duration (up to eight minutes in medium sands and three days in fine sediment material) (Chapter 7, Section 7.1.6 Moray East 2012 ES).

The effect of SSC was determined in the Moray East ES 2012 to be highly localised and temporary, lasting for the duration of the construction activity only. Effect magnitude was therefore considered to be low. Local receiving habitats are predominately sedimentary in nature and are characterised by sediment burrowing animals and are thus expected to be tolerant to temporary light sediment deposition. Receptor sensitivity was therefore regarded as low, meaning the overall impact significance in the Moray East ES 2012 was predicted to be **minor**.

With regards to seabed disturbance, the proposed trencher has a slight increase in temporary disturbance from the trencher tracks (as discussed in Section 15.1.4 above); however the reduction in SSC from the trench and the reduction in length of cable corridor means overall the magnitude of the effect is still considered to be low. Additionally, biotope and species receptors will be the same, meaning receptor sensitivity is still considered to be low. Therefore, overall the impact significance of the proposed trencher is predicted to be **minor**.

15.3 Fish and Shellfish Ecology

Impacts to fish and shellfish vary depending on the type of species resulting in the sensitivity of the receptor ranging from medium to low. Increased SSC and sediment re-deposition due to installation of the inter-array cable was assessed within the Moray East ES 2012, in relation to fish and shellfish ecology. The impacts of relevance to the new trenching method are therefore increased SSC and seabed re-deposition and disturbance.

With regards to increased SSC, the Moray East ES 2012 assessment shows that increased SSC may result in localised avoidance of the area by mobile and migratory fish leading to limited disturbance. Additionally, sediment re-deposition has the potential to smother fish and shellfish species which lay their eggs on the seabed. However, the impact magnitude of increased SSC and sediment re-deposition was determined to be small due to the localised and short-term nature of the impact. Due to the sensitivity of the fish and shellfish receptors being medium to low and the impact magnitude being small the impact was assessed to be negative of **minor** significance for all fish and shellfish species.

With regards to seabed disturbance, given the small level of disturbance predicted from the increased trencher tracks as described above and the decrease in amounts of SSC due to the proposed trencher in comparison to the consented trencher, the impact of increased SSC, sediment re-deposition and disturbance as a result of the proposed trencher is still considered to be of negative **minor** significance.

15.4 Archaeology

Within the Moray East ES 2012, **no significant** effects were identified for potential indirect effects, which included re-distribution of fine sediments upon Cultural Heritage receptors. The small increase in seabed disturbance from the proposed trencher tracks (as described in Section 15.1.4 above) has not changed the outcome of the assessment in the Moray East ES 2012 meaning **no significant** indirect effects have been identified.

15.5 Summary

Following an update to the quantities of SSC and deposition reported in the Moray East ES 2012, to take into account the dimensions of the proposed trencher, an impact assessment was carried out on all receptors with the potential to be affected by SSC and sediment deposition and disturbance from trencher tracks. A summary of the outcome of the impact assessment of the proposed trencher in comparison to the consented trencher is presented in Table 15-4 below. Overall, due to the small disturbance as a result of the proposed trencher tracks, the reduction in SSC now expected and the reduction in the cable corridor length (when compared to the consented cable trencher parameters; Moray East ES, 2012), no changes to the assessed impacts are predicted.

Table 15-4 Summary of impacts of the proposed trencher

Receptor	Impact	Impact Significance	
		Consented Trencher	Proposed trencher
Benthic Ecology	Indirect disturbance (increase in SSC and sediment deposition)	Minor	Minor
Fish and Shellfish Ecology	Temporary disturbance of the seabed (increased SSCs and sediment re-deposition)	Minor	Minor
Archaeology	Re-distribution of fine sediments	Not significant	Not significant

16 References

ABPmer. 2012. Physical Environment (Offshore). In Moray Offshore Renewables Limited - Environmental Statement.

Cathie Associates (2018a). Moray East Wind Farm Array Cables CBRA Report – C950R01- Revision A – 17/08/18

Cathie Associates (2018b) Marine Traffic, AIS Traffic Data, Array and Export Areas – five calendar years 01/05/2013 to 30/04/2018 © marinetraffic.com – provided by Cathie Associates

Carbon Trust (2015). Cable Burial Risk Assessment Methodology: Guidance for the Preparation of Cable Burial Depth of Lowering Specification.

Moray East (2012). Telford, Stevenson and MacColl Wind Farms and Transmission Infrastructure. Moray Offshore Renewables Limited – Environmental Statement (Moray East ES 2012).

Moray East (2018a). Offshore Transmission Infrastructure (OfTI) Cable Plan, Moray East Offshore Wind Farm Offshore Transmission Infrastructure. Document Reference 846001-PCA0030-MWE-REP-001

Moray East (2018b). Environmental Management Plan, Moray East Offshore Wind Farm and Associated Offshore Transmission Infrastructure. Document Reference 8460001-PCA0010-MWE-REP-001.

Moray East (2018c). Construction Programme and Construction Method Statement, Moray East Offshore Wind Farm and Associated Offshore Transmission Infrastructure. Document Reference 8460001-PCA0010-MWE-REP-004.

Moray East (2018d). Archaeological Reporting Protocol (MARP) and Written Scheme of Investigation (WSI), Moray East Offshore Wind Farm and Associated Offshore Transmission Infrastructure. Document Reference 846001-PCA0010-RHD-REP-001.

Moray East (2018e). Project Environmental Monitoring Programme, Moray East Offshore Wind Farm and Associated Offshore Transmission Infrastructure. Document Reference 8460001-PCA0010-MOR-REP-016.

Moray East (2019). Development Specification and Layout Plan, Moray East Offshore Wind Farm and Associated Offshore Transmission Infrastructure. Document Reference 8460001-PCA0010-MWE-REP-003.

Appendix 1 Compliance with cable installation parameters assessed and commitments in the Moray East ES 2012

Source	Cable element	Moray East ES 2012 parameter/commitment	Final design parameter/relevant section of Wind Farm CaP
Moray East ES 2012	General cable specifications	Indicative number of strings per site: 7 to 12	15 across the 3 sites (i.e. across the whole Wind Farm) as shown in Figure 7-1 (and detailed within DSLP)
		Capacity of each string: up to 36 MW in Moray East ES 2012, but varied to up to 80 MW	Up to 76.2 MW (8 WTG Maximum per circuit) (as detailed within DSLP)
		Configuration of strings: branched or looped	Branched as shown in Figure 7-1 (and detailed within DSLP)
		Voltage of cabling: 33 or 66 kV	66 kV as detailed within Section 7-2 (and detailed within DSLP)
		Entry / exit method to WTGs and OSPs: J tube	J-tube (as detailed in the DSLP)
		Target burial depth in seabed: 1 m	Target depth of lowering is 1 m as highlighted in Section 10.6.
		Protection where burial not achieved: rock placement, concrete mattresses / concrete tunnels / grout, bags, proprietary steel / plastic ducting /protecting sleeves.	Where the minimum depth of lowering cannot be achieved, then appropriate means of additional protection will be employed. Likely protection measure will be rock placement as highlighted in Section 11.6.2.
		Trench affected width during installation and decommissioning: 6 m per cable.	6 m is the maximum width of seabed effected by trenching tooling (excluding vehicle tracks). Up to 4 m of seabed additional temporary disturbance due to vehicle tracks is also considered. Section 15 confirms no significant changes from the assessment provided within Moray East ES 2012 resulting from the updated width of seabed disturbance (up to 10 m including vehicle tracks).

Source	Cable element	Moray East ES 2012 parameter/commitment	Final design parameter/relevant section of Wind Farm CaP
		Total length of inter -array cables: 572 km.	Total inter-array cable length approximately 156 km as detailed in Table 7-1.
	Cable installation	The available techniques for creating the cable trenches are ploughing, jetting, jet–assisted plough, tracked devices or mechanical cutting. The technique used is chosen so it is suitable for the seabed conditions.	Section 11.6 details the cable installation.
	Remedial protection	Cables will be buried to a target depth of 0 to 1 m where it is technically practical to do so. In instances where adequate burial cannot be achieved then cable protection will be installed. Over trawl surveys will be carried out on inter - array cables to ensure that the cable burial and protection scheme has been successful.	Where the minimum depth of lowering cannot be achieved, then appropriate means of additional protection will be employed. Likely protection measure will be rock placement as highlighted in Section 11.6.2. Over trawl survey details provided in Section 13.
	Mitigation of impacts on archaeology	Where cultural heritage assets (identified in the MORL ES) may potentially be subject to direct or secondary effects, infrastructure will be micro-sited and temporary exclusion zones will be implemented to prevent invasive activities. Exclusion zones of at least 100 m will be established around sites identified as being of high sensitivity while an exclusion zone of a minimum 50 m will be established around those of medium sensitivity.	Section 9.2 provides detail on exclusion zones, including exclusion zones due to archaeological interests.
	Cable layout design	Wind farm infrastructure will not be sited within 50 m of existing abandoned well heads.	Section 9.2 provides details of exclusion zones, including avoidance of oil and gas well heads.
		MORL will ensure that all practicable mitigation measures to minimise the risk of health and safety incidents associated with unexploded ordnance (UXO) are fully developed prior to construction. A UXO site survey will be undertaken prior to construction and site safety instructions will be prepared in the event that an item of UXO is located. All contractors' staff will be given munitions awareness briefings prior to and during the construction work. Should suspected items of UXO be discovered, their location will be accurately mapped and recorded for future assessment and possible removal / disposal or remediation in situ by a specialist contractor.	Section 8.5 provides details on the UXO survey and clearance

Source	Cable element	Moray East ES 2012 parameter/commitment	Final design parameter/relevant section of Wind Farm CaP
	Third party cables in proximity and cable crossings	Adherence to cable crossing / proximity agreements being secured post consent which will include detailed crossing conditions and methodology. Faroese Telecom will also be notified of any MORL works within 1,000m of the SHEFA-2 cable.	Section 9.1 provides detail on routing constraints.
	Post installation surveys	Offshore generating station infrastructure will be suitably monitored for unintended exposure if previously buried and for unwanted scour if exposed above the seabed. Scour protection may be applied to turbine foundations or to sections of cable that would otherwise be exposed at the seabed surface. Cable protection has dual purposes in both preventing scour and protecting the cable from external damage. The width of seabed about cable routes and the area around foundations potentially affected by either scour or protection materials is generally similar.	Section 12.2 provides details on the post-installation monitoring.

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