



# Beatrice Offshore Wind Farm Consent Plan

## Development Specification and Layout Plan

November 2015

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Project Title/ Location	Beatrice Offshore Wind Farm
Project Reference Number	LF0000005
Date:	November 2015

# Beatrice Offshore Wind Farm




## Development Specification and Layout Plan

Pursuant to Section 36 Consent Condition 13 and the Marine Licence  
(Offshore Transmission Works) Condition 3.2.2.6 (Partial)

For the approval of the Scottish Ministers

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Term	Definition / Description
AEZ	Archaeological Exclusion Zone.
Application	The application letters and Environmental Statement submitted to the Scottish Ministers by BOWL on 23 April 2012 and Supplementary Environmental Information Statement submitted to the Scottish Ministers by BOWL on 29 May 2013.
BOWL	Beatrice Offshore Windfarm Limited (Company Number SC350248) and having its registered office at Inveralmond House, 200 Dunkeld Road, Perth, PH1 3AQ.
CaP	Cable Plan as required for approval under Condition 19 of the s36 consent and Condition 3.2.2.10 of the OfTW Marine Licence.
CMS	Construction Method Statement as required for approval under Condition 11 of the s36 consent and Condition 3.2.2.4 of the OfTW Marine Licence.
CoS	Chamber of Shipping.
ddm	Degrees Decimal Minutes.
Development	The Wind Farm and the OfTW.
DOL	Depth of Lowering.
DS	Design Statement as required for approval under Condition 14 of the S36 Consent and Condition 3.2.2.7 of the OfTW Marine Licence.
DSLPP	Development Specification and Layout Plan as required for approval under Condition 13 of the S36 consent and Condition 3.2.2.6 of the OfTW Marine Licence.
ES	The Environmental Statement submitted to the Scottish Ministers by the Company on 23 April 2012 as part of the Application as defined above.
GIS	Geographic Information Systems.
HAT	Highest Astronomical Tide.
IALA	International Association of Lighthouse Authorities.
Inter-array cables/cabling	The AC electrical cables that connect the wind turbines to the OTMs (and OTM to OTM).
JNCC	Joint Nature Conservation Committee.
Key Contractors	The Contractors appointed for the individual work streams of Marine Installation; Transmission; and, wind turbines.
LAT	Lowest Astronomical Tide.
Licensing Authority	The Scottish Ministers.

Term	Definition / Description
LMP	Lighting and Marking Plan as required for approval under Condition 20 of the S36 consent and Condition 3.2.2.14 of the OfTW Marine Licence.
Marine Licences	The written consents granted by the Scottish Ministers under Section 20(1) of the Marine (Scotland) Act 2010, which are dated 2 September 2014.
MCA	Maritime and Coastguard Agency.
MS - LOT	Marine Scotland Licensing Operations Team.
MW	Megawatts.
NLB	Northern Lighthouse Board.
OfTW	The Offshore Transmission Works. The OfTW includes the transmission cable required to connect the Wind Farm to the OnTW. This covers the OTMs and the cable route from the OTMs to the Mean High Water Springs (MHWS) at the landfall west of Portgordon on the Moray coast.
OfTW CMS	The Construction Method Statement in respect of the export cable installation and OTM commissioning to be submitted for approval under Condition 3.2.2.4 of the OfTW Marine Licence.
OfTW DSLP	The Development Site Layout Plan in respect of the export cable installation to be submitted for approval under Condition 3.2.2.6 of the OfTW Marine Licence.
OSP	Offshore Substation Platform.
OTM	Offshore Transformer Module means an alternating current (AC) OSP which is a standalone modular unit that utilises the same substructure and foundation design as a wind turbine generator.
PS	Piling Strategy as required for approval under Condition 12 of the S36 Consent and Condition 3.2.2.5 of the OfTW Marine Licence.
RAL	System for defining standard colours for paint and coatings.
rpm	Revolutions Per Minute.
RYA	Royal Yachting Association.
S36 Consent	Consent granted by the Scottish Ministers under Section 36 of The Electricity Act 1989 to construct and operate the Beatrice Offshore Wind farm electricity generating station, dated 19 <sup>th</sup> March 2014.
SAR	Search and Rescue.
SEIS	The Supplementary Environmental Information Statement submitted to the Scottish Ministers by the Company on 29

Term	Definition / Description
	May 2013 as part of the Application as defined above.
SFF	Scottish Fishermen's Federation.
Site	The area outlined in red in Figure 1 attached to the (S36) Consent Annex 1 and the area outlined in red and the area outlined in black in the figure contained in Part 4 of the (OfTW) Marine Licence.
SNH	Scottish Natural Heritage.
Subcontractors	Subcontractors to Key Contractors as defined above.
SWT	Siemens Wind Turbine.
TTD	Target Trench Depth.
WGS84	World Geodetic System 1984; the reference coordinate system used by the Global Positioning System.
Wind Farm	The offshore array development as assessed in the ES including wind turbines, their foundations, inter-array cabling and meteorological masts.
WTG	Wind Turbine Generator.



## 1 Introduction

### 1.1 Background

1.1.1 The Beatrice Offshore Wind Farm received consent under Section 36 of the Electricity Act 1989 from the Scottish Ministers on 19 March 2014 (the S36 Consent) and was granted two Marine Licences from the Scottish Ministers, for the Wind Farm and associated Offshore Transmission Works (OfTW), on 2<sup>nd</sup> September 2014 (the Marine Licences).

### 1.2 Objectives of this Document

1.2.1 The S36 Consent and Marine Licences 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 the proposed layout and specification of the Wind Farm and OfTW design through the preparation and approval of a Design Specification and Layout Plan (DSLPL).

1.2.2 The relevant conditions setting out the requirement for a DSLPL for approval are set out in full in Table 1.1.

1.2.3 This document is intended to satisfy the requirements of the S36 and the OfTW Marine Licence conditions by providing details of the proposed design and layout specification.

1.2.4 It should be noted that this DSLPL is intended to provide full details to allow the complete discharge of the relevant S36 Consent condition and the partial discharge of the OfTW Marine Licence condition in so far as it relates to the offshore substation platforms (OSPs), referred to as offshore transformer modules (OTMs).

1.2.5 A separate DSLPL will be prepared for the remainder of the OfTW (i.e. the export cables) and subsequently submitted for approval by the Scottish Ministers.

**Table 1.1 - Consent conditions**

Consent Document	Condition Reference	Condition Text	Reference to relevant Section of this DSLPL
Section 36	13	The Company must, no later than 6 months prior to the Commencement of the Development, submit a DSLPL in writing, to the Scottish Ministers for their written approval.	This document sets out the DSLPL for approval by the Scottish Ministers
		Such approval may only be granted following consultation by the Scottish Ministers with the Maritime and Coastguard Agency (MCA), Northern Lighthouse Board (NLB), Chamber of Shipping (CoS), the Joint Nature Conservation Committee (JNCC), Scottish Natural Heritage (SNH), Scottish Fishermen's Federation (SFF) and any such other	Consultation to be undertaken by the Scottish Ministers



Consent Document	Condition Reference	Condition Text	Reference to relevant Section of this DSLP
		advisors or organisations as may be required at the discretion of the Scottish Ministers.	
		The Development must, at all times, be constructed in accordance with the approved DSLP (as updated and amended from time to time by the Company).	Section 2.0
		Any updates or amendments made to the DSLP by the Company must be submitted, in writing, by the Company to the Scottish Ministers for their written approval.	Section 3.0
		The DSLP must include, but not be limited to the following: a) A plan showing the proposed location of each individual Wind Turbine Generator (WTG) (subject to any required micro-siting), including information on WTG spacing, WTG identification / numbering, location of the substation platforms, seabed conditions, bathymetry, confirmed foundation type for each WTG and any key constraints recorded on the Site;	Section 4.2
		b) A list of latitude and longitude co-ordinates accurate to three decimal places of minutes for each WTG, this should also be provided as a Geographic Information System (GIS) shape file using WGS84 format;	Section 4.3 and GIS data in Appendix C
		c) A table or diagram of each WTG dimensions including - height to blade tip (measured above Highest Astronomical Tide (HAT)), height to hub (measured above HAT to the centreline of the generator shaft), rotor diameter and rotation speed;	Section 4.4
		d) The generating capacity of each WTG used on the Site and a confirmed generating capacity for the Site overall;	Section 4.5
		e) The finishes for each WTG (see condition 20 on WTG lighting and marking); and	Section 4.6
		f) The length and proposed arrangements on the seabed of all inter-array cables.	Section 4.7
OFTW Marine Licence	3.2.2.6	The Licensee must, no later than 6 months prior to the Commencement of the Works, submit a DSLP, in writing, to the Licensing Authority for their written approval.	This document sets out the DSLP in so far as it relates to the offshore substation platforms (OSPs), referred to as

Consent Document	Condition Reference	Condition Text	Reference to relevant Section of this DSLP
			offshore transformer modules (OTMs) for approval by the Scottish Ministers
		Such approval may only be granted following consultation by the Licensing Authority with the MCA, NLB, CoS, JNCC, SNH, SFF and any such other advisors or organisations as may be required at the discretion of the Licensing Authority.	Consultation to be undertaken by the Scottish Ministers
		The DSLP must include, but not be limited to the following: a) A plan showing the proposed location of each individual OSP, seabed conditions, bathymetry, confirmed foundation type for each OSP and any key constraints recorded on the Site;	Section 5.2
		b) A list of latitude and longitude co-ordinates accurate to three decimal places of minutes for each OSP, this should also be provided as a GIS shape file using WGS84 format;	Section 5.3 and GIS data in Appendix C
		c) A table or diagram of each OSP;	Section 5.4
		d) The finishes for each OSP; and	Section 5.5
		e) The length and proposed arrangements on the seabed of all cables.	Captured within a separate OfTW DSLP

1.2.6 In addition to the specific consent requirements for a DSLP and the requirements thereof (as set out in Table 1.1), this DSLP also includes information in respect of another condition within the Project consents as set out in Table 1.2.

**Table 1.2 - Other consent conditions relevant to this DSLP**

Reference	Summary of Condition	Where Addressed
Section 36 Condition 38	The Company must ensure no WTGs, offshore substation platforms or meteorological masts are erected within 2.5km of Beatrice Alpha, Bravo, Charlie or Jacky Platforms.	Section 4.2

### **1.3 DSLP Document Structure**

- 1.3.1 In response to the specific requirements of the S36 Consent and the OfTW Marine Licence conditions, this DSLP has been structured so as to be clear that each part of the specific requirements have been met and that the relevant information to allow the Scottish Ministers to approve the DSLP has been provided. The document structure is set out in Table 1.3.

**Table 1.3 – DSLP document structure**

Section	Title	Overview
1	Introduction	Background to consent requirements and overview of the DSLP scope and structure; and Identifies those other consent plans relevant to the Design and specification of the Development and provides a statement of consistency between the DSLP and those plans.
2	BOWL Statements of Compliance	Sets out the BOWL statements of compliance in relation to the DSLP consent conditions.
3	Updates and amendments to this DSLP	Sets out the procedures for any required updating to or amending of the approved DSLP and subsequent further approval by the Scottish Ministers.
4	Design, specification and layout of the Wind farm	Provides the required details in relation to the design, specification and layout of the wind farm including inter-array cables.
5	Design, specification and layout of the Offshore Transmission Works	Provides the required details in relation to the design, specification and layout of the offshore transformer modules and export cables.
6	Compliance with the Environmental Statement	Sets out confirmation that the details set out in this DSLP are in accordance with those assessed in the ES.

#### **1.4 Linkages with other Consent Plans**

- 1.4.1 This DSLP document sets out the proposed design and layout specification for the Wind Farm and the OTMs. However, ultimately it will form part of a suite of approved documents that will provide the framework for the construction process – namely the other Consent Plans required under the Section 36 and OfTW marine licence.
- 1.4.2 Condition 14 of the S36 Consent and Condition 3.2.2.7 of the OfTW Marine Licence require the submission for approval of a Design Statement (DS). The DS provides visualisations of the final Development from a number of agreed viewpoints and is based upon the DSLP.
- 1.4.3 Condition 20 of the S36 Consent and Condition 3.2.2.14 of the OfTW Marine Licence require the submission for approval of a Lighting and Marking Plan (LMP). Lighting and marking requirements will be based upon the layout presented in the DSLP.
- 1.4.4 The linkage between this DSLP and other Consent Plans is summarised in Table 1.3 below.

**Table 1.4 – DSLP consistency and links to other Consent Plans**

Consent Plan	Consistency with and linkage to DSLP
DS	Provides representative wind farm visualisations of the wind farm layout, as detailed in the DSLP, from key viewpoints.
LMP	Provides details of lighting and marking of the Development structures during construction and operation. Operational lighting requirements will be defined upon the basis of the layout presented in the DSLP.

## **2 BOWL Statements of Compliance**

### **2.1 Introduction**

- 2.1.1 The following section is intended to re-affirm the BOWL commitment to ensuring that the Development is constructed in such a manner as to meet the relevant legislative requirements set out by the S36 Consent and Marine Licences.

### **2.2 Statements of Compliance**

- 2.2.1 BOWL in undertaking the final design and construction of the Development will require compliance with this DSLP as approved by the Scottish Ministers (and as updated or amended from time to time following the procedure set out in Section 3 of this DSLP).
- 2.2.2 Where updates or amendments are required to this DSLP, BOWL will ensure the Scottish Ministers are informed as soon as reasonably practicable and where necessary the DSLP will be updated or amended (see Section 3 below).
- 2.2.3 BOWL in undertaking the construction and operation of the project will require compliance with other, relevant Consent Plans as approved by the Scottish Ministers including, as set out in Section 1.4 above.
- 2.2.4 BOWL in undertaking the construction of the project will require compliance with the limits defined by the original Application and the project description defined in the Environmental Statement (ES) and Supplementary Environmental Information Statement (SEIS) and referred to in Annex 1 of the S36 Consent in so far as they apply to this DSLP (unless otherwise approved in advance by the Scottish Ministers) (see Section 6).
- 2.2.5 BOWL will, in undertaking the design and construction of the Development, require compliance with the approved DSLP (and all other relevant, approved Consent Plans) by the Key Contractors and Subcontractors through condition of contract and by an appropriate auditing process.

### **3 Updates and Amendments to this DSLP**

3.1.1 This DSLP sets out the proposed design and layout specification for the Wind Farm and offshore transmission components of the Wind Farm and OTMs.

3.1.2 The S36 Consent condition recognises that updates or amendments to this DSLP may be required, stating that:

*The Development [Wind Farm] must, at all times, be constructed in accordance with the approved DSLP (as updated and amended from time to time by the Company [BOWL]). Any updates or amendments made to the DSLP by the Company [BOWL] must be submitted, in writing, by the Company [BOWL] to the Scottish Ministers for their written approval.*

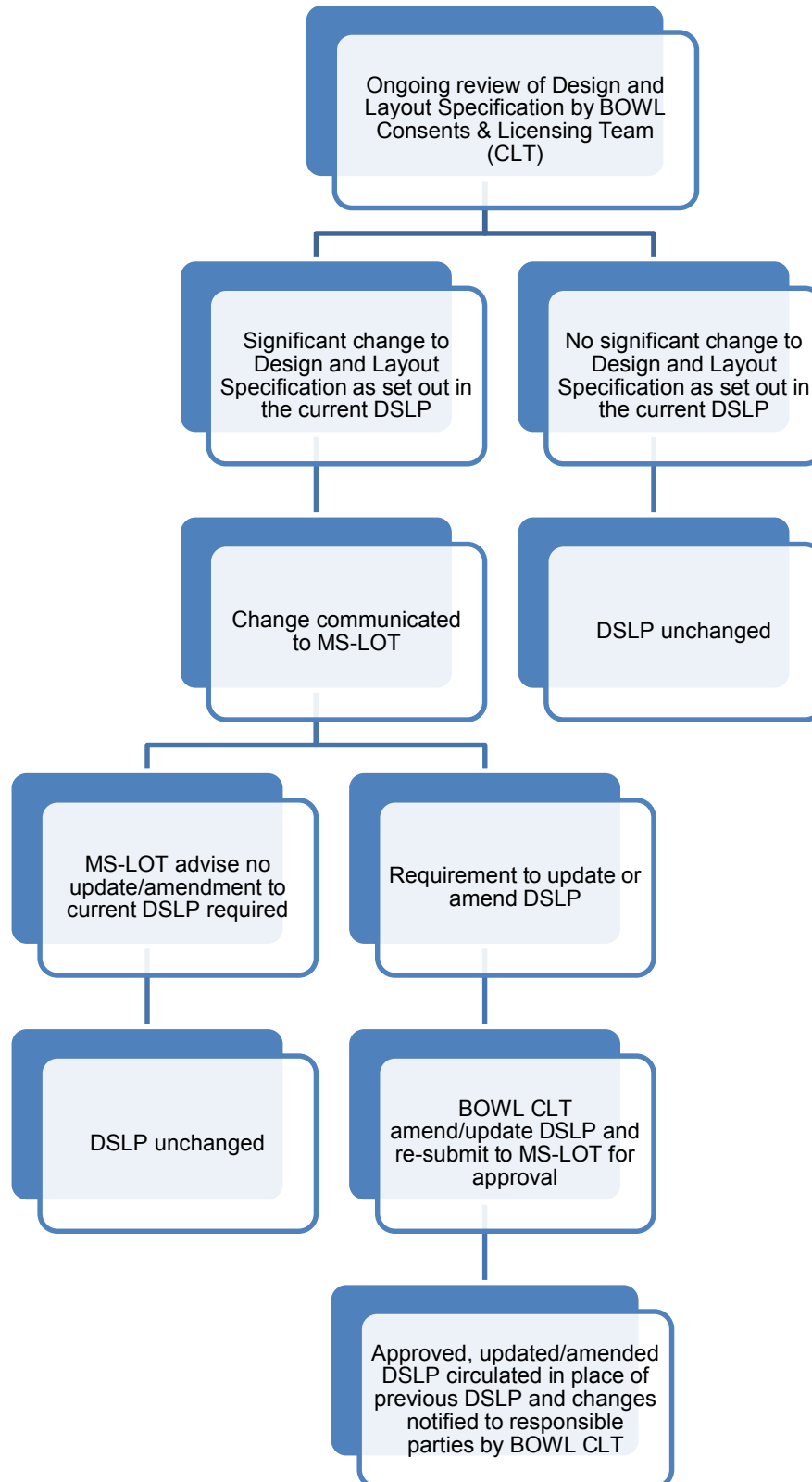
3.1.3 The main design and layout specifications for both the Wind Farm and OTMs are described in this DSLP including:

- Wind turbine and OTM layout plans;
- Wind turbine and OTM location co-ordinates;
- Wind turbine and OTM specifications (including wind turbine generating capacity and total Development generating capacity);
- Wind turbine and OTM finishes; and
- Inter-array lengths and arrangements.

3.1.4 Where it is necessary to update this DSLP in light of any significant new information related to the design and layout specification, BOWL proposes to use the change management process set out in Figure 3.1 in identifying such information, communicating such change to the Scottish Ministers, re-drafting the DSLP, seeking further approval for the necessary amendments or updates and disseminating the approved changes/amendments to responsible parties.



**Figure 3.1 - DSLP change management procedure**



## 4 Design, Specification and Layout – Wind Farm

### 4.1 Introduction

- 4.1.1 This section of the DSLP details the wind farm design and layout specification as required by the S36 Consent condition detailed in Table 1.1. Details related to the OTMs required by the OfTW Marine Licence condition are provided separately under Section 5.

### 4.2 Wind Farm Layout and Specification

- 4.2.1 S36 Consent Condition 13 requires that this DSLP include the following:

*A plan showing the proposed location of each individual WTG (subject to any required micro-siting), including information on WTG spacing, WTG identification / numbering, location of the substation platforms, seabed conditions, bathymetry, confirmed foundation type for each WTG and any key constraints recorded on the Site;*

- 4.2.2 The Wind Farm layout is presented in Figure 4.1 below. There are a total of 88 locations shown in Figure 4.1, representing:

- 84 wind turbines;
- 2 OTMs; and
- 2 'spare' locations.

- 4.2.3 The spare locations would only be utilised in the event of difficulties being encountered during the foundation installation operations at one of the wind turbine or OTM locations that could not be otherwise overcome by micro-siting.

- 4.2.4 The wind turbine identification system is described in paragraphs 4.2.8 to 4.2.12.

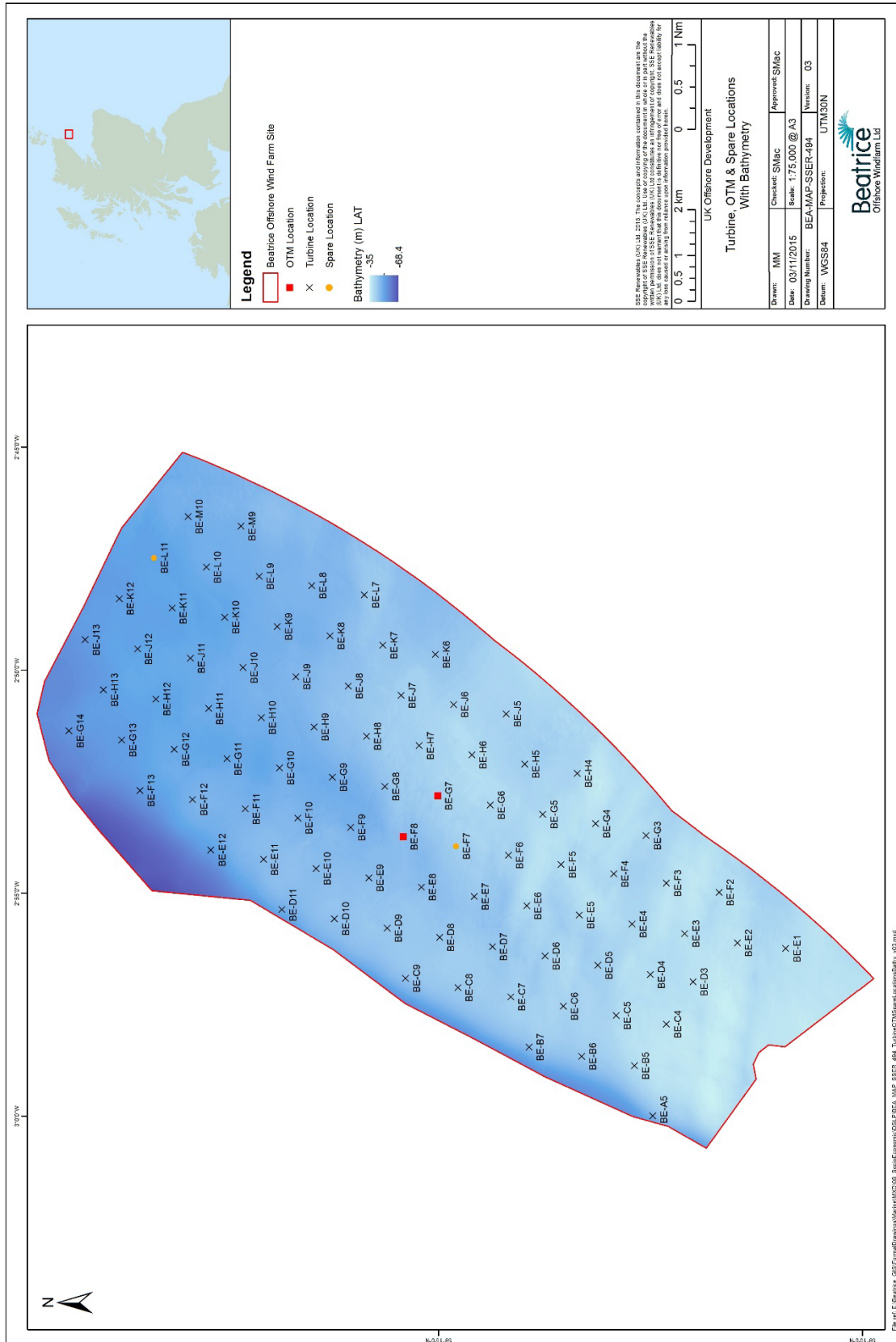


Figure 4.1 – Wind Farm wind turbine and OTM layout and site bathymetry

### **Wind Turbine Spacing**

- 4.2.5 The wind turbines are arranged in a regular geometric pattern that permits navigation between rows of turbines in any direction. The layout should not preclude commercial fishing from the wind farm site. A Commercial Fisheries Mitigation Strategy (CFMS) will be developed in consultation with fishery industry representatives to ensure co-existence and to explore potential mitigation measures.
- 4.2.6 The wind turbines are spaced at a distance of approximately 1170 m apart in all directions, a distance roughly equivalent to 7.6 wind turbine rotor diameters. There are minor variations in spacing in the layout shown in Figure 4.1. Specifically the spacing of 4 turbines differs slightly; this results from turbines which at a spacing of 1170 m lay marginally outwith the 'developable area' (the developable area is shown in Figure 4.4) being moved to ensure they lie with the developable (red line) boundary. The wind turbines that are spaced differently are as follows:
- BE-C4 (1121.5m to nearest turbine);
  - BE-D3 (945.5m to nearest turbine);
  - BE-E1 (1065.5m to nearest turbine); and
  - BE-G3 (1102m to nearest turbine).
- 4.2.7 The distances stated above are separations pre-micrositing. Micro-siting allows for the movement of a wind turbine or OTM structure by up to 50m on any axis as measured from the centrepoint position.

### **Wind Turbine Identification**

- 4.2.8 Each wind turbine is marked with a unique alpha-numeric identifier, as shown in Figure 4.1. The turbine identification system has been devised in line with the following principles and/ or requirements:
- Each unique turbine or OTM identifier is prefixed with a capital B for Beatrice;
  - The unique identifiers consist of a letter and a number;
  - The use of O and I has been avoided to prevent confusion with numeric characters in line with MCA guidance (MGN 371);
  - Consideration has been given to 'SAR lanes', and facilitating navigation thorough the Wind Farm.
- 4.2.9 The MCA confirmed that the indicative SAR lanes through the Beatrice Wind Farm extend in a slight northeast to southwest (and vice versa) direction (letter from the MCA titled 'Beatrice Offshore Wind Farm – Search and Rescue and Navigational Safety Layout Assessment' dated 21<sup>st</sup> April 2015). The proposed numbering system has considered this in that the turbines and OTMs located along these lanes all have the same letter in their unique identifiers, followed by a descending or ascending number from the next turbine/ OTM along the lane, depending on the direction of travel.

4.2.10 Further to this, the numbering system has been designed to aid navigation through the Wind Farm. When navigating through the Wind Farm along any lane in any direction, one would follow rows of turbines and OTMs with unique identifiers of either the same letter and ascending/ descending number, or letters in ascending/ descending alphabetical order, and the same number.

4.2.11 The unique identifiers will be situated on the turbine towers directly above the yellow transition pieces and on the outside of the transition piece railings so as to provide adequate visual coverage and can therefore be read from all directions. The lettering will be black on a yellow background that is clearly readable by an observer stationed 3 m above sea level, at a distance of at least 150 m away from the turbine and illuminated by low intensity white shrouded lights (which will be controlled by a twilight sensor). Aviation unique identifiers will be on top of the nacelles in clear black lettering and designed so as to be visible from a height of 500 ft (150 m) above the highest part of the turbine (excluding the blades). Illumination will be controlled from the BOWL Marine Coordination Centre and activated as required.

4.2.12 A separate electrical turbine identification system is required to ensure suitable electrical safety management during the operational phase of the Wind Farm. As such, BOWL propose to add a separate unique identifier in line with the electrical numbering system to each turbine and OTM structure. This number would be considerably smaller in size than the unique identifiers required for SAR operations, and would be visible when standing on the transition piece platform of the turbines. It is likely the number would be shown on a sign attached to the access door at the base of each turbine.

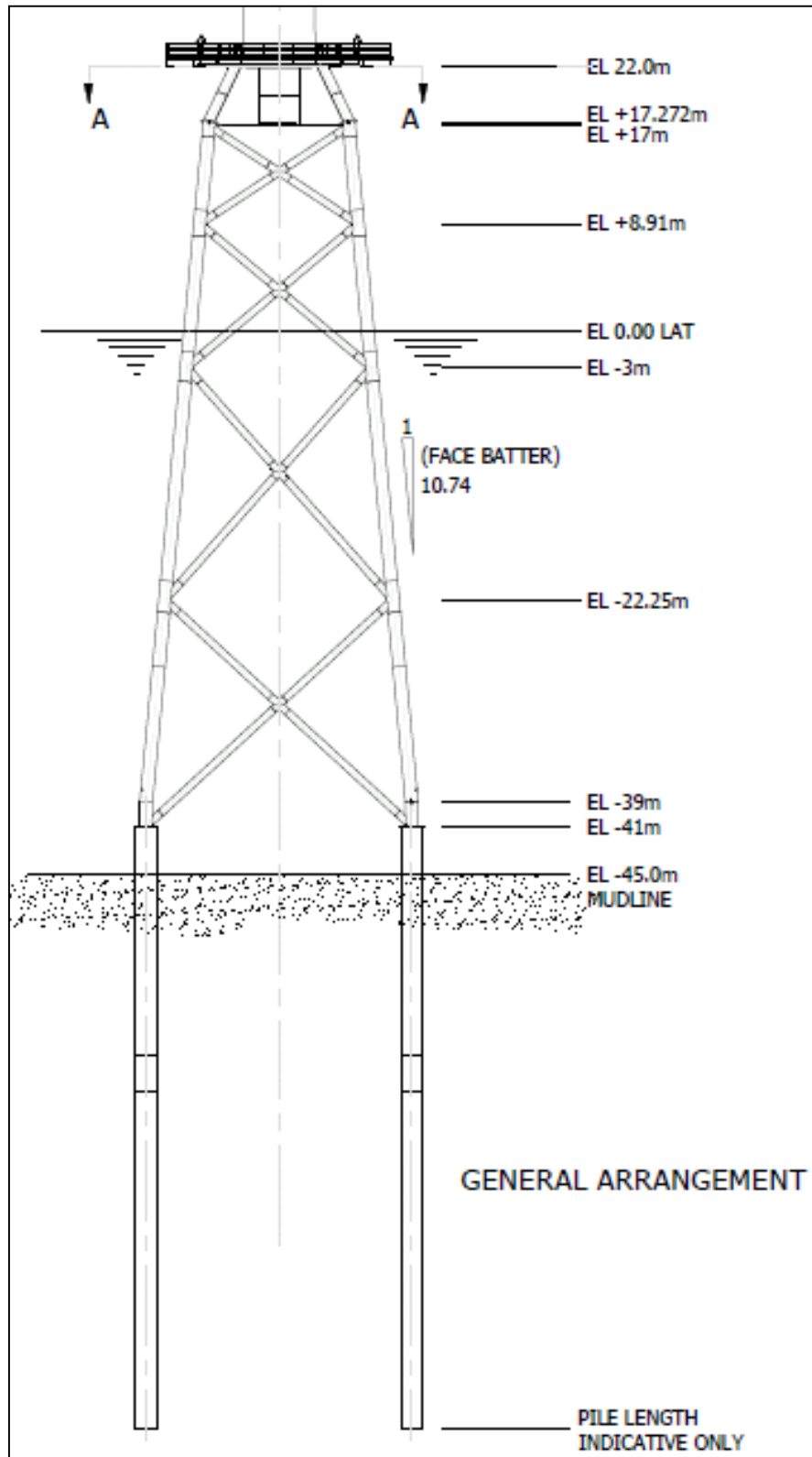
#### **Wind Turbine Foundation Types**

4.2.13 All of the 84 wind turbines will be supported by tubular jacket substructures and piled foundations.

4.2.14 The foundation piles measure 2.2m in diameter and protrude the seabed by 2 – 6m, penetrating the seabed by 35 – 60m.

4.2.15 The jacket substructures range in overall height from 57m up to 77m to take account of variable water depths across the site, and they each have a footprint measuring 24m by 24m. Figure 4.2 below shows the general design and arrangement of a wind turbine support structure for a location in 45m water depth, which is representative of depths encountered across the Wind Farm site. Whilst the structures will vary slightly in height to allow for water depth, their design and arrangement will otherwise not alter. The height of the structures above the surface of the sea will be consistent across the site at 22 m above LAT.

**Figure 4.2 – Illustration of a wind turbine support structure for a location in 45m water depth**



## **Wind Farm Bathymetry and Seabed Conditions**

- 4.2.17 Bathymetry across the Wind Farm ranges from 35m below Lowest Astronomical Tide (LAT) in the south-west corner up to 68m in the northwest-corner (see Figure 4.1). There is a gentle slope of around  $0.5^{\circ}$  along the length of the site.
- 4.2.18 The wind turbines will be installed in water depths ranging from 38.0m to 54.9m below LAT. Nearly two-thirds of the wind turbines will be installed in depths between 40.0m and 50.0m below LAT; the remaining wind turbines being installed at locations divided more or less equally between the limits of the range. Water depths at each wind turbine location are listed in Table 4.1 below.
- 4.2.19 During construction, pile foundation and jacket substructure installation will be phased across five 'clusters' within the Wind Farm. The clusters have been defined on the basis of their depth range. Further information on the phasing of installation across clusters is presented in the Piling Strategy (PS).
- 4.2.20 Seabed sedimentary conditions across the Wind Farm are characterised in general as being comprised of loose to very dense sand with occasional beds of gravel. Boulders of ~1m diameter or greater are rare based on the most recent analysis of geophysical and geotechnical information. Seabed sediments are shown in Figure 4.3.

### **Key Constraints**

- 4.2.21 There are a small number of physical spatial constraints within the Wind Farm 'developable area'. Infrastructure within the array avoids the following constraints, as shown in Figure 4.4:
- A single plugged and abandoned wellhead;
  - Several features of potential archaeological interest, identified by geophysical survey, and their associated Archaeological Exclusion Zones (AEZs).
- 4.2.22 A review of AEZs was carried out in October 2015 following completion of a ground truthing survey in July 2015 to investigate potential archaeological interests. Following consultation with Historic Scotland three AEZs were removed from the wind farm site in light of the evidence presented in the review. These AEZs have been removed from Figure 4.4.
- 4.2.23 The following constraints have been taken into account in defining the Wind Farm 'developable area' boundaries, and are also shown on Figure 4.4:
- A 2.5km buffer zone around the 'Jacky' platform to preclude the construction of any wind turbines, offshore substations or meteorological masts (as required by Section 36 consent condition 38 (See Table 1.2));
  - A 100m buffer from the site lease boundary (as required under the terms of the Crown Estate Agreement for Lease);
  - A 770m buffer from the Moray Firth Round 3 Zone boundary (as required



under the terms of the Crown Estate Agreement for Lease); and

- An avoidance of water depths in excess of 55m below LAT (for reasons of BOWL engineering feasibility).

4.2.24 A series of environmental baseline surveys have been commissioned by BOWL to understand environmental conditions across the Wind Farm site and to identify any environmental sensitivities. Surveys have not identified any environmental sensitivities relevant to determination of the final Wind Farm layout.

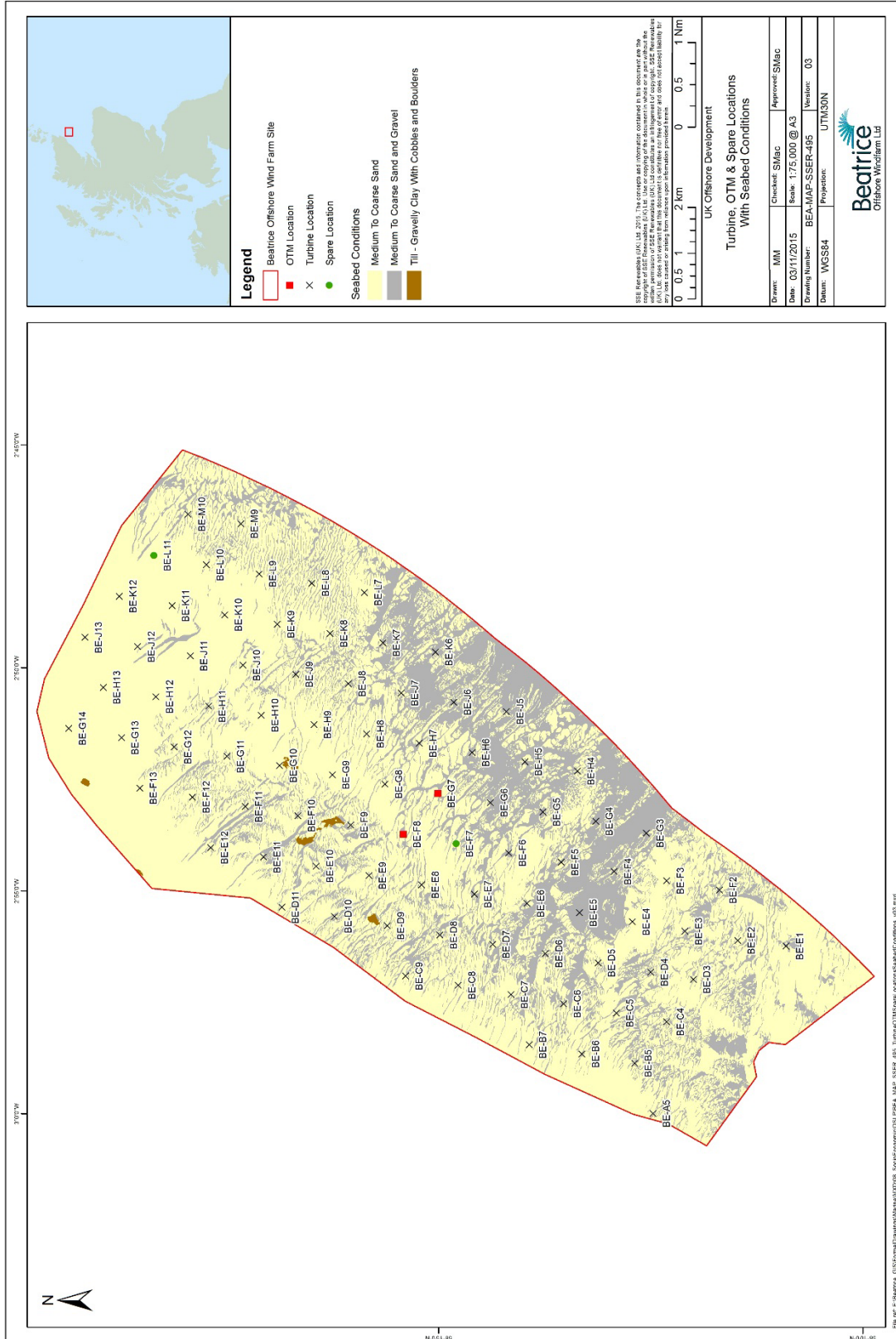


Figure 4.3 – Seabed conditions across the Wind Farm site

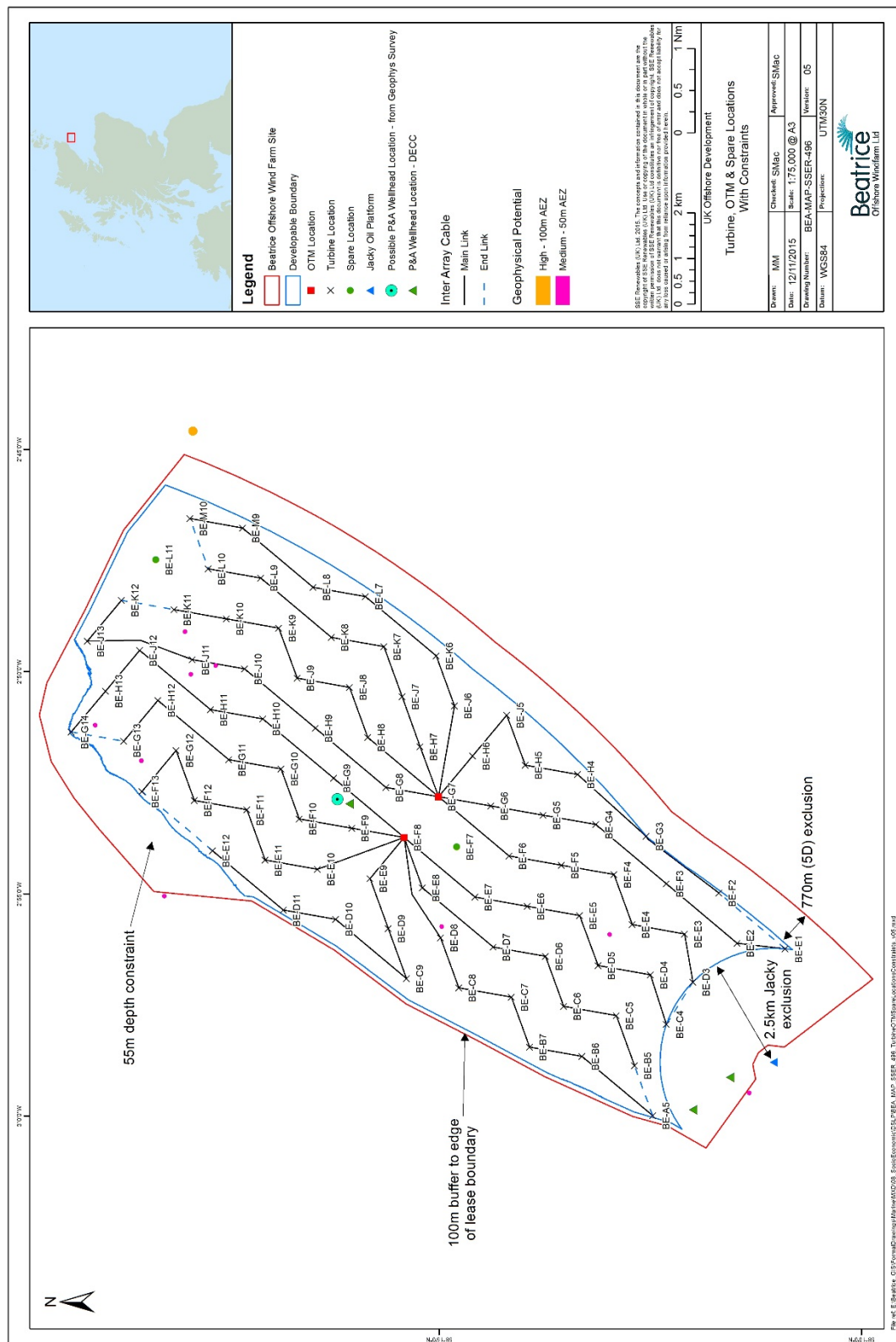


Figure 4.4 – Key constraints to the Wind Farm developable area

### 4.3 Co-ordinates for Wind Turbine Locations

4.3.1 S36 Consent Condition 13 requires that this DSLP include the following:

*A list of latitude and longitude co-ordinates accurate to three decimal places of minutes for each WTG, this should also be provided as a GIS shape file using WGS84 format;*

4.3.2 The wind turbines will be installed, within a permitted 50m radius micro-siting tolerance, at the locations listed in Table 4.1, below. The co-ordinates of the 'spare' locations are provided in Table 4.2, below.

4.3.3 As required by the S36 Consent condition, a GIS shape file with this co-ordinate data is provided under Appendix C.

**Table 4.1 – Wind Turbine location co-ordinates (WGS84) and water depths**

Wind Turbine Identification	Latitude (ddm) WGS84	Longitude (ddm) WGS84	Depth (m) LAT
BE-A5	58 12.471' N	2 59.996' W	47.7
BE-B5	58 12.687' N	2 58.873' W	39.7
BE-B6	58 13.308' N	2 58.664' W	44.0
BE-B7	58 13.929' N	2 58.456' W	46.4
BE-C4	58 12.307' N	2 57.948' W	38.0
BE-C5	58 12.902' N	2 57.749' W	40.4
BE-C6	58 13.524' N	2 57.541' W	41.4
BE-C7	58 14.144' N	2 57.332' W	42.3
BE-C8	58 14.766' N	2 57.124' W	43.3
BE-C9	58 15.386' N	2 56.915' W	45.5
BE-D3	58 11.995' N	2 57.002' W	38.3
BE-D4	58 12.497' N	2 56.834' W	39.4
BE-D5	58 13.117' N	2 56.626' W	41.8
BE-D6	58 13.739' N	2 56.417' W	42.2
BE-D7	58 14.359' N	2 56.209' W	44.0
BE-D8	58 14.981' N	2 55.999' W	43.8
BE-D9	58 15.602' N	2 55.790' W	44.4
BE-D10	58 16.223' N	2 55.582' W	45.3
BE-D11	58 16.844' N	2 55.373' W	50.1
BE-E1	58 10.900' N	2 56.256' W	38.8
BE-E2	58 11.470' N	2 56.128' W	38.2
BE-E3	58 12.090' N	2 55.920' W	38.6
BE-E4	58 12.712' N	2 55.710' W	40.7
BE-E5	58 13.333' N	2 55.502' W	40.4
BE-E6	58 13.954' N	2 55.293' W	40.7
BE-E7	58 14.575' N	2 55.084' W	43.7
BE-E8	58 15.196' N	2 54.875' W	46.0
BE-E9	58 15.817' N	2 54.665' W	46.0
BE-E10	58 16.438' N	2 54.456' W	46.6
BE-E11	58 17.059' N	2 54.247' W	46.6
BE-E12	58 17.680' N	2 54.037' W	52.9
BE-F2	58 11.685' N	2 55.005' W	40.2

Wind Turbine Identification	Latitude (ddm) WGS84	Longitude (ddm) WGS84	Depth (m) LAT
BE-F3	58 12.306' N	2 54.796' W	38.7
BE-F4	58 12.927' N	2 54.588' W	40.4
BE-F5	58 13.548' N	2 54.378' W	39.7
BE-F6	58 14.168' N	2 54.169' W	41.6
BE-F9	58 16.031' N	2 53.540' W	49.0
BE-F10	58 16.653' N	2 53.330' W	48.2
BE-F11	58 17.274' N	2 53.120' W	48.8
BE-F12	58 17.894' N	2 52.911' W	48.6
BE-F13	58 18.516' N	2 52.701' W	54.2
BE-G3	58 12.544' N	2 53.726' W	40.5
BE-G4	58 13.142' N	2 53.464' W	38.6
BE-G5	58 13.762' N	2 53.254' W	39.7
BE-G6	58 14.384' N	2 53.044' W	40.2
BE-G8	58 15.625' N	2 52.625' W	45.2
BE-G9	58 16.247' N	2 52.415' W	49.9
BE-G10	58 16.867' N	2 52.204' W	49.4
BE-G11	58 17.488' N	2 51.994' W	51.1
BE-G12	58 18.109' N	2 51.784' W	50.5
BE-G13	58 18.730' N	2 51.574' W	53.4
BE-G14	58 19.351' N	2 51.362' W	54.9
BE-H4	58 13.356' N	2 52.339' W	41.1
BE-H5	58 13.977' N	2 52.130' W	41.9
BE-H6	58 14.598' N	2 51.920' W	40.0
BE-H7	58 15.219' N	2 51.709' W	42.5
BE-H8	58 15.840' N	2 51.499' W	44.2
BE-H9	58 16.461' N	2 51.289' W	47.8
BE-H10	58 17.082' N	2 51.079' W	49.6
BE-H11	58 17.703' N	2 50.867' W	50.2
BE-H12	58 18.324' N	2 50.657' W	51.8
BE-H13	58 18.944' N	2 50.446' W	53.4
BE-J5	58 14.192' N	2 51.005' W	41.4
BE-J6	58 14.812' N	2 50.795' W	41.5
BE-J7	58 15.433' N	2 50.585' W	42.7
BE-J8	58 16.055' N	2 50.373' W	45.5
BE-J9	58 16.675' N	2 50.163' W	47.8
BE-J10	58 17.296' N	2 49.952' W	49.5
BE-J11	58 17.917' N	2 49.741' W	50.8
BE-J12	58 18.538' N	2 49.530' W	52.2
BE-J13	58 19.159' N	2 49.319' W	54.2
BE-K6	58 15.027' N	2 49.669' W	44.6
BE-K7	58 15.648' N	2 49.459' W	44.3
BE-K8	58 16.269' N	2 49.247' W	47.6
BE-K9	58 16.890' N	2 49.036' W	48.6
BE-K10	58 17.510' N	2 48.825' W	51.5
BE-K11	58 18.131' N	2 48.614' W	52.0
BE-K12	58 18.752' N	2 48.403' W	53.1
BE-L7	58 15.862' N	2 48.333' W	44.5
BE-L8	58 16.482' N	2 48.122' W	47.8

Wind Turbine Identification	Latitude (ddm) WGS84	Longitude (ddm) WGS84	Depth (m) LAT
BE-L9	58 17.104' N	2 47.910' W	49.4
BE-L10	58 17.724' N	2 47.698' W	49.6
BE-M9	58 17.317' N	2 46.784' W	49.0
BE-M10	58 17.938' N	2 46.571' W	49.9

**Table 4.2 – Spare location co-ordinates (WGS84) and water depths**

Spare Location Identification	Latitude (ddm) WGS84	Longitude (ddm) WGS84	Depth (m) LAT
BE-F7	58 14.790' N	2 53.959' W	42.5
BE-L11	58 18.345' N	2 47.487' W	52.4

#### 4.4 Wind Turbine Dimensions

4.4.1 S36 Consent Condition 13 requires that this DSLP includes the following:

*A table or diagram of each WTG dimensions including height to blade tip (measured above HAT), height to hub (measured above HAT to the centreline of the generator shaft), rotor diameter and rotation speed;*

4.4.2 BOWL has chosen to install Siemens SWT-7.0-154 wind turbines. The dimensions of the turbines are presented in Figure 4.5 below and summarised in Table 4.3. Further wind turbine specifications are provided in the Construction Method Statement (CMS).

**Table 4.3 - Key dimensions of the Siemens SWT-7.0-154 wind turbine**

Parameter	Dimension
Height to blade tip	Upper (12 o'clock) 182.5 metres above HAT (187 metres above LAT) Lower (6 o'clock) 28.5 metres above HAT (33 metres above LAT)
Height to hub	105.2 metres above HAT (109.7 metres above LAT)
Rotor diameter	154 metres (blade length 75m)
Rotational speed	11.8 rpm at nominal rating, range 4 – 13 rpm



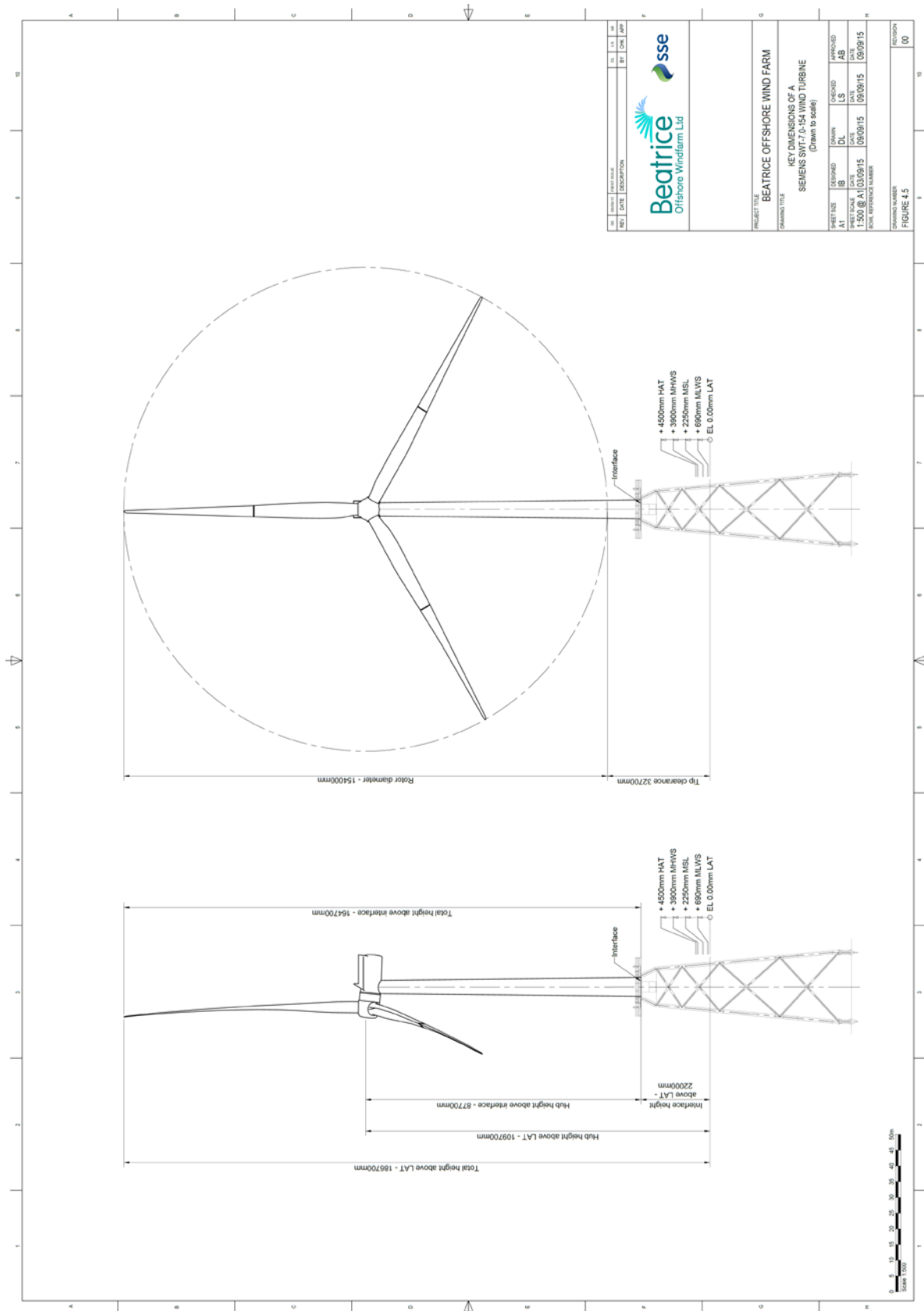


Figure 4.5 – Key dimensions of a Siemens SWT-7.0-154 wind turbine



#### **4.5 Generating Capacity**

4.5.1 S36 Consent Condition 13 requires that this DSLP include the following:

*The generating capacity of each WTG used on the Site and a confirmed generating capacity for the Site overall;*

4.5.2 The chosen wind turbine for installation at the Beatrice Offshore Wind Farm is the Siemens SWT-7.0-154. Each of the wind turbines will have a generating capacity of 7MW.

4.5.3 The total generating capacity of the wind farm will be 588MW.

#### **4.6 Wind Turbine Finishes**

4.6.1 S36 Consent Condition 13 requires that this DSLP include the following:

*The finishes for each WTG (see condition 20 on WTG lighting and marking); and*

4.6.2 Each wind turbine (tower sections, nacelle and blades) will be finished in the standard light grey, RAL 7035. The turbine rotor blades will have blade hover reference markings (red marks painted at 10, 20 and 30 metres from the hub) of at least 60cm width (to assist SAR helicopter operations).

4.6.3 The heli-hoist platform on top of the wind turbine nacelle will be finished in traffic red RAL 3020.

4.6.4 The jacket substructure and transition piece will be finished in golden yellow RAL 1004 from 2m below LAT up to the interface point at 22m above LAT.

#### **4.7 Inter-Array Cable Arrangement and Lengths**

4.7.1 S36 Consent Condition 13 requires that this DSLP include the following:

*The length and proposed arrangements on the seabed of all inter-array cables.*

4.7.2 The wind turbines are connected at a voltage of 33kV by inter-array cabling in 'strings'. There are fourteen strings and six wind turbines per string. The first wind turbine in a string is connected by an inter-array cable to an OTM. The strings are cross-connected at the ends in pairs. These cross connections are to provide auxiliary power to the string in the event of an outage on a string. In addition there is a single 220kV inter-connector cable that connects the two OTMs and allows power to be exported should one of the two export cables be unavailable.

4.7.3 The arrangement of the cables between the wind turbines and the connections to the OTMs is set out in Figure 4.6.

4.7.4 The nominal lengths of the cables are the straight-line distances between turbine locations as presented in Table 4.4 below. The total length of the inter-array cabling is expected to lie within the range of 170 – 190km.

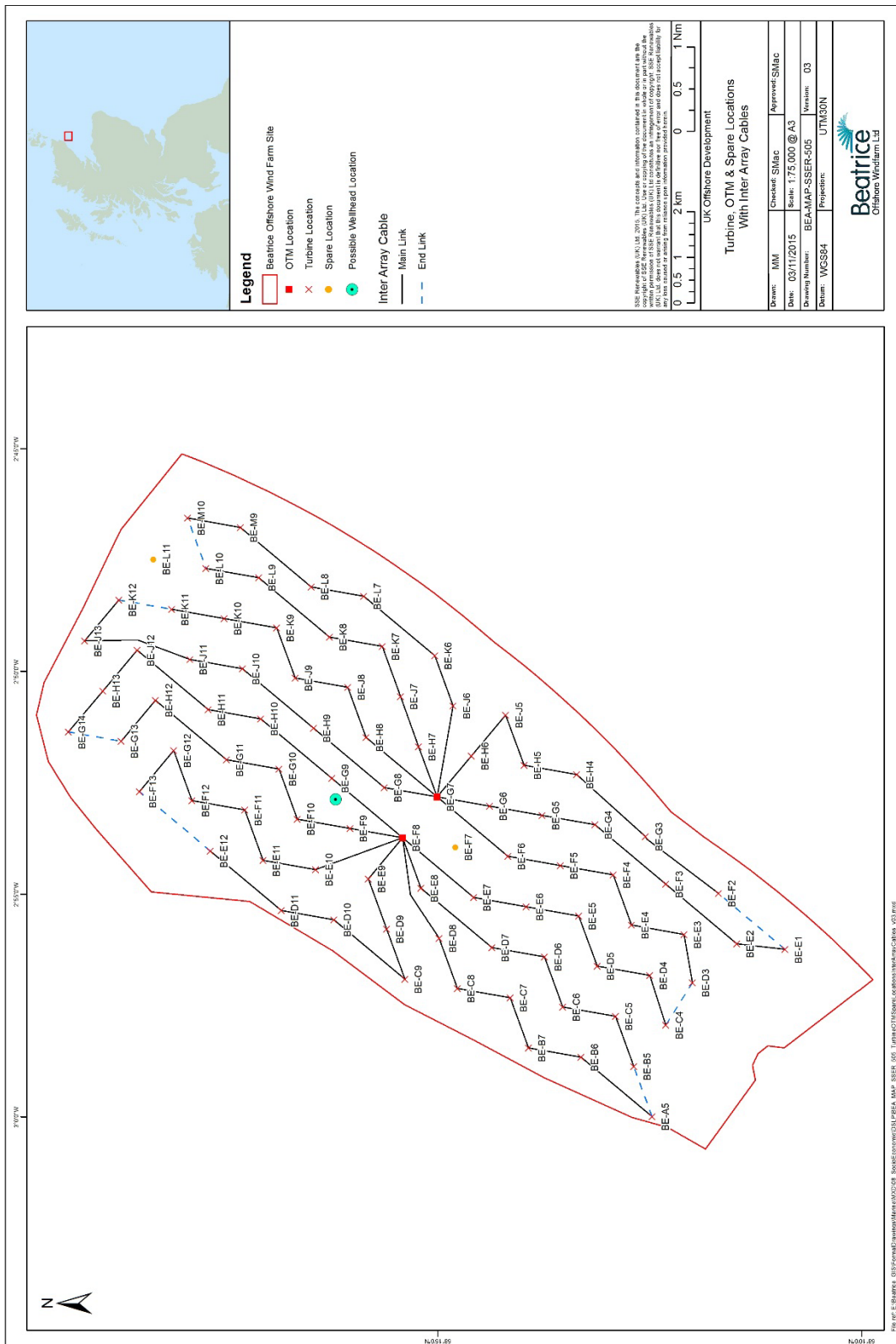


Figure 4.6 – Inter-array cable connection configuration, showing 33kV cable connectivity between turbines and OTMs

**Table 4.4 – Inter-array cable string arrangements and cable lengths**

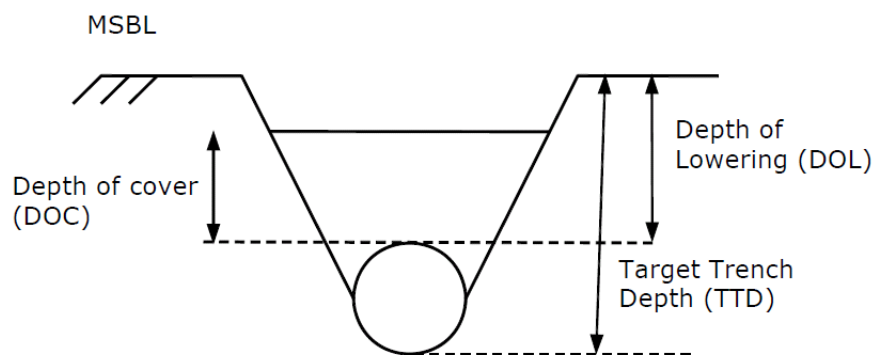
Array Layout		Start Point			End Point			Straight Length (m)	Comment
Start	End	Latitude (ddm) WGS84	Longitude (ddm) WGS84	Water Depth (m) LAT	Latitude (ddm) WGS84	Longitude (ddm) WGS84	Water Depth (m) LAT		
BE-F8	BE-E7	58 15.411' N	2 53.750' W	-45.7	58 14.575' N	2 55.084' W	-43.7	2027.2	First Link
BE-E7	BE-E6	58 14.575' N	2 55.084' W	-43.7	58 13.954' N	2 55.293' W	-40.7	1170.7	
BE-E6	BE-E5	58 13.954' N	2 55.293' W	-40.7	58 13.333' N	2 55.502' W	-40.4	1169.7	
BE-E5	BE-D5	58 13.333' N	2 55.502' W	-40.4	58 13.117' N	2 56.626' W	-41.8	1170.8	
BE-D5	BE-D4	58 13.117' N	2 56.626' W	-41.8	58 12.497' N	2 56.834' W	-39.4	1169.7	
BE-D4	BE-C4	58 12.497' N	2 56.834' W	-39.4	58 12.307' N	2 57.948' W	-38.0	1147	
BE-C4	BE-D3	58 12.307' N	2 57.948' W	-38.0	58 11.995' N	2 57.002' W	-38.3	1093.4	Closing Loop
BE-F8	BE-E8	58 15.411' N	2 53.750' W	-45.7	58 15.196' N	2 54.875' W	-46.0	1170.8	First Link
BE-E8	BE-D7	58 15.196' N	2 54.875' W	-46.0	58 14.359' N	2 56.209' W	-44.0	2027.2	
BE-D7	BE-D6	58 14.359' N	2 56.209' W	-44.0	58 13.739' N	2 56.417' W	-42.2	1169.7	
BE-D6	BE-C6	58 13.739' N	2 56.417' W	-42.2	58 13.524' N	2 57.541' W	-41.4	1170.5	
BE-C6	BE-C5	58 13.524' N	2 57.541' W	-41.4	58 12.902' N	2 57.749' W	-40.4	1170.7	
BE-C5	BE-B5	58 12.902' N	2 57.749' W	-40.4	58 12.687' N	2 58.873' W	-39.7	1170.5	
BE-B5	BE-A5	58 12.687' N	2 58.873' W	-39.7	58 12.471' N	2 59.996' W	-47.7	1170.8	Closing Loop
BE-F8	BE-D8	58 15.411' N	2 53.750' W	-45.7	58 14.981' N	2 55.999' W	-43.8	2340.3	First Link
BE-D8	BE-C8	58 14.981' N	2 55.999' W	-43.8	58 14.766' N	2 57.124' W	-43.3	1170.5	
BE-C8	BE-C7	58 14.766' N	2 57.124' W	-43.3	58 14.144' N	2 57.332' W	-42.3	1170.7	
BE-C7	BE-B7	58 14.144' N	2 57.332' W	-42.3	58 13.929' N	2 58.456' W	-46.4	1170.5	
BE-B7	BE-B6	58 13.929' N	2 58.456' W	-46.4	58 13.308' N	2 58.664' W	-44.0	1170.7	
BE-B6	BE-A5	58 13.308' N	2 58.664' W	-44.0	58 12.471' N	2 59.996' W	-47.7	2027.9	
BE-F8	BE-E9	58 15.411' N	2 53.750' W	-45.7	58 15.817' N	2 54.665' W	-46.0	1169.8	First Link
BE-E9	BE-D9	58 15.817' N	2 54.665' W	-46.0	58 15.602' N	2 55.790' W	-44.4	1170.5	
BE-D9	BE-C9	58 15.602' N	2 55.790' W	-44.4	58 15.386' N	2 56.915' W	-45.5	1170.8	
BE-C9	BE-D10	58 15.386' N	2 56.915' W	-45.5	58 16.223' N	2 55.582' W	-45.3	2027.2	
BE-D10	BE-D11	58 16.223' N	2 55.582' W	-45.3	58 16.844' N	2 55.373' W	-50.1	1170.7	
BE-D11	BE-E12	58 16.844' N	2 55.373' W	-50.1	58 17.680' N	2 54.037' W	-52.9	2027.2	
BE-E12	BE-F13	58 17.680' N	2 54.037' W	-52.9	58 18.516' N	2 52.701' W	-54.2	2027.2	Closing Loop
BE-F8	BE-E10	58 15.411' N	2 53.750' W	-45.7	58 16.438' N	2 54.456' W	-46.6	2027.1	First Link
BE-E10	BE-E11	58 16.438' N	2 54.456' W	-46.6	58 17.059' N	2 54.247' W	-46.6	1169.7	
BE-E11	BE-F11	58 17.059' N	2 54.247' W	-46.6	58 17.274' N	2 53.120' W	-48.8	1170.8	
BE-F11	BE-F12	58 17.274' N	2 53.120' W	-48.8	58 17.894' N	2 52.911' W	-48.6	1169.7	
BE-F12	BE-G12	58 17.894' N	2 52.911' W	-48.6	58 18.109' N	2 51.784' W	-50.5	1170.5	
BE-G12	BE-F13	58 18.109' N	2 51.784' W	-50.5	58 18.516' N	2 52.701' W	-54.2	1171.2	

Array Layout		Start Point			End Point			Straight Length (m)	Comment
Start	End	Latitude (ddm) WGS84	Longitude (ddm) WGS84	Water Depth (m) LAT	Latitude (ddm) WGS84	Longitude (ddm) WGS84	Water Depth (m) LAT		
BE-F8	BE-F9	58 15.411' N	2 53.750' W	-45.7	58 16.031' N	2 53.540' W	-49.0	1169.9	First Link
BE-F9	BE-F10	58 16.031' N	2 53.540' W	-49.0	58 16.653' N	2 53.330' W	-48.2	1170.7	
BE-F10	BE-G10	58 16.653' N	2 53.330' W	-48.2	58 16.867' N	2 52.204' W	-49.4	1170.5	
BE-G10	BE-G11	58 16.867' N	2 52.204' W	-49.4	58 17.488' N	2 51.994' W	-51.1	1170.7	
BE-G11	BE-H12	58 17.488' N	2 51.994' W	-51.1	58 18.324' N	2 50.657' W	-51.8	2027.2	
BE-H12	BE-G13	58 18.324' N	2 50.657' W	-51.8	58 18.730' N	2 51.574' W	-53.4	1170.5	
BE-G13	BE-G14	58 18.730' N	2 51.574' W	-53.4	58 19.351' N	2 51.362' W	-54.9	1170.9	Closing Loop
BE-F8	BE-G9	58 15.411' N	2 53.750' W	-45.7	58 16.247' N	2 52.415' W	-49.9	2027.2	First Link
BE-G9	BE-H10	58 16.247' N	2 52.415' W	-49.9	58 17.082' N	2 51.079' W	-49.6	2027.2	
BE-H10	BE-H11	58 17.082' N	2 51.079' W	-49.6	58 17.703' N	2 50.867' W	-50.2	1169.9	
BE-H11	BE-J12	58 17.703' N	2 50.867' W	-50.2	58 18.538' N	2 49.530' W	-52.2	2027.2	
BE-J12	BE-H13	58 18.538' N	2 49.530' W	-52.2	58 18.944' N	2 50.446' W	-53.4	1170.5	
BE-H13	BE-G14	58 18.944' N	2 50.446' W	-53.4	58 19.351' N	2 51.362' W	-54.9	1170.4	
BE-G7	BE-G8	58 15.004' N	2 52.834' W	-41.2	58 15.625' N	2 52.625' W	-45.2	1170.7	First Link
BE-G8	BE-H9	58 15.625' N	2 52.625' W	-45.2	58 16.461' N	2 51.289' W	-47.8	2027.2	
BE-H9	BE-J10	58 16.461' N	2 51.289' W	-47.8	58 17.296' N	2 49.952' W	-49.5	2027.2	
BE-J10	BE-J11	58 17.296' N	2 49.952' W	-49.5	58 17.917' N	2 49.741' W	-50.8	1169.7	
BE-J11	BE-J13	58 17.917' N	2 49.741' W	-50.8	58 19.159' N	2 49.319' W	-54.2	2341.6	
BE-J13	BE-K12	58 19.159' N	2 49.319' W	-54.2	58 18.752' N	2 48.403' W	-53.1	1170.4	
BE-K12	BE-K11	58 18.752' N	2 48.403' W	-53.1	58 18.131' N	2 48.614' W	-52.0	1169.7	Closing Loop
BE-G7	BE-H8	58 15.004' N	2 52.834' W	-41.2	58 15.840' N	2 51.499' W	-44.2	2027.2	First Link
BE-H8	BE-J8	58 15.840' N	2 51.499' W	-44.2	58 16.055' N	2 50.373' W	-45.5	1170.8	
BE-J8	BE-J9	58 16.055' N	2 50.373' W	-45.5	58 16.675' N	2 50.163' W	-47.8	1169.7	
BE-J9	BE-K9	58 16.675' N	2 50.163' W	-47.8	58 16.890' N	2 49.036' W	-48.6	1170.8	
BE-K9	BE-K10	58 16.890' N	2 49.036' W	-48.6	58 17.510' N	2 48.825' W	-51.5	1169.7	
BE-K10	BE-K11	58 17.510' N	2 48.825' W	-51.5	58 18.131' N	2 48.614' W	-52.0	1170.7	
BE-G7	BE-H7	58 15.004' N	2 52.834' W	-41.2	58 15.219' N	2 51.709' W	-42.5	1170.8	First Link
BE-H7	BE-J7	58 15.219' N	2 51.709' W	-42.5	58 15.433' N	2 50.585' W	-42.7	1169.5	
BE-J7	BE-K7	58 15.433' N	2 50.585' W	-42.7	58 15.648' N	2 49.459' W	-44.3	1170.5	
BE-K7	BE-K8	58 15.648' N	2 49.459' W	-44.3	58 16.269' N	2 49.247' W	-47.6	1170.9	
BE-K8	BE-L9	58 16.269' N	2 49.247' W	-47.6	58 17.104' N	2 47.910' W	-49.4	2027.2	
BE-L9	BE-L10	58 17.104' N	2 47.910' W	-49.4	58 17.724' N	2 47.698' W	-49.6	1169.7	
BE-L10	BE-M10	58 17.724' N	2 47.698' W	-49.6	58 17.938' N	2 46.571' W	-49.9	1170.8	Closing Loop
BE-G7	BE-J6	58 15.004' N	2 52.834' W	-41.2	58 14.812' N	2 50.795' W	-41.5	2026.8	First Link

Array Layout		Start Point			End Point			Straight Length (m)	Comment
Start	End	Latitude (ddm) WGS84	Longitude (ddm) WGS84	Water Depth (m) LAT	Latitude (ddm) WGS84	Longitude (ddm) WGS84	Water Depth (m) LAT		
BE-J6	BE-K6	58 14.812' N	2 50.795' W	-41.5	58 15.027' N	2 49.669' W	-44.6	1170.8	
BE-K6	BE-L7	58 15.027' N	2 49.669' W	-44.6	58 15.862' N	2 48.333' W	-44.5	2027.2	
BE-L7	BE-L8	58 15.862' N	2 48.333' W	-44.5	58 16.482' N	2 48.122' W	-47.8	1169.7	
BE-L8	BE-M9	58 16.482' N	2 48.122' W	-47.8	58 17.317' N	2 46.784' W	-49.0	2027.2	
BE-M9	BE-M10	58 17.317' N	2 46.784' W	-49.0	58 17.938' N	2 46.571' W	-49.9	1170.9	
BE-G7	BE-H6	58 15.004' N	2 52.834' W	-41.2	58 14.598' N	2 51.920' W	-40.0	1169.7	First Link
BE-H6	BE-J5	58 14.598' N	2 51.920' W	-40.0	58 14.192' N	2 51.005' W	-41.4	1170.5	
BE-J5	BE-H5	58 14.192' N	2 51.005' W	-41.4	58 13.977' N	2 52.130' W	-41.9	1170.8	
BE-H5	BE-H4	58 13.977' N	2 52.130' W	-41.9	58 13.356' N	2 52.339' W	-41.1	1169.7	
BE-H4	BE-G3	58 13.356' N	2 52.339' W	-41.1	58 12.544' N	2 53.726' W	-40.5	2028.5	
BE-G3	BE-F2	58 12.544' N	2 53.726' W	-40.5	58 11.685' N	2 55.005' W	-40.2	2028.2	
BE-F2	BE-E1	58 11.685' N	2 55.005' W	-40.2	58 10.900' N	2 56.256' W	-38.8	1904.2	Closing Loop
BE-G7	BE-G6	58 15.004' N	2 52.834' W	-41.2	58 14.384' N	2 53.044' W	-40.2	1169.7	First Link
BE-G6	BE-G5	58 14.384' N	2 53.044' W	-40.2	58 13.762' N	2 53.254' W	-39.7	1170.9	
BE-G5	BE-G4	58 13.762' N	2 53.254' W	-39.7	58 13.142' N	2 53.464' W	-38.6	1169.7	
BE-G4	BE-F3	58 13.142' N	2 53.464' W	-38.6	58 12.306' N	2 54.796' W	-38.7	2027.2	
BE-F3	BE-E2	58 12.306' N	2 54.796' W	-38.7	58 11.470' N	2 56.128' W	-38.2	2027.2	
BE-E2	BE-E1	58 11.470' N	2 56.128' W	-38.2	58 10.900' N	2 56.256' W	-38.8	1065.6	
BE-G7	BE-F6	58 15.004' N	2 52.834' W	-41.2	58 14.168' N	2 54.169' W	-41.6	2027.2	First Link
BE-F6	BE-F5	58 14.168' N	2 54.169' W	-41.6	58 13.548' N	2 54.378' W	-39.7	1169.7	
BE-F5	BE-F4	58 13.548' N	2 54.378' W	-39.7	58 12.927' N	2 54.588' W	-40.4	1170.9	
BE-F4	BE-E4	58 12.927' N	2 54.588' W	-40.4	58 12.712' N	2 55.710' W	-40.7	1169.5	
BE-E4	BE-E3	58 12.712' N	2 55.710' W	-40.7	58 12.090' N	2 55.920' W	-38.6	1170.9	
BE-E3	BE-D3	58 12.090' N	2 55.920' W	-38.6	58 11.995' N	2 57.002' W	-38.3	1074.7	

- 4.7.5 The inter-array cabling will be protected primarily by burial. Currently, a minimum Target Trench Depth (TTD) of 1.0m as measured between the bottom of the cable and mean seabed level is anticipated (see Figure 4.7, below). Where the TTD cannot be achieved, then appropriate means of protection, such as rock dumping or concrete matting, will be employed. The BOWL Cable Plan (CaP) will provide additional detail on cable burial and protection and will present the results of the cable burial risk assessment. This information will be inform a CFMS to minimise any impacts on commercial fishery interests during the operational phase of the project.

**Figure 4.7 – Illustration of cable trenching parameters**



## **5 Design, Specification and Layout – Offshore Transformer Modules**

### **5.1 Introduction**

- 5.1.1 This section of the DSLP details the OTM design and layout specification as required by the OfTW Marine Licence condition 3.2.2.6 detailed in Table 1.1.

### **5.2 Offshore Transformer Modules Layout and Specification**

- 5.2.1 OfTW Marine Licence Consent Condition 3.2.2.6 requires that this DSLP include the following:

*A plan showing the proposed location of each individual OSP, seabed conditions, bathymetry, confirmed foundation type for each OSP and any key constraints recorded on the Site;*

- 5.2.2 The Wind Farm layout presented in Figure 4.1 above includes the location of the two OTMs. The two OTMs are located close to the geometric centre of the site.

#### **OTM Foundation Types**

- 5.2.3 Each OTM is supported by a tubular jacket substructure and piled foundations. To encourage efficiencies and make best use of project assets, such as the pile installation template, the jackets are as per those used for the wind turbines and as described in Section 4.2 above.

#### **Wind Farm Bathymetry and Seabed Conditions**

- 5.2.4 The bathymetry in the area close to the OTMs is in the middle of the depth range found across the site and as described under Section 4.2 (see also Figure 4.1, Figure 4.3 and Table 5.1 below). The seabed conditions in this area are characterised similarly to those of the wider site as described under Section 4.2, in general as loose to very dense sand with occasional beds of gravel. The water depths at the OTM locations (below LAT) are set out in Table 5.1 below.

#### **Other Spatial Constraints**

- 5.2.5 The constraints that have been taken into account in defining the Wind Farm 'developable area' boundaries, within which the OTMs are located, are presented in Section 4.2.

### **5.3 Co-ordinates for Offshore Transformer Module Locations**

- 5.3.1 OfTW Marine Licence Consent Condition 3.2.2.6 requires that this DSLP include the following:

*A list of latitude and longitude co-ordinates accurate to three decimal places of minutes for each OSP, this should also be provided as a geographic information system ("GIS") shape file using WGS84 format;*



5.3.2 The OTMs will be installed, within a permitted 50m radius micro-siting tolerance, in the locations presented in Table 5.1, below.

5.3.3 As required by the OfTW Marine Licence consent condition, the GIS shapefile in Appendix C includes the co-ordinate data for the OTMs.

**Table 5.1 – OTM location co-ordinates (WGS84) and water depths**

OTM Identification	Latitude (ddm) WGS84	Longitude (ddm) WGS84	Water depth (below LAT)
BE-G7	58 15.004' N	2 52.834' W	41.2
BE-F8	58 15.411' N	2 53.750' W	45.7

#### **5.4 Offshore Transformer Module Dimensions**

5.4.1 OfTW Marine Licence Consent Condition 3.2.2.6 requires that this DSLP include the following:

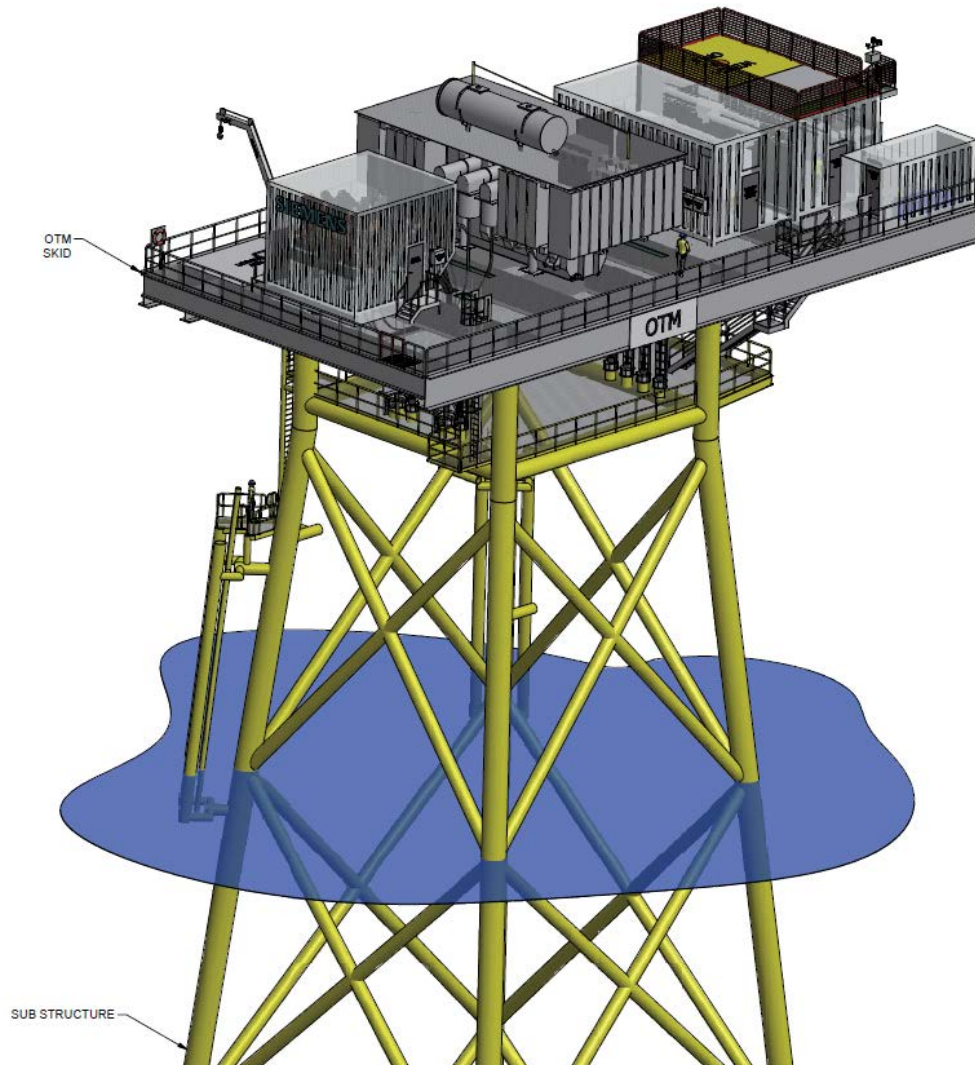
*A table or diagram of each OSP;*

5.4.2 The OTMs are comprised of the OTM topside which sits upon the tubular jacket substructure. The general arrangement is shown in Figure 5.1 below, and the OTM topside arrangement is shown in Figures 5.2 and 5.3. Dimensions for the OTMs are provided in Table 5.2 below.

**Table 5.2 – Key dimensions of the OTMs**

Parameter	Dimension
OTM topside dimensions (underside of the deck to the top of the transformer tank, as identified in Figure 5.3)	33m (l) x 17.2m (w) x 9m (h)
Height of OTM jacket (above HAT)	19.5m (24.0m above LAT) (cable deck, as shown in Figure 5.1, at 14.5m above HAT (19.0m above LAT))
Height of topside (above HAT)	28.5m (33.0m above LAT)

**Figure 5.1 – OTM general arrangement - OTM topside mounted on a tubular jacket substructure**



**Figure 5.2 – OTM general arrangement of topside – side elevation, end elevation and reverse side elevation**

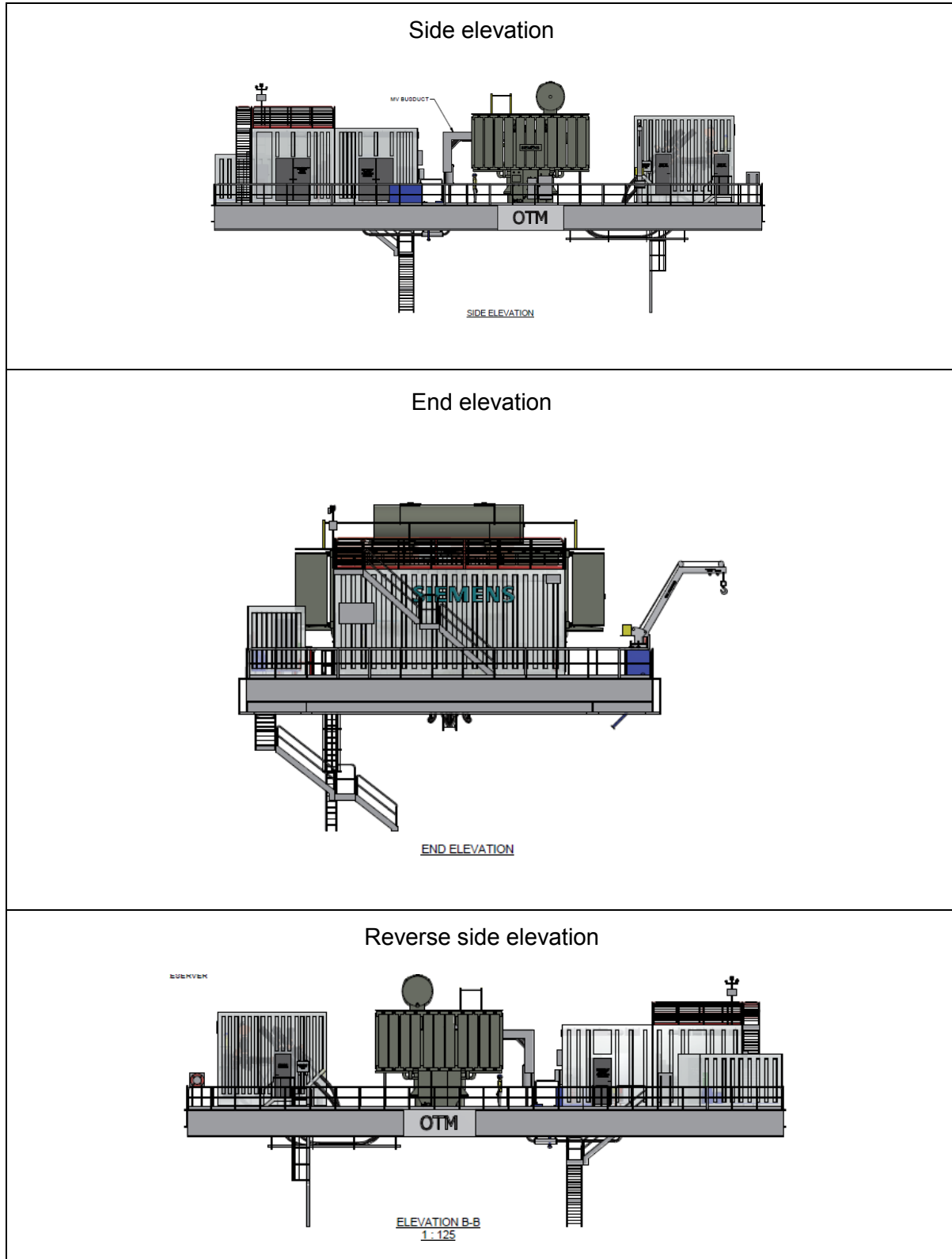
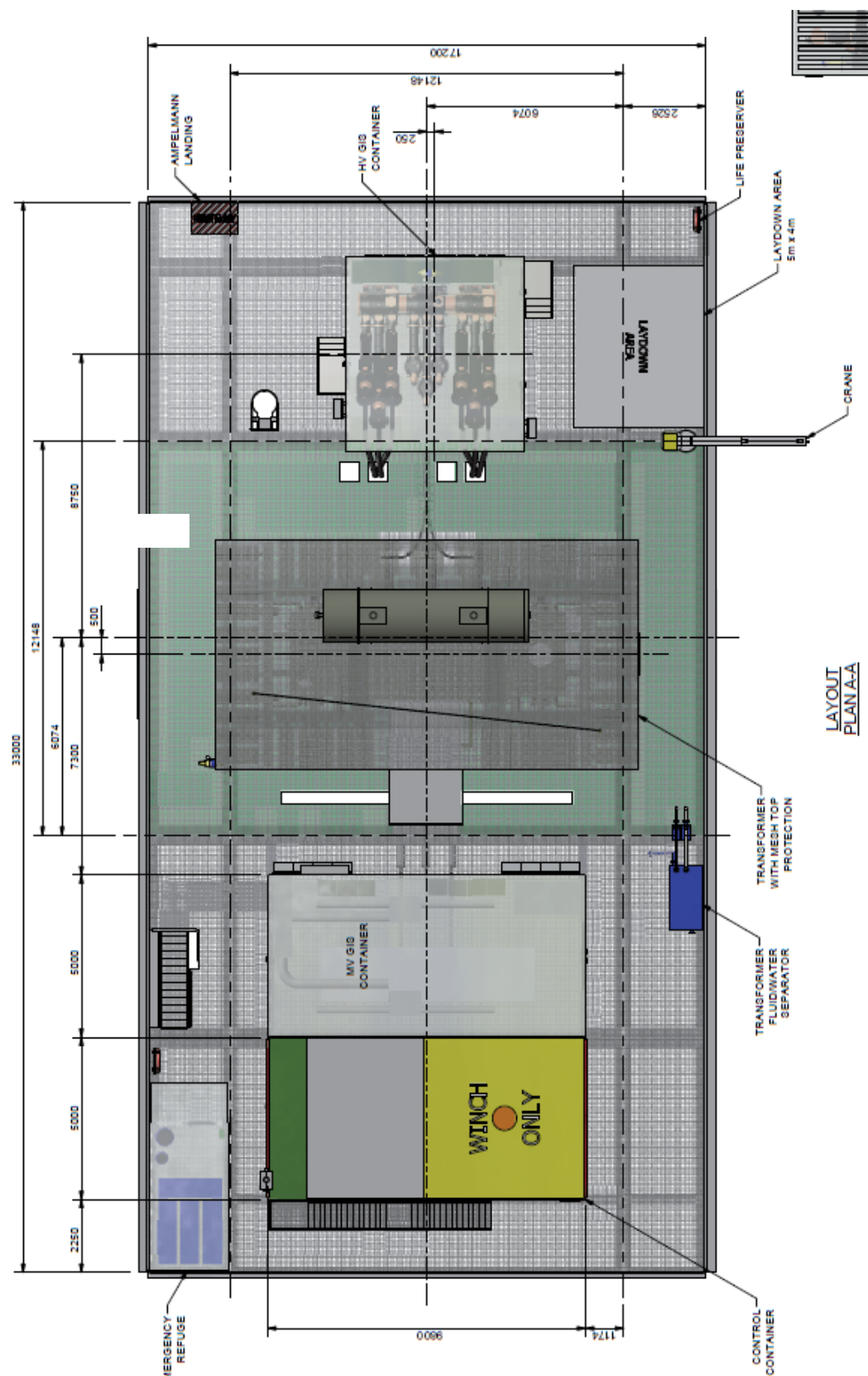


Figure 5.3 – OTM general arrangement – plan view of topside



## 5.5 Offshore Transformer Module Finishes

- 5.5.1 OfTW Marine Licence Consent Condition 3.2.2.6 requires that this DSLP include the following:

*The finishes for each OSP;*

- 5.5.2 The topside of each OTM will be finished in light grey, RAL 7035.
- 5.5.3 The jacket substructure will be finished in golden yellow RAL 1004 from 2m below LAT up to the interface point at 24m above LAT.

## 5.6 Length and Proposed Arrangements of Cables

- 5.6.1 The details of the offshore transmission export cables will be provided, for approval, in the separate OfTW DSLP.

## 6 Compliance with the Application

### 6.1 Introduction

- 6.1.1 In addition to the conditions presented in Table 1.1, Condition 8 of the S36 Consent states:

*The Development [Wind Farm] must be constructed and operated in accordance with the terms of the Application and related documents, including the accompanying ES, the SEIS and Annex 1 of this letter, except in so far as amended by the terms of this section 36 consent.*

- 6.1.2 Sections 6.2 and 6.3 set out information from the ES/SEIS with regard to:

- Compliance with the specification and layout assessed; and
- Delivery of the stated design-related mitigation.

### 6.2 Compliance with the Specification and Layout Assessed in the ES/SEIS

- 6.2.1 The ES and SEIS 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.

- 6.2.2 Since the Development consents were awarded, the design of the Development has been substantially refined to that described in this DSLP (and in other relevant Consent Plans). In order to demonstrate compliance of this refined design, Appendix A provides a tabulated comparison of project design parameters as presented in the ES/SEIS and this DSLP.

### 6.3 Delivery of Design-related Mitigation Proposed in the ES/SEIS

- 6.3.1 The ES and SEIS detailed a number of mitigation commitments specific to the design of the Development. Measures are presented in full in Appendix B, which also identifies where each commitment has been addressed within the DSLP.

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## Appendix A – Comparison of ES/SEIS Rochdale Envelope and DSLP design parameters

Design-related parameter	ES/SEIS	DSLP
Overall Wind Farm		
Number of wind turbine structures	Up to 277 (3.6MW capacity turbines)	84 (7MW capacity turbines)
Maximum site generating capacity	997.2MW	588MW
Wind Turbine and OSP foundations (piling)		
Foundation type	Pin piles (up to four per foundation) Suction piles Gravity base	Pin piles (four per foundation)
Maximum number of pin piles	1108 (wind turbines) + 12 (OSPs)	344 (84 x wind turbines + 2 x OTMs)
Pin pile diameter	2.4m (wind turbines) 3.0m (OSPs)	2.2m (wind turbines and OTMs)
Pin pile lengths	20m – 80m	Variable: ~35m – 60m
Wind Turbine and OSP substructures		
Substructure type	Tubular jacket Monotower	Tubular jacket
Design	Tubular steel lattice structure with up to 4 'legs'	Tubular steel lattice structure with 4 'legs'
Dimensions	Unknown – dependent on water depth and foundation type	Base dimensions (pile to pile): 24m x 24m
Wind Turbines		
Tip height range	132.6m – 198.4m	186.7m
Hub height range	79m – 115.9m	109.7m
Nacelle dimensions	Up to 26m x 16m x 12m	20.6m(l) x 9m(h) x 9.1m(w) including hub
Blade clearance above Lowest Astronomical Tide	25.4m – 33.4m	32.7m
Maximum rotor diameter	165m	154m
Rotational speed (rpm)	4.8 - 13	11.8 rpm at nominal rating, range 4 – 13 rpm
Blade swept area	Up to 21,382.5m <sup>2</sup>	18,626.5m <sup>2</sup>
Minimum spacing	642m	945.5m (in single case; most



Design-related parameter	ES/SEIS	DSL P
		turbines spaced at 1170m)
Finishes	Colour scheme incorporating: Wind turbines in RAL 7035 (grey) Substructures in RAL 1004 (yellow)	Colour scheme incorporating: Wind turbines and OTMs in RAL 7035 (grey) (with red blade hover reference marks on the rotor blades) Substructures in RAL 1004 (yellow)
Inter-array cabling		
Voltage range	33kV – 66kV AC	33kV
Maximum length	350km	~170-190km
Length buried	325km	All inter-array cables are expected to be buried
Burial depth range	0m – 2.5m	Target burial depth of 1m
Maximum extent of cable protection	0.48 km <sup>2</sup>	0 km <sup>2</sup> anticipated
Offshore Substations		
Type	AC or DC OSP	AC OTM (a form of OSP)
Maximum number	2 AC & 1 DC	2 AC
Maximum dimensions	115m x 55m x 42m	33m (l) x 17.2m (w) x 9m (h)
Maximum height above LAT	20m	20m
Available Foundation Types	Pin Piles (excluding pre-driven piles) (3 m pin piles) Suction Piles	Pin Piles
Available Substructure Type	Tubular Jacket	Tubular Jackets
Met masts		
Maximum number	3	0

## Appendix B - ES and SEIS Mitigation Commitments

Source	Reference (ES or SEIS Chapter)	Details of commitment	Implementation
ES	Site Selection and Consideration of Alternatives	The minimum distance between turbines will be six rotor diameters.	DSLPP Section 4.2
ES	Site Selection and Consideration of Alternatives	Turbines will be aligned in straight lines where possible to aid navigational safety, although there may be irregular spacing between the rows.	DSLPP Section 4.2
ES	Project Description	...the nacelle of the turbine will be fitted with a heli-hoist platform (typically a minimum of 4 m x 4 m) with associated markings and lighting.	DSLPP Section 4.6 (see also details in the LMP)
ES	Project Description	All parts of the turbine from 18.9 m above LAT upwards will be painted the standard colour for offshore wind turbines, a semi-matt pale grey colour RAL 7035.	DSLPP Section 4.6 and 5.5
ES	Project Description	The tower and substructure of every turbine will be painted yellow colour RAL 1004 from the level of LAT up to 18.9 m, or up to the height of the navigation lights (whichever is greater) for observational or navigational purposes.	DSLPP Section 4.6 and 5.5
ES	Shipping and Navigation	The wind turbines will be aligned in straight lines to ensure navigable channels where possible. It is noted there could be slight alterations to wind turbine alignment and spacing due to micro-siting.	DSLPP Section 4.2
ES	Other Issues	Minimum separation distances will be maintained from cables and pipelines as per best practice ensuring there is no risk of damage to these cables during construction and operation of the Project.	DSLPP Section 4.2.21
ES	Project Description	Turbines will incorporate turbine identification markings including, but not limited to, an identifier on the turbine tower, an identifier on the nacelle roof, contrast stripes on the blades and illuminated signage on the turbine tower.	DSLPP Section 4.2 (see also details in the LMP)
ES	Project Description	The external colour scheme and marking requirements of the OSP will comply with the guidelines set by the MCA, RYA and IALA.	DSLPP Section 4.2, 4.6 and 5.5 (see also details in the LMP)

## **Appendix C – GIS information to Support the DSLP**

Provided as a separate accompanying ZIP file containing shapefiles.