Arklow Bank Wind Park 2

Environmental Impact Assessment Report

Volume II, Chapter 4: Description of Development

SSE Renewables

Version	Date	Status	Author	Checked by	Approved by
1.0	10/05/2024	Final (External)	Sure Partners Limited	GoBe Consultants	Sure Partners Limited

Statement of Authority

Experts	Qualifications	Relevant Experience
Marc Walshe	BEng (Hons), MSc.	Marc Walshe is a Consents Manager with SPL/SSE Renewables and a full Member of the Institution of Environmental Sciences. Marc holds a honours degree in Environmental Engineering (BEng), a masters degree in Renewable Energy (MSc) and an Advanced Diploma in Planning and Environmental Law. Marc has over 23 years experience working in both the energy and environmental sectors on a range of projects which include large scale infrastructural developments in both Ireland and the UK. The management of consents has been key to his role whether through the consent application process or ensuring compliance with the subsequent post consent requirements during construction and/or operation.
Kaj Christiansen	BEng (Hons.) in Environmental Engineering from the University of Galway, MSc (Hons.) in Renewable Energy from University of Aberdeen, CEng with Engineers Ireland	Kaj has over 14 years' experience within the renewable energy industry, specifically in the field of offshore wind and solar energy development. Kaj has acted in both project engineering and project management roles for a number of offshore wind projects throughout the North Sea. Within these projects Kaj was responsible for delivering foundation structures and has experience across the project lifecycle; from procurement and design to construction and commissioning. Kaj also has extensive Irish based development management experience in taking solar and offshore wind energy infrastructure through the development cycle; from early conceptual planning

	stages through to design, construction and operation.

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Glossary

Term	Meaning
Arklow Bank Wind Park 1 (ABWP1)	Arklow Bank Wind Park 1 consists of seven wind turbines, offshore export cable and inter-array cables. Arklow Bank Wind Park 1 has a capacity of 25.2 MW. Arklow Bank Wind Park 1 was constructed in 2003/04 and is owned and operated by Arklow Energy Limited. It remains the first and only operational offshore windfarm in Ireland.
Arklow Bank Wind Park 2 – Offshore Infrastructure	“The Proposed Development”, Arklow Bank Wind Park 2 Offshore Infrastructure: This includes all elements under the existing Maritime Area Consent.
Arklow Bank Wind Park 2 (ABWP2) (The Project)	Arklow Bank Wind Park 2 (ABWP2) (The Project) is the onshore and offshore infrastructure. This EIAR is being prepared for the Offshore Infrastructure. Consents for the Onshore Grid Infrastructure (Planning Reference 310090) and Operations Maintenance Facility (Planning Reference 211316) has been granted on 26th May 2022 and 20th July 2022, respectively. • Arklow Bank Wind Park 2 Offshore Infrastructure: This includes all elements to be consented in accordance with the Maritime Area Consent. This is the subject of this EIAR and will be referred to as ‘the Proposed Development’ in the EIAR. • Arklow Bank Wind Park 2 Onshore Grid Infrastructure: This relates to the onshore grid infrastructure for which planning permission has been granted. • Arklow Bank Wind Park 2 Operations and Maintenance Facility (OMF): This includes the onshore and nearshore infrastructure at the OMF, for which planning permission has been granted. • Arklow Bank Wind Park 2 EirGrid Upgrade Works: any non-contestable grid upgrade works, consent to be sought and works to be completed by EirGrid.
Array Area	The Array Area is the area within which the Wind Turbine Generators (WTGs), the Offshore Substation Platforms (OSPs), and associated cables (export, inter- array and interconnector cabling) and foundations will be installed.
Artificial fronds	A solution for preventing scour around subsea structures installed on the seabed that float to resemble seaweed. Mats typically several metres wide and long, composed of continuous lines of overlapping buoyant polypropylene fronds that create a drag barrier which prevents sediment in their vicinity being transported away. The frond lines are secured to a polyester webbing mesh base that is itself secured to the seabed by a weighted perimeter or anchors pre-attached to the mesh base.
Bathymetry	The measurement of water depth in oceans, seas and lakes.
Cable Corridor and Working Area	The Cable Corridor and Working Area is the area within which export, inter-array and interconnector cabling will be installed This area will also facilitate vessel jacking operations associated with installation of WTG structures and associated foundations within the Array Area.
Cable protection	External armouring applied to exposed cables or used at cable crossings, typically comprised of rock (berms or bags), ducting

Term	Meaning
	(polyurethane, steel, High Density Polyethylene (HDPE), cast iron or plastic) or concrete mattresses.
Concrete mattressing	A solution for providing protection to cables from dropped objects, fishing trawl boards and scour (Subsea Protection Systems, 2020). Typically, several metres wide and long, cast of articulated concrete blocks which are linked by a polypropylene rope lattice which are placed on and/or around structures to stabilise the seabed and inhibit erosion.
EirGrid	State-owned electric power transmission system operator (TSO) in Ireland and Transmission Asset Owner (TAO) for the Project's transmission assets.
Foreshore	The bed and shore, below the line of high water of ordinary or medium tides, of the sea and of every tidal river and tidal estuary and of every channel, creek, and bay of the sea or of any such river or estuary including the subsoil below, and the water column above the bed and shore and extending to the 12 nautical mile limit.
Foundation	The load carrying support structure for the wind turbine generator tower or offshore substation platform topside. The foundation is the part of the structure from the interfacing flange with the turbine tower or topside-foundation interface, down to below seabed. This includes any secondary steel items associated with the structure. For the purposes of the EIAR the term 'foundation' includes the structure from the WTG tower or topside interface down to the lower end of the monopile commonly known as the 'substructure' and encompasses monopiles and transition pieces.
Intertidal area	The area between the high water mark (HWM) and the low water mark (LWM).
Landfall	The area in which the offshore export cables make landfall and is the transitional area between the offshore cabling and the onshore cabling.
Maritime Area Consent (MAC)	A consent to occupy a specific part of the maritime area on a non-exclusive basis for the purpose of carrying out a Permitted Maritime Usage strictly in accordance with the conditions attached to the MAC granted on 22nd December 2022 with reference number 2022-MAC-002.
Major component	Major components include removable parts and equipment associated with the WTG and OSP infrastructure.
Permitted Maritime Usage	The construction and operation of an offshore windfarm and associated infrastructure (including decommissioning and other works required on foot of any permission for such offshore windfarm).
Pile refusal	A scenario where a pile does not achieve the planned installation depth due to an unexpected physical constraint below seabed.
Rehabilitation Schedule	The Rehabilitation Schedule sets out how SPL will, before the expiration of the MAC, rehabilitate the consent area and any other part of the maritime area adversely affected by the Proposed Development.
Scour protection	A solution for preventing scour around subsea structures, typically comprised of rock or concrete mattresses.
The Application	The full set of documents that will be submitted to An Bord Pleanála in support of the consent.

Term	Meaning
The Developer	Sure Partners Ltd.
Trenchless techniques	Trenchless techniques include steerable direct pipe thrusting (“Direct Pipe”) and Horizontal Directional Drilling (HDD) which allow cable ducts to be installed underground without the need to excavate trenches.
Transition Piece (TP)	Structural interface between monopile foundation and WTG tower that contains ancillary infrastructure such as boat landings, working platform and j tubes.

Acronyms

Term	Meaning
ABWP1	Arklow Bank Wind Park 1
ABWP2	Arklow Bank Wind Park 2
ACoPS	Approved Codes of Practice
ADCP	Acoustic Doppler Current Profilers
AIS	Automatic Identification Systems
AMP	Archaeological Management Plan
AtoN	Aids to Navigation
CCTV	Closed-Circuit Television
CFE	Controlled Flow Excavation
CIL	Commissioners of Irish Lights
CLV	Cable Lay Vessel
CMS	Construction Method Statement
CNMP	Construction Noise Management Plan
CPOD	Cetacean Porpoise Detectors
CPS	Cable Protection Systems
CPT	Cone Penetration Tests
CSV	Construction Support Vessel
CTV	Crew Transfer Vessel
DDD	Drive-Drill-Drive
DHLGH	Department of Housing, Local Government and Heritage
DP	Dynamic Positioning (DP) for vessels
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
EMF	Electromagnetic Field
EMP	Environmental Management Plan
EPA	Environmental Protection Agency
EVMP	Environmental Vessel Management Plan
FLO	Fisheries Liaison Officer
FMMS	Fisheries Management and Mitigation Strategy
GVI	General Visual Inspections
HAT	Highest Astronomical Tide
HDD	Horizontal Directional Drilling
HDPE	High Density Polyethylene
HSA	Health & Safety Authority

Term	Meaning
HVAC	High Voltage Alternating Current
HWM	High Water Mark – the level reached by the sea at high tide
IAA	Irish Aviation Authority
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
ICCP	Impressed current cathodic protection
INISMP	Invasive Non-Indigenous Species Management Plan
IPS	Intermediate Periphery Structures
IRCG	Irish Coast Guard
JUV	Jack Up Vessel
LAT	Lowest Astronomical Tide
LMP	Lighting and Marking Plan
LSBL	Lowest Seabed Level
LWM	Low Water Mark – the level reached by the sea at low tide
MAC	Maritime Area Consent
MMMP	Marine Mammal Mitigation Plan
MP	Monopile
MPCP	Marine Pollution Contingency Plan
MSO	Marine Survey Office
MTBM	Micro tunnel bore machine
NtM	Notice to Mariners
OFLO	Offshore Fisheries Liaison Officer
OGI	Onshore Grid Infrastructure
OMF	Operations and Maintenance Facility
OSP	Offshore Substation Platform
OWF	Offshore Windfarm
PEMP	Project Environmental Monitoring Plan
PLGR	Pre-Lay Grapnel Run
pUXO	potential Unexploded Ordnances
PV	Photovoltaic
ROV	Remotely Operated Vehicle
SAR	Search and Rescue
SBL	Seabed Level
SBP	Sub-Bottom Profiler
SCADA	Supervisory Control and Data Acquisition system
SEL	Sound Exposure Level
SF6	Sulphur hexafluoride
SOV	Service Operation Vessel

Term	Meaning
SPL	Sound Pressure Level
SPS	Significant Peripheral Structure
SSS	Side Scan Sonar
TP	Transition Piece
TJB	Transition Joint Bay
UK	United Kingdom
USV	Unmanned Surface Vehicles
UXO	Unexploded Ordnance
VC	Vibrocores
VMP	Vessel Management Plan
WTG	Wind Turbine Generator
W2W	Walk to Work
XLPE	Cross-Linked Polyethylene

Units

Unit	Description
kg	Kilogram
kJ	Kilojoules
km	Kilometre
kV	Kilovolt
l	litres
m	Metre
m above LAT	Meters above Lowest Astronomical Tide
mT	metric Tonne
m/s	Metres per second (wind speed)
MW	Megawatt (power; equal to one million watts)
m^2	Square meter
m^3	Cubic meter
RPM	revolutions per minute
t	Tonne

4 Description of Development

4.1 Introduction

4.1.1 Overview

4.1.1.1 This Chapter of the Environmental Impact Assessment Report (EIAR) provides a description of the Arklow Bank Wind Park 2 (ABWP2) Offshore Infrastructure (hereafter referred to as 'the Proposed Development'). Specifically, this Chapter sets out the individual components associated with the Proposed Development located seaward of the High Water Mark (HWM), and the associated construction, operational and decommissioning methodology.

4.1.2 Purpose of this Chapter

4.1.2.1 The primary purpose of the EIAR is to assist the competent authority in conducting an EIA. The EIAR identifies and describes the direct and indirect significant effects on the environment of the Proposed Development, in order to enable An Bord Pleanála to carry out an environmental impact assessment.

4.1.2.2 In particular, this EIAR Chapter fulfils the requirements of Part 1, Annex IV of Directive 2011/92/EU (as amended) (the EIA Directive):

- A description of the project including in particular:
    a) a description of the physical characteristics of the whole project and the land-use requirements during the construction and operational phases;
    b) a description of the main characteristics of the production processes, for instance, the nature and quantity of the materials used; and
    c) an estimate, by type and quantity, of expected residues and emissions (water, air and soil pollution, noise, vibration, light, heat, radiation, etc.) resulting from the operation of the Proposed Development (assessed separately in this EIAR under Volume II, Chapter 20: Air Quality and Climate). A Resource and Waste Management Plan (RWMP) has been submitted with this Application (Volume III, Appendix 25.1, Annex 5).

4.1.3 Project Design Options

4.1.3.1 The Developer is seeking consent for two discrete Project Design Options. The details of each Project Design Option are set out within this Chapter and the parameters for each have been fully assessed in the EIAR.

4.1.4 Approach to Assessment

4.1.4.1 The assessment approach is designed to ensure that the Proposed Development, including the Project Design Options, is fully and comprehensively assessed.

4.1.4.2 This approach enables consent, if granted, to be granted for both Project Design Options. The preferred option for the Proposed Development can then be identified and confirmed with An Bord Pleanála post-consent during the project delivery phase.

4.1.4.3 Where required, modelling has been used as a tool to support the assessment of both Project Design Options.

4.1.4.4 The full EIAR Assessment Methodology is set out in Volume II, Chapter 5: EIAR Methodology.

4.1.5 Location

4.1.5.1 The Proposed Development will be located on and around Arklow Bank, in the Irish Sea off the East coast of Ireland. As described in Volume II, Chapter 1: Introduction, the Proposed Development holds a Maritime Area Consent (MAC) which covers both the Array Area and Cable Corridor and Working Area. The Array Area and Cable Corridor and Working Area are shown in Figure 4.1 and described below.

4.1.6 Array Area

4.1.6.1 The Array Area is the area where the WTGs, the OSPs, and associated foundations and cables will be installed. These cables will comprise export, inter array and interconnector cabling and is delineated on the Location Map as presented in Figure 4.1 below and shown in Planning Drawing AW-SSE-000-CVL-PEV-0002-000 (Site Layout).

4.1.7 Cable Corridor and Working Area

4.1.7.1 The Cable Corridor and Working Area is the area where the export, inter array and interconnector cabling will be installed and is delineated on the Location Map as presented in Figure 4.1 below and shown in Planning Drawing AW-SSE-000-CVL-PEV-0002-000 (Site Layout). This area will also facilitate vessel operations associated with installation of WTGs, cables and foundation structures within the Array Area.

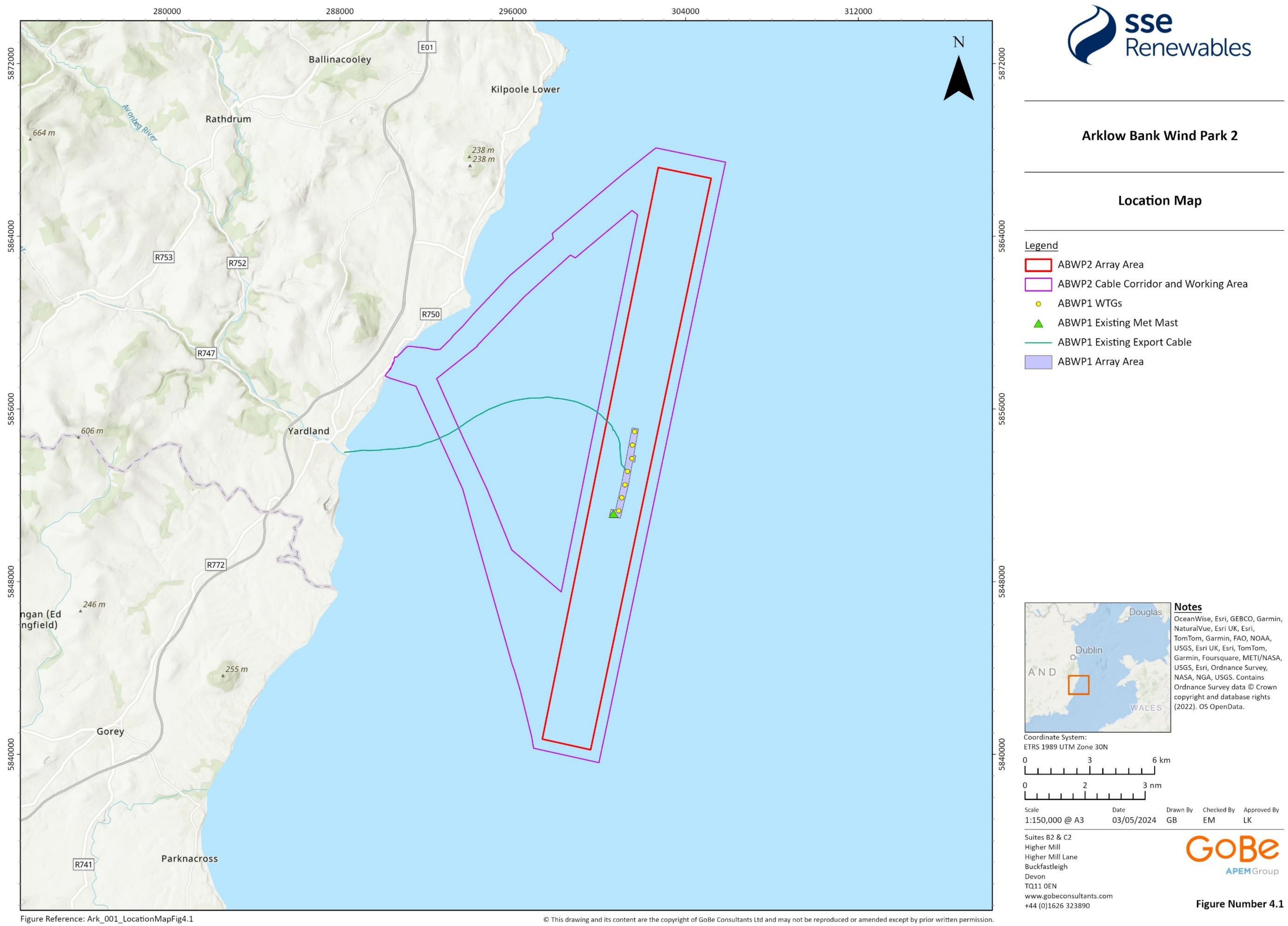


Figure 4.1: Arklow Bank Wind Park 2 Location Map

4.2 Offshore infrastructure

4.2.1 Overview

4.2.1.1 The proposed offshore infrastructure associated with ABWP2 will comprise all development seaward of the HWM. Consent is sought by the Developer to construct the Proposed Development in accordance with one of two discrete Project Design WTG Options (Table 4.1), combined with two OSPs and associated foundation and cabling systems. These WTG design option layouts are displayed in Figure 4.3 (Project Design Option 1) and Figure 4.4 (Project Design Option 2) and shown in Planning Drawings AW-SSE-000-CVL-PEV-0003-000 to AW-SSE-000-CVL-PEV-0007-000 (Project Design Option 1 – Wind Park Layout) and Planning Drawings AW-SSE-000-CVL-PEV-0008-000 to AW-SSE-000-CVL-PEV-0012-000 (Project Design Option 2 – Wind Park Layout) respectively.

4.2.1.2 The coordinates for WTG and OSP locations for Project Design Option 1 and Project Design Option 2 are provided in Annex 1.

4.2.1.3 Figure 4.2 presents an overview of the main components of an offshore windfarm.

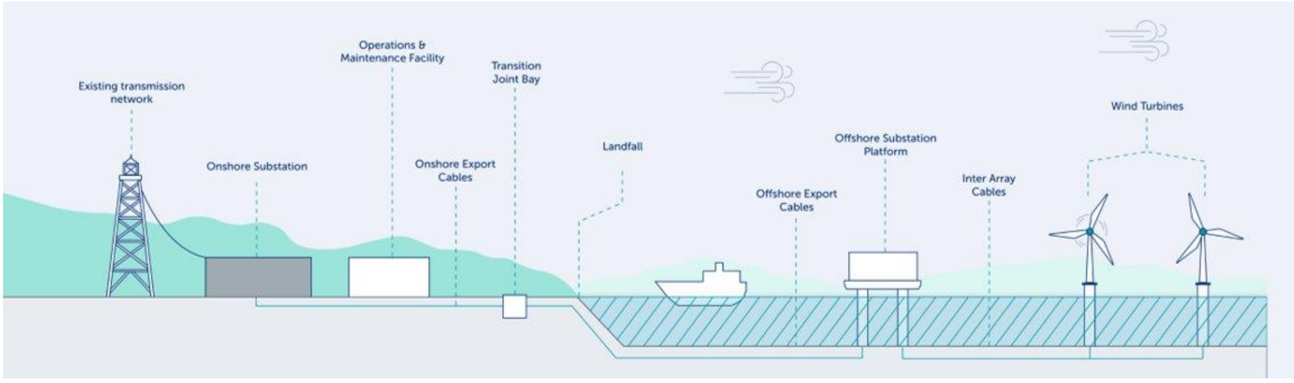


Figure 4.2: Main components of an offshore windfarm (OWF)

4.2.1.4 Each WTG will comprise a tower section, nacelle and three rotor blades. The WTG foundations will be monopiles (MPs) and a network of inter-array cabling shall be used to transmit power from the WTGs to the OSPs. Each OSP will comprise a topside structure supported on a MP foundation. As there are two OSPs proposed, interconnector cables may be used to connect these to one another to improve the availability of the electrical system and to provide redundancy. Each OSP will be connected to an export cable, and these two offshore export cables will be installed in the Array Area and the Cable Corridor and Working Area presented in Figure 4.1 and will make landfall at Johnstown North, North of Arklow town. The Proposed Development will also include scour protection and cable protection.

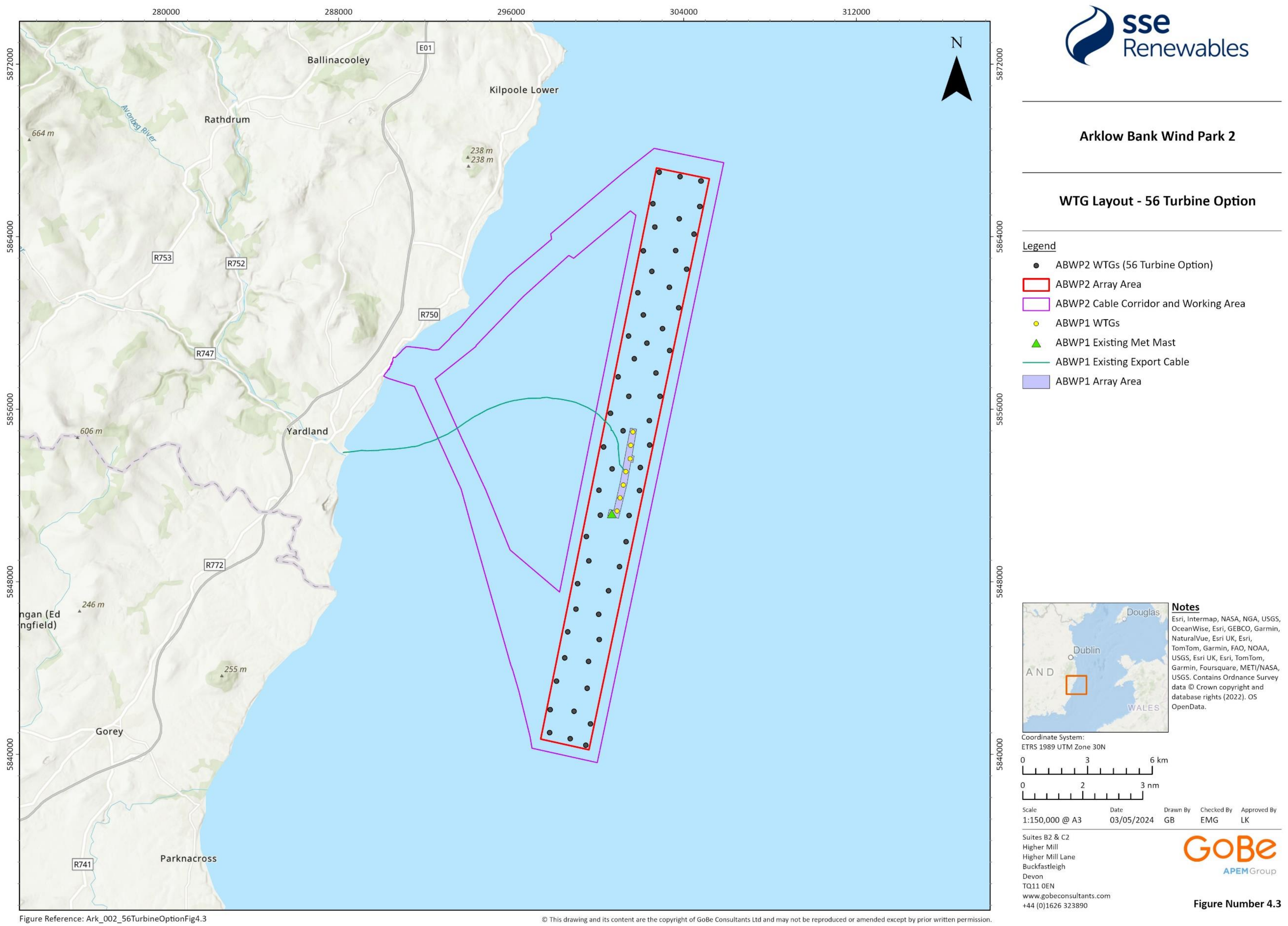


Figure 4.3: Proposed Development Project Design Option 1 (56 WTGs)

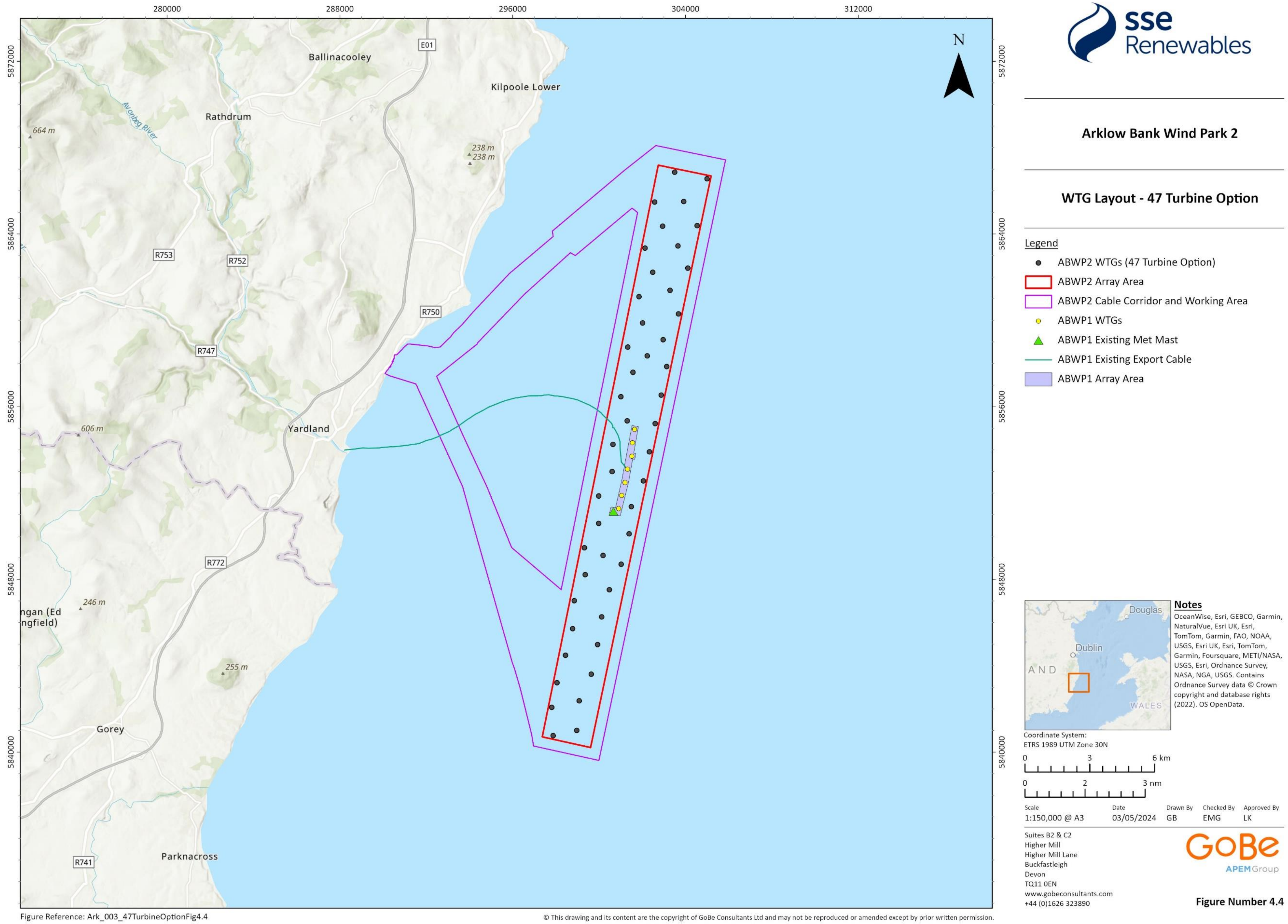


Figure 4.4: Proposed Development Project Design Option 2 (47 WTGs)

4.2.1.5 The following sections provide a description of each component of the Proposed Development.

4.2.2 Wind turbine generators (WTGs)

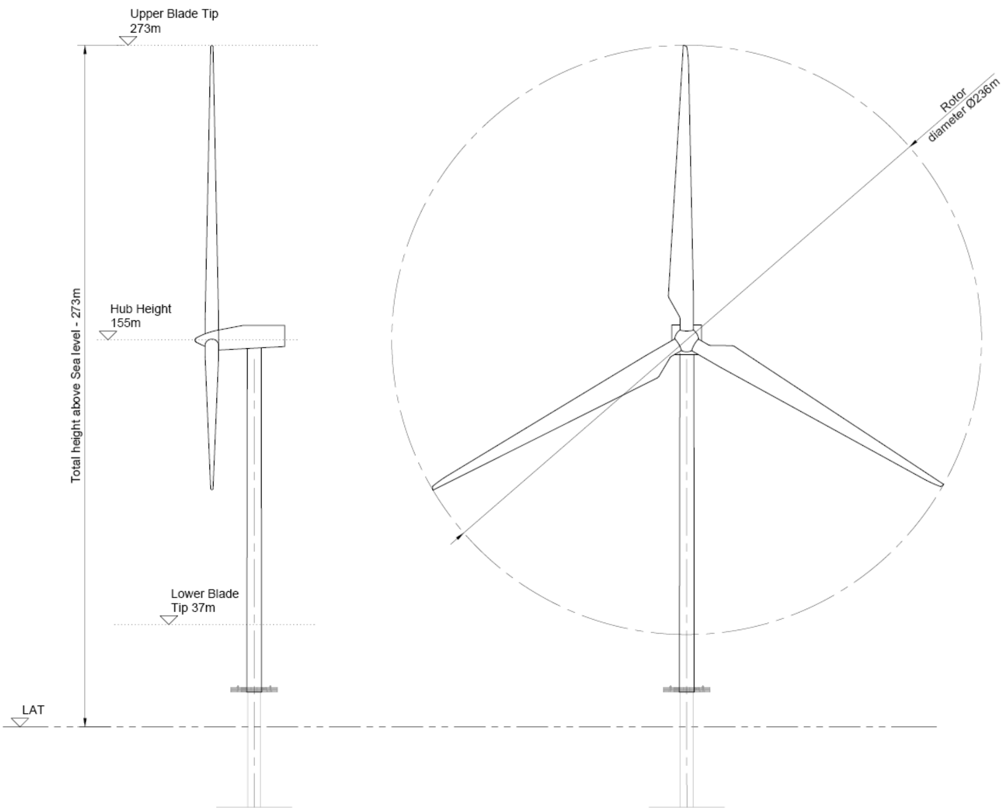
4.2.2.1 The Proposed Development will comprise either 56 or 47 WTGs. The WTG layouts for each Project Design Option have been developed to best utilise the available wind resource, suitability of seabed, environmental conditions and wake effects, while seeking to minimise environmental impacts and avoid site constraints. An illustration of the Project Design Options is presented in Figure 4.5.

4.2.2.2 A limit of deviation of up to 100 m will be applied for the WTGs, OSP's and associated foundations. This is in order to adapt to site constraints during construction (e.g. ground conditions) and/or to avoid areas of sensitive habitat.

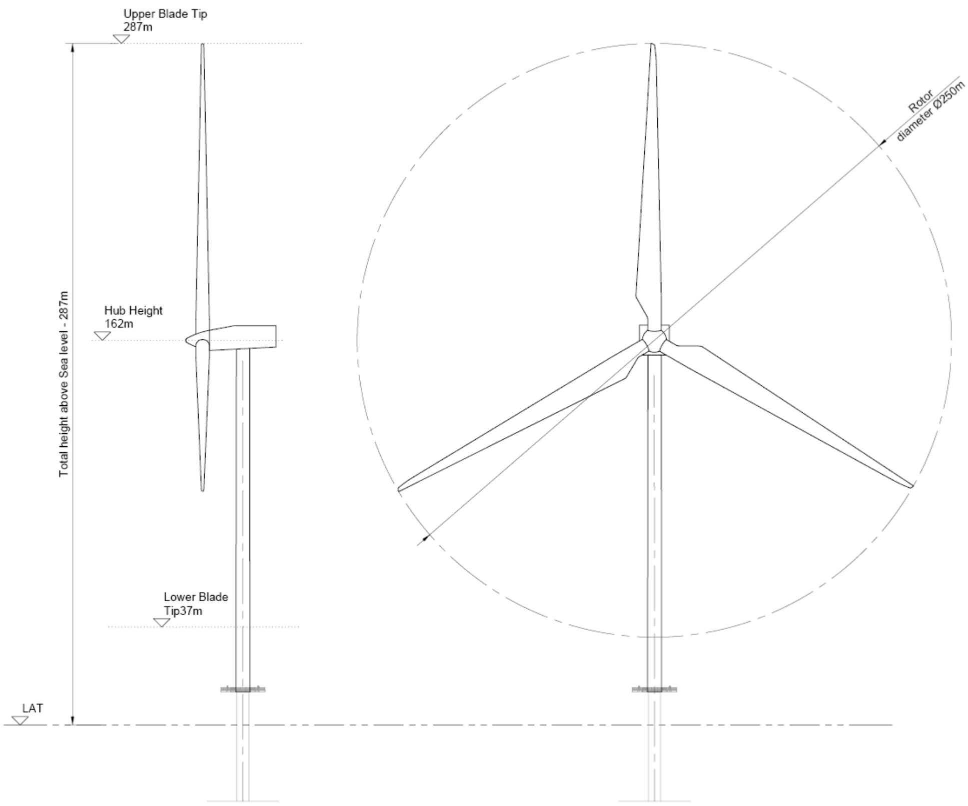
4.2.2.3 The WTGs for both Project Design Options will comprise three blades and a horizontal axis rotor. The blades will be connected to the hub, forming a rotor which turns a shaft connected either directly to the generator ('direct drive') or to a gearbox, which are located within the nacelle. The nacelle is supported by the tower and is able to yaw on the vertical axis in order to continually align the rotor with the oncoming wind direction.

4.2.2.4 A general arrangement schematic of a WTG and Monopile Foundation is presented in Figure 4.6.

4.2.2.5 The WTG towers will be coloured grey (RAL 7035) and the foundation structure will be coloured yellow (RAL 1023) to a minimum distance of 15 m above HAT for navigation marking purposes (see paragraph 4.2.4.2).



Project Design Option 1 – 56 WTGs



Project Design Option 2 – 47 WTGs

Figure 4.5: WTGs associated with Project Design Option 1 and Project Design Option 2

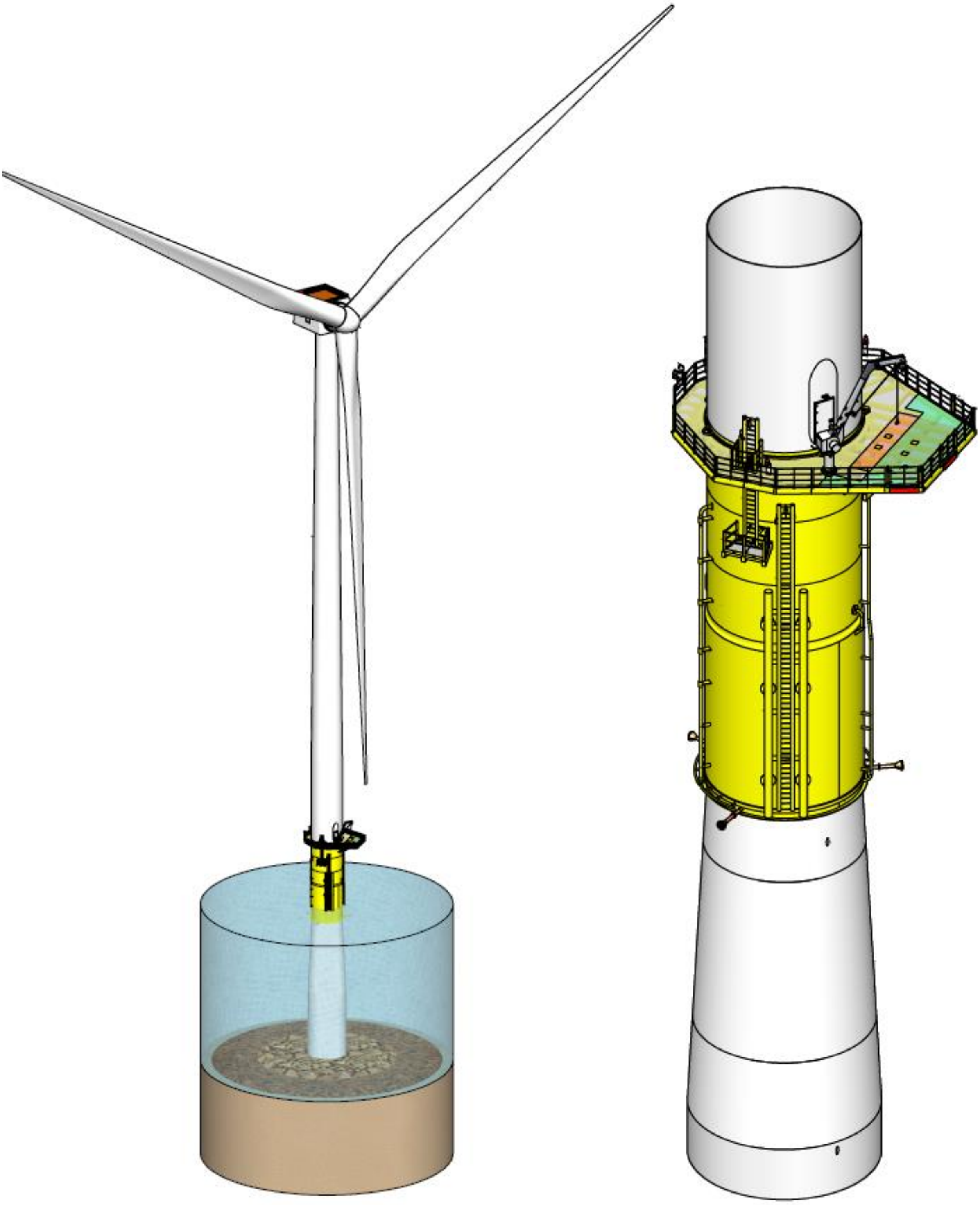


Figure 4.6: WTG and Monopile Foundation General Arrangement

4.2.2.6 The Project Design Options for the WTGs are presented in Table 4.1. Two WTG options are being considered as displayed in Figure 4.5 above with associated parameters outlined in Table 4.1. The two WTG options comprise Project Design Option 1 (Model 1a or 1b) and Project Design Option 2. As shown in Table 4.1 below, Project Design Option 1 (Models 1a and 1b) have the same rotor diameter, hub height, tip heights and layouts however, chord width and revolutions per minute (RPM) will vary slightly across the two models.

Table 4.1: Project Design WTG Options

	Project Design Option 1		Project Design Option 2
Hub Height (above LAT) (m)	155		162
Rotor Diameter (m)	236		250
Upper Blade tip height (above LAT) (m)	273		287
Lower Blade tip height (above LAT) (m)	37		37
Number of WTGs	56		47
Turbine and OSP Locations (with maximum 100 m limit of deviation)	As illustrated in Figure 4.3 above		As illustrated in Figure 4.4 above)
Chord Width (m)	Model 1a	Model 1b	6.9
	5.4	6.8	
Average annual RPM	6.34	5.73	6.19

4.2.2.7 The WTGs will be accessed by personnel with their tools and equipment from either a vessel or a helicopter. Access by vessel will be facilitated by boat landing systems fixed to the WTG foundation, and external working platforms will be designed to allow ‘walk-to-work’ access directly from the vessel via gangway systems (see section 4.5.5). The nacelle will have a helicopter hoist (‘heli-hoist’) area allowing access for personnel with their tools and equipment and for emergency rescue operations.

4.2.2.8 Each WTG will contain quantities of oils and fluids (such as lubricating oils, hydraulic oils, coolants) to support regular operations and maintenance activities. The types of oils and fluids include:

- Grease
- Synthetic Oil
- Hydraulic Oil
- Gear Oil
- Lubricants
- Nitrogen
- Water/Glycol
- Transformer Silicon/Ester oil
- Sulphur hexafluoride (SF6)

- Glycol/Coolants

4.2.2.9 Oils and fluids as listed above will be replaced as required during the operational and maintenance phase (see section 4.5.2). In addition, petroleum fuels may be used to fuel temporary generators providing power to equipment and marine lighting during the construction, operational, maintenance and decommissioning phases.

4.2.3 Offshore substation platforms (OSPs)

4.2.3.1 The Proposed Development will require two OSPs comprising one OSP in the north and one OSP in the south of the Array Area, see Figure 4.7 and Planning Drawings AW-SSE-000-CVL-PEV-0003-000 (Project Design Option 1 - Wind Park Layout) and AW-SSE-000-CVL-PEV-0008-000 (Project Design Option 2 - Wind Park Layout). The purpose of the OSPs is to transform the electricity generated by the WTGs (at 66 kV) to a higher voltage (220 kV), allowing the power to be efficiently transmitted to shore. An example of an OSP is shown in Figure 4.8. Elevations of the OSP's are shown in Planning Drawing AW-SSE-000-CVL-PEV-0037-000 (Offshore Substation Platform Elevations). Due to the distances of electricity transmission between the Proposed Development and the connection point to the National Electricity Transmission Network at the Avoca River Park, the electricity generated will operate on an HVAC (high voltage alternating current) system.

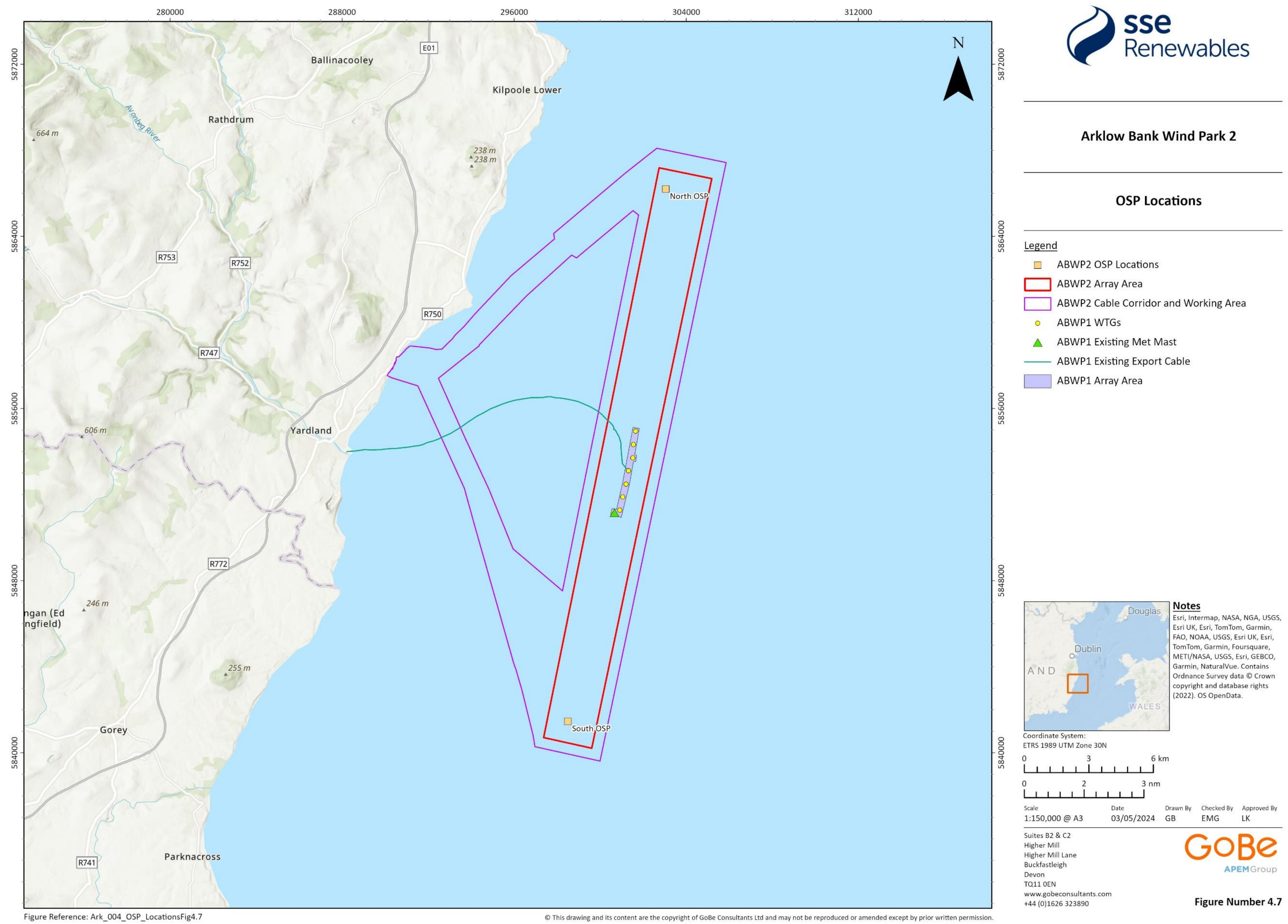


Figure 4.7: OSP Locations

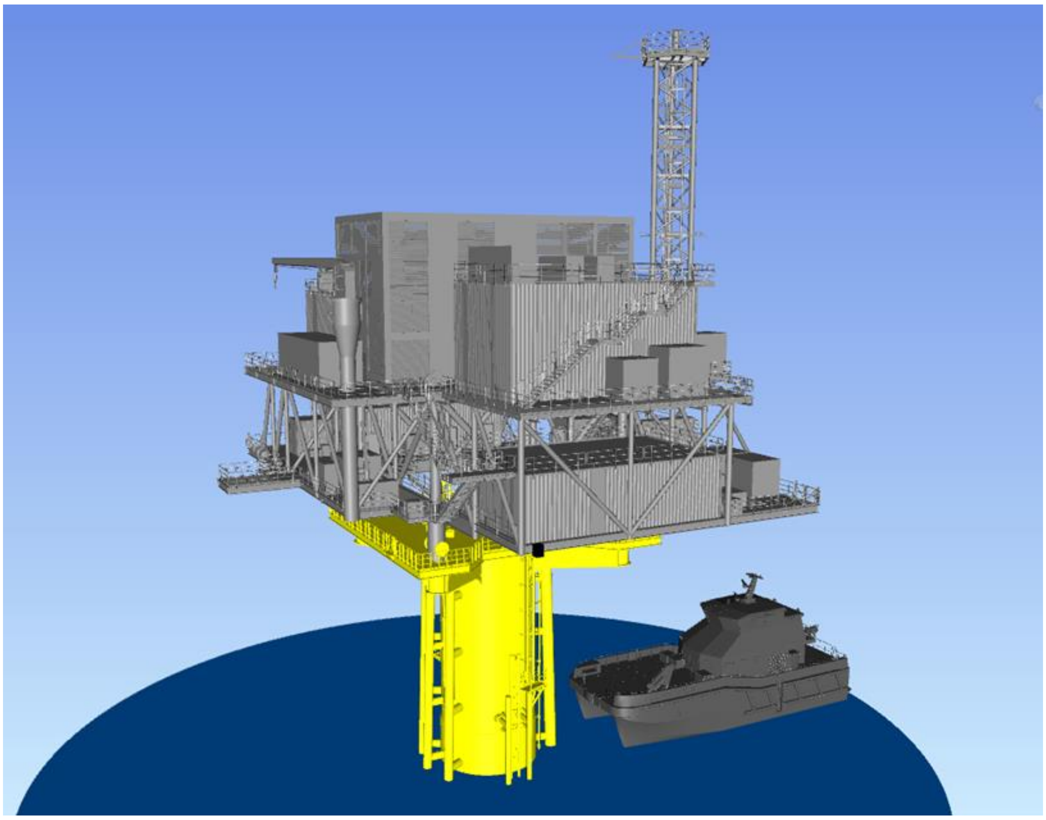


Figure 4.8: OSP Topside General Arrangement

4.2.3.2 The OSP topsides will contain switchgear, transformers, control equipment, auxiliary electrical equipment, cranes, batteries, generators, fire control systems and a communications mast. The OSP will comprise a platform with a number of decks, which will include a heli-hoist area. OSP topsides will generally be grey in colour, with the foundation structure painted yellow (RAL1023) for navigation marking purposes. The OSP topside parameters are presented in Table 4.2.

Table 4.2: OSP topside parameters

Parameter	OSPs
Number of OSPs	2
Height of main structure above LAT (m)	53
Height of top of antennae structure above LAT (m)	63
Topside length (m)	46
Topside width (m)	33.5

4.2.3.3 The topside structure of the OSP will also provide access and emergency welfare facilities for personnel, as well as a lower deck where the inter-array, interconnector and offshore export cable hang-offs are located. The hang-offs will support the weight of the cables as they enter the underside of the OSP topside structure. The structures will be un-manned and will only have personnel on them construction and operation and maintenance activities. The topside structure of the OSP will have lightning protection in the form of rods and finials mounted on top of the antennae structure and other equipment and/or containers to ensure adequate lightning protection for the structure.

4.2.3.4 Each OSP will contain quantities of oils and fluids (such as lubricating oils, hydraulic oils, coolants). The types of oils and fluids required for the OSPs include:

- Diesel fuel;
- Transformer coolant oil;
- UPS Batteries;
- Biodegradable electrolyte;
- Fire Suppression Systems;
- HVAC Coolant; and
- SF6.

4.2.3.5 The oils and fluids as listed above will be replaced as required during the operational and maintenance phase. In addition, diesel may be used to fuel temporary generators providing power to equipment during the construction, operational and maintenance and decommissioning phases.

4.2.4 Foundations

Overview

4.2.4.1 All WTG and OSP foundations will consist of steel monopiles. Figure 4.9 shows monopile general arrangement schematics for WTG and OSP foundations with further details provided in Planning Drawing AW-SSE-000-CVL-PEV-0035-000 (Wind Turbine Generator Foundations) and Planning Drawing AW-SSE-000-CVL-PEV-0036-000 (Offshore Substation Platform Foundations).

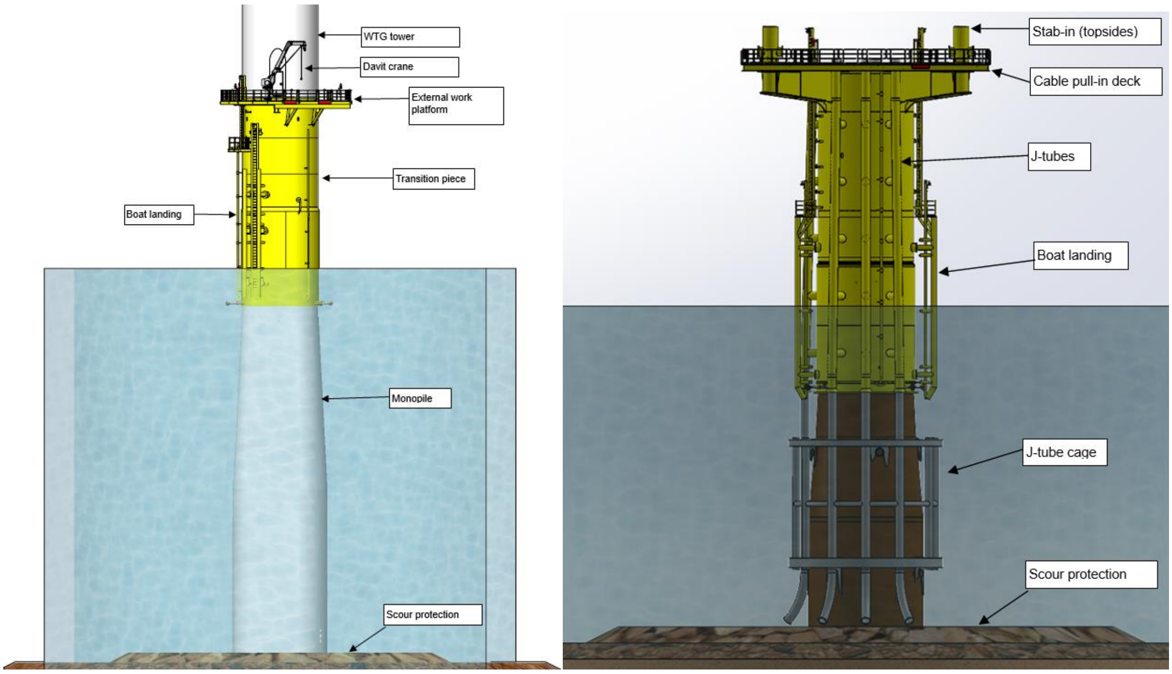


Figure 4.9: Typical monopile foundation general arrangement (left WTG, right OSP)

4.2.4.2 For WTG foundations and the OSP foundations, a Transition Piece (TP) may be installed over the monopile acting as a structural interface between the monopile and WTG tower or OSP topside respectively. The TP for the WTG foundations, if employed, will include boat landing ladders (and rest platform if applicable), an external working platform, a davit crane and other ancillary components (i.e. communication antennae, navigational aids, identification signage, lighting etc). The TP for the OSP foundations will include support for the topside structure, a deck to facilitate cable pulling and access to the topside, boat landing systems (including rest platforms if applicable), davit cranes and other ancillary equipment. Alternatively for the WTGs, the monopile may be directly connected to the WTG tower, in which case the TP-less monopile would provide the same functionality as defined for the TP above, but with secondary steel components installed to the monopile offshore. For navigational purposes the upper sections of the foundations are coloured yellow (RAL 1023) to a minimum height of HAT +15 m.

4.2.4.3 Cathodic protection will be installed on each foundation. This may consist of subsea zinc or aluminium anodes, as is typical for offshore windfarms (OWFs) and other subsea structures. These are also known as ‘sacrificial’ anodes, as the anodes gradually dissipate and are diluted into the sea water, protecting the foundation. Alternatively, an impressed current cathodic protection (ICCP) system may be used or used in combination with sacrificial anodes. Other corrosion protection methods may also be used such as application of corrosion resistant coatings, inclusion of corrosion allowance (additional sacrificial steel) or use of non-metallic or corrosion resistant materials.

4.2.4.4 Scour protection will be installed around each foundation to prevent scour holes developing around the structures. Each foundation type and associated scour protection are considered below.

Monopile foundations

4.2.4.5 Monopile foundations consist of a single hollow steel tube installed at depth into the seabed. Monopile foundation parameters are presented in Table 4.3.

4.2.4.6 The monopile foundation parameters such as pile diameter and pile penetration depth will depend on location specific water depths and ground conditions, both of which are dynamic and will change with time, as a result these parameters will be confirmed at the time of construction and a range is presented below. The ranges required for the WTG and OSP monopile foundation parameters are set out in Table 4.3.

Table 4.3: Monopile foundation infrastructure parameters for WTGs and OSPs

Parameter	WTG	OSP
Pile diameter (m)	7-11	7-14
Pile penetration depth below Lowest Seabed Level (m)	20-37	20-45
Seabed footprint per pile (m^2)	38-96	38-154
Total seabed footprint for component type (m^2)	1,786-5,380	76-310

Scour protection

4.2.4.7 As stated above, scour protection will be installed around the foundations to prevent the development of scour holes. In the absence of scour protection, scour holes may develop due to the localised increase in flow rates experienced in the immediate vicinity of a structure.

4.2.4.8 Scour protection may include the use of:

- Concrete mattresses: typically several metres wide and long, cast of articulated concrete blocks which are linked by a polypropylene rope lattice which are placed around the structures to stabilise the seabed and inhibit erosion;

- Rock: methods such as placement of layers of graded stones on and/or around structures to inhibit erosion.
- Artificial fronds: mats typically several metres wide and long, composed of continuous lines of overlapping buoyant polypropylene fronds that create a drag barrier which prevents sediment in their vicinity being transported away. The frond lines are secured to a polyester webbing mesh base that is secured to the seabed by a weighted perimeter or anchors pre-attached to the mesh base.
- Rockbags: mesh bags comprising rope fabric which contains elements of recycled plastic. Mesh bags are currently sized up to 12 tonnes in weight per bag and are filled with a loose mix of varying sized rocks. These bags are placed in overlapping concentric rings.
- Geotextile Sand Containers: comprise geotextile fabric bags filled with sand instead of rock. The bags are positioned around the monopile structures, that acts to reduce turbulent flow and reduce scour.

4.2.4.9 The type, design and quantity of the scour protection to be installed will depend on the monopile foundation diameter and will take into account factors such as seabed conditions, currents and water depth. Scour protection parameters for monopiles are presented in Table 4.4.

Table 4.4: Scour protection infrastructure parameters

Parameter	WTG's	OSPs
Height (m)	0.5-3	0.5-3
Radius (m)	14-39	14-49
Area per foundation requiring scour protection (m^2)	615-4,779	615-7,543
Volume per foundation (m^3)	307-14,337	307-22,629
Total volume for component type (m^3)	14,429-802,872	614-45,258

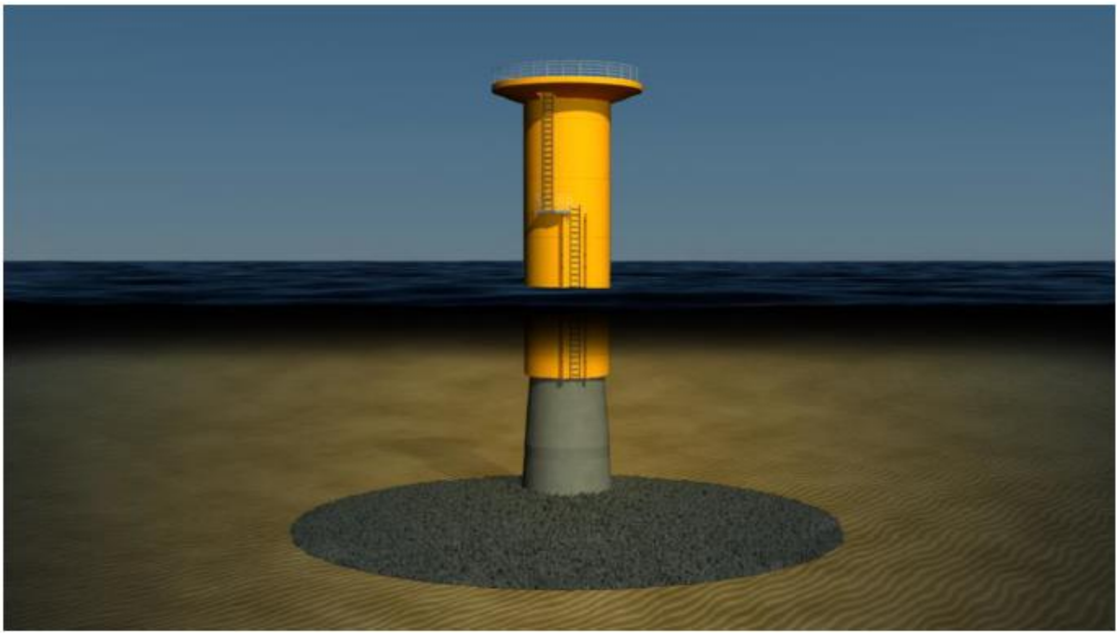


Figure 4.10: Image showing Scour protection (Rock) installed around monopile (Image courtesy of Dogger Bank Windfarm)

4.2.5 Subsea cables

4.2.5.1 The total lengths, burial depths and routing of inter array, export and interconnector cabling required will depend upon the final WTG and OSP locations (within the WTG and OSP limits of deviation) as well as site constraints such as wrecks, sensitive habitats and difficult ground conditions such as stiff clays and shallow rock. A range for the lengths and the burial depths are presented in the respective sections below. Indicative cable layouts are provided in Planning Drawings AW-SSE-000-CVL-PEV-0013-000 to 0021 (Project Design Option 1) - Cables Layout) and Planning Drawings AW-SSE-000-CVL-PEV-0022-000 to 0030 (Project Design Option 2 - Cables Layout).

4.2.5.2 The Developer will seek to bury the cables to ensure the cables are adequately protected from activities such as anchoring and fishing. Ground conditions such as shallow rock, boulders or stiff clays may prevent the cable installation equipment reaching adequate burial depth. In areas where adequate burial depth has not been achieved the cables will require additional protection and these parameters are outlined in Table 4.8.

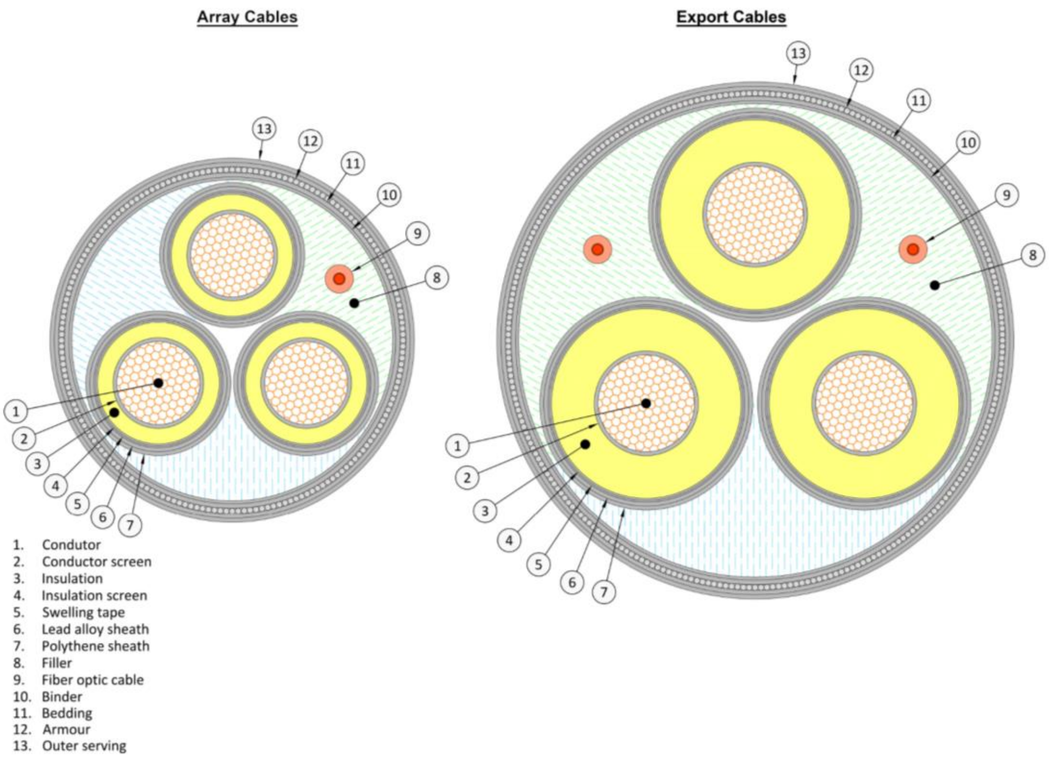


Figure 4.11:Example of Submarine cable cross section

Inter-array cables

4.2.5.3 Inter-array cabling (66 kV HVAC) will connect each WTG to an OSP and in some cases via other WTGs. The proposed cable will consist of a cross-linked polyethylene (XLPE) insulated aluminium or copper conductor submarine cable and will contain fibre optic cores. Each submarine cable will consist of a three-core cable (i.e. three electrical conductors within the one cable) and fibre optic cores. Figure 4.11 shows an indicative submarine cable cross section.

4.2.5.4 The width of seabed disturbance from the installation tool is anticipated to be 15 m resulting in a total area of seabed disturbed from inter array cable installation of 1,830,000 m^2. Inter-array cable parameters are presented in Table 4.5.

Table 4.5: Inter-array cable infrastructure parameters

Parameter	Value
Voltage (kV)	66
Transmission system	HVAC
Total length (km)	110-122
Burial depth (m below Lowest Seabed Level)	0 -1.5

Offshore export cables

4.2.5.5 Two offshore export cable circuits will be installed to transmit the electricity generated by the WTGs from the OSP's to the landfall at Johnstown North. Each circuit consists of three cores and fibre optic cores, together in a single subsea cable (see Figure 4.11). The offshore export cable circuits will be routed within the Array Area and Cable Corridor and Working Area. At the landfall, the offshore export cables will be connected to the consented ABWP2 Onshore Grid Infrastructure (OGI) landward of the HWM.

4.2.5.6 The width of seabed disturbance from the installation tool is anticipated to be 15 m resulting in a total area of seabed disturbed from export cable installation of 600,000 m^2. Export cable parameters are presented in Table 4.6.

4.2.5.7 As the export cables approach the landfall area and transits onshore using trenchless techniques, different installation parameters apply and are outlined in Table 4.18.

Table 4.6: Offshore export cable infrastructure parameters

Parameter	Value
Number of cable circuits	2
Voltage (kV)	220
Transmission system	HVAC
Total length (km)	35-40
Burial depth (m below Lowest Seabed Level)	0 – 2.5

Interconnector cable

4.2.5.8 Due to the installation of two OSPs, an interconnector cable may be required to connect the OSPs to each other to provide redundancy and improve the availability of the electrical system. The cable will consist of either XLPE insulated aluminium or copper conductor submarine cable and will contain fibre optic cores (see Figure 4.11).

4.2.5.9 The width of seabed disturbance from the installation tool is anticipated to be 15 m resulting in a total area of seabed disturbed from interconnector cable installation of 420,000 m^2. Interconnector cable parameters are presented in Table 4.7.

Table 4.7: Interconnector cable infrastructure parameters

Parameter	Value
Number of cable circuits	1
Voltage	220 kV
Transmission system	HVAC
Total length (km)	25 – 28
Burial depth (m) (below Lowest Seabed Level)	0-2.5 m

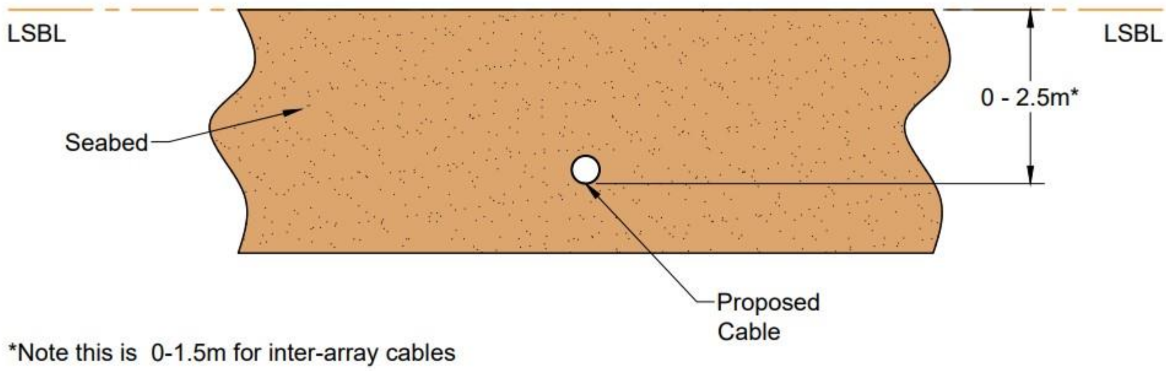


Figure 4.12: Example figure of proposed cable buried under LSBL

Cable protection

4.2.5.10 Cables will be buried to depths as set out in Table 4.5, Table 4.6, and Table 4.7 for inter-array, offshore export and interconnector cables, respectively. However, there are four scenarios where cable burial will not be possible. These scenarios are as follows:

- Where the cable leaves the seabed and enters the J-tube attached, or the cable entry hole on, the WTG or OSP foundation.
- At cable crossings (see paragraph 4.2.5.19 et seq.).
- Difficult ground conditions preventing adequate cable burial. Difficult ground conditions can comprise stiff clays, glacial tills, exposed bedrock or areas of significant seabed mobility which may limit the installation tools achieving target burial depths.
- Where the cable leaves the duct from the landfall and transitions from the exit pit to burial.

4.2.5.11 Where cable burial is not possible external cable protection is installed to prevent movement or exposure of the cables over the lifetime of the Proposed Development. This will protect cables from other activities such as fishing, anchor placement, dropped objects, and limit the effects of heat and/or induced magnetic fields. Cable Protection is external armouring applied to exposed cables or used at cable crossings, typically comprising;

- Cable Protection system (CPS) or Ducting; (polyurethane, steel, High Density Polyethylene (HDPE), cast iron or plastic)
- Concrete mattresses
- Rock Installation; (berms or bags)

4.2.5.12 The appropriate solution for external protection will depend on seabed conditions along the route as well as reflecting the specific risks presented to the cables including level of scouring, seabed mobility, vessel activity and nearby infrastructure. Cable protection parameters, applicable to inter-array, interconnector and offshore export cables, are presented in Table 4.8.

Table 4.8: Cable protection infrastructure parameters

Parameter	Offshore Export Cables	Inter-Array Cables	Interconnector Cable
Type	Combination of concrete mattress and/or rock installation		
Height (m)	0-1.5	0-1.5	0-1.8
Width (m)	0-8	0-8	0-10
Maximum Percentage of length of cables	20	15	50

Parameter	Offshore Export Cables	Inter-Array Cables	Interconnector Cable
requiring cable protection (%)			
Maximum Length of cables requiring cable protection (m)	8,000	18,300	14,000
Total maximum footprint of cable protection (m^2)	64,000	146,400	140,000
Total maximum volume of cable protection (m^3)	96,000	219,600	252,000

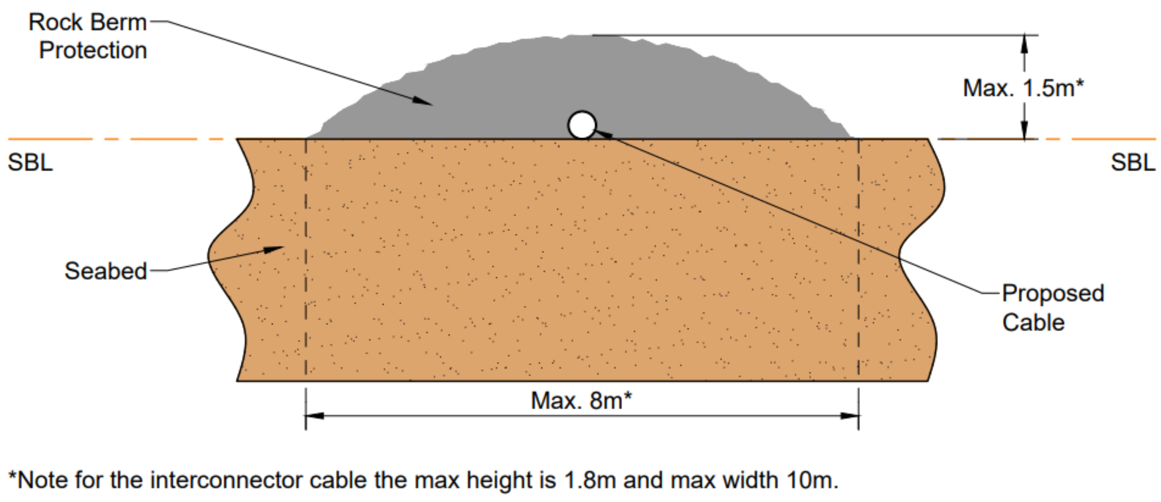


Figure 4.13: Example of cable protection (rock berm)

CABLE PROTECTION SYSTEMS OR DUCTING

4.2.5.13 CPS can consist of concrete, polyurethane, steel, cast iron shells, HDPE or plastic ducts or a mixture of materials (see Figure 4.14). The CPS can either be assembled around the cable on the vessel during the cable lay campaign or pre-installed on the WTG or OSP foundation and the cables pulled through during the cable installation campaign. CPS are usually used to protect the free span of cable before entering the WTG and OSP foundation aperatures. CPS may also be used to complete cable crossings (see paragraph 4.2.5.19 *et seq.*) and is usually stabilised with rock protection.

Figure 4.14: Ducting cable protection systems (Left: Polyurethane ducting; Right: Steel ducting (HDPE/ plastic J-tube))

CONCRETE MATTRESSING

4.2.5.14 Concrete mattresses are constructed using high strength concrete blocks and U.V. stabilised polypropylene rope. They are typically supplied in standard 6 x 3 x 0.3 m units of standard density, however modifications to size, density, and shape (tapered edges for high current environments, or denser concrete) can be engineered bespoke to the locality.

4.2.5.15 The mattresses can be installed over the cables with a standard Dynamic Positioning (DP) vessel and installation frame as shown in Figure 4.15. The mattresses are lowered to the seabed and once the correct position is confirmed, a frame release mechanism is triggered and the mattress is deployed on the seabed. This single mattress installation is repeated for the length of cable that requires protection. The mattresses may be gradually layered in a stepped formation on top of each other dependent on local conditions and expected scour. Concrete mattressing can be used for cable protection and at cable crossings (see paragraph 4.2.5.19 *et seq.*).

Figure 4.15: Concrete mattressing

ROCK INSTALLATION

4.2.5.16 Rock installation over cables to provide additional protection is carried out either by creating a berm or by the use of rock bags (see Figure 4.16).

4.2.5.17 Rock installation is achieved using a vessel with equipment such as a ‘fall pipe’ which allows for installation of rock onto the seabed. Rock installation will be a maximum of 1.5 m in height above the inter array and export cable and a maximum of 1.8 m in height above the interconnector cable, generally with a 3:1 gradient and a maximum 3 m in height above cables as they approach WTG and OSP foundations. This shape is designed to stabilise the cable as well as provide protection from anchor strike and anchor dragging, and to allow over trawl by fishing vessels. The cross section of the berm may vary dependent on local conditions and expected scour. The length of the berm is dependent on the length of the cable which requires protection.

4.2.5.18 Alternatively, pre-filled rock bags can be placed above the cables with specialist installation beams. Rock bags consist of various sized rocks contained within a rope or wire net. Similar to the installation of the concrete mattresses, they are lowered to the seabed and, when in the correct position, are deployed on to the seabed. Each rock bag will have a maximum height of 1.5 m. Rock placement can be used for cable protection and at cable crossings (see paragraph 4.2.5.19 *et seq.*). The number of rock bags required is dependent on the length of cable which requires protection.

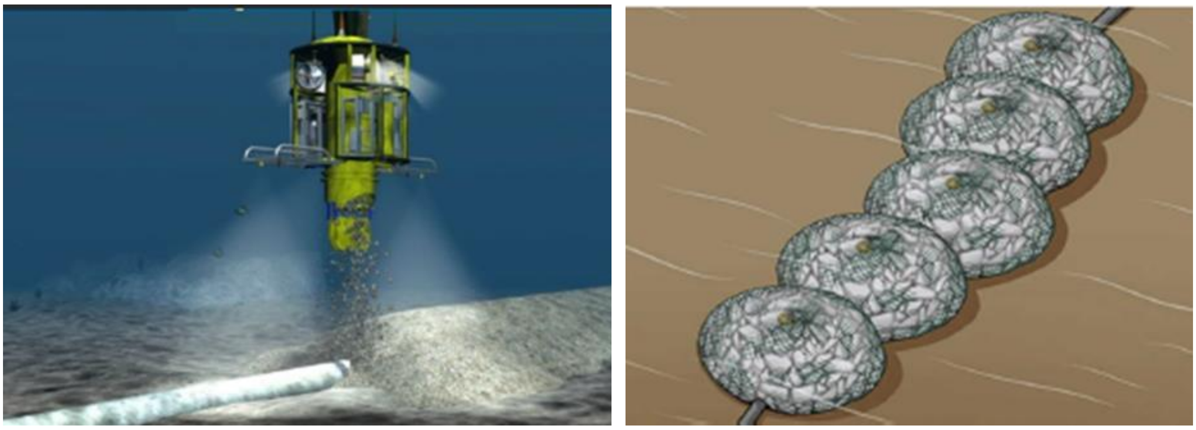


Figure 4.16: Rock cable protection methods (Left: Rock berm; Right: Rock bags)

Cable crossings

4.2.5.19 Cable crossings may be required where cables associated with the Proposed Development cross each other and/or the existing ABWP1 export cable. This will be facilitated by the installation of standard cable crossing designs, likely to be comprised of rock installation, concrete mattress and/or CPS as described for cable protection above. Cable crossing parameters are presented in Table 4.9. Further description of the crossing methodology is described in section 4.4 below.

4.2.5.20 The preferred solution for cable crossings will depend on seabed conditions along the route and crossing methodology, therefore ranges are presented below.

Table 4.9: Cable crossing infrastructure parameters

Parameter	Cable Crossings
Crossing material	Rock installation, concrete mattressing and / or CPS
Height (m)	0.5-2.5
Width (m)	5-16
Length of crossing (per crossing) (m)	50-500
Footprint of cable crossings (m^2)	750-24,000
Total volume of cable crossings (m^3)	375-60,000

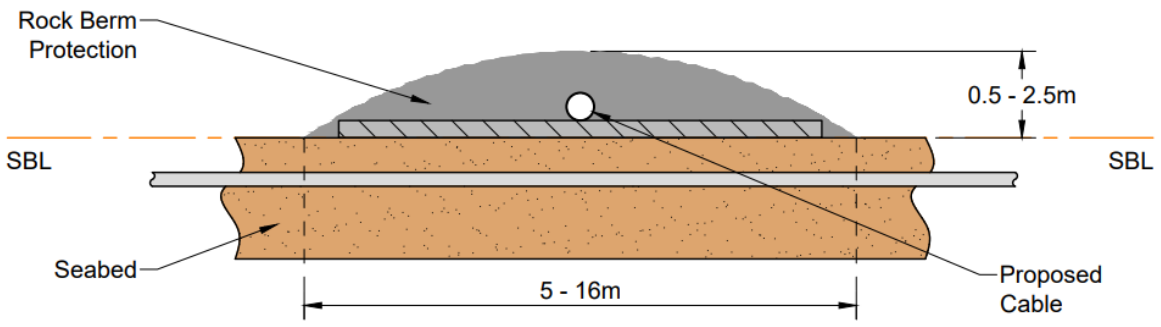


Figure 4.17: Example figure of cable crossing

4.3 Confirmatory Surveys

4.3.1.1 A number of confirmatory surveys will be required to support each phase of the Proposed Development and are assessed as part of the EIAR. Various surveys will be carried out which include the survey activities as outlined in Table 4.10.

Figure 4.18: Borehole Drilling Rig at Arklow Bank

Figure 4.19: ABWP2 Nearshore Surveys using a Jack-Up vessel

Table 4.10: Anticipated Confirmatory surveys

Item	Survey Type		Description	Location
1	Geotechnical	Boreholes x 131	A borehole is a method of drilling into the seabed to recover samples and enable downhole geotechnical testing to be completed. A drilling head is lowered to the seabed via a drill string and potentially stabilised using a seabed frame if required. The drill string is then rotated to commence boring. Tools are lowered into the drill string to recover samples or conduct in-situ soil testing such as downhole CPTs. Downhole geophysical tools will be used post completion of the borehole for further data collection. Boreholes may be up to 80 m deep within the Array Area.	To be deployed at WTG Substructure, Inter Array and Export Cable and Jack-Up locations across the Array Area and Cable Corridor & Working Area.
		Cone Penetration Tests (CPTs) x 431	CPTs are a method for measuring the soils strength and stiffness parameters using a rod-shaped tool whose end has the shape of a cone with a known apex angle (e.g. 60 degrees) which is pushed at a constant speed into the soil. CPTs can be performed in seabed mode, down-hole mode or as a seismic CPT.	To be deployed at WTG Substructure, Inter Array and Export Cable and Jack-Up locations across the Array Area and Cable Corridor & Working Area.
		Vibrocore x 300	Vibrocore is a method of collecting un-consolidated seabed samples. A vibrocorer is lowered onto the seabed, position and depth are noted, after which the vibrocoring process is started. Upon refusal or at target depth, the stop condition is recorded and the vibrocorer is recovered on deck where the recovery rate is measured.	To be deployed at Inter Array and Export Cable locations across the Array Area and Cable Corridor & Working Area.

Item	Survey Type		Description	Location
		Grab Samples x 240	Benthic grab sampling will be carried out by lowering a lightweight sampling device from the vessel, either by crane or handheld device depending on requirements. Upon returning grab samples to the deck, material will be sieved, examined and logged and then stored in a suitable medium in a sealed container for a comprehensive laboratory analysis on land.	To be deployed at Inter Array and Export Cable locations across the Array Area and Cable Corridor & Working Area.
2	Geophysical	Multibeam Echosounder (MBES)	MBES is a system for collecting detailed topographical data of the seabed. The MBES system will be hull mounted. The equipment will operate within frequency of 200 – 700 kHz and with sound pressure levels in the range of typically 213 - 225dB re1µPa @1 m (rms).	Array Area and Cable Corridor & Working Area
		Side Scan Sonar (SSS)	SSS surveys are used to determine sediment characteristics and seabed features and provides detailed imagery of the seabed. SSS is typically towed behind the vessel on an armoured tow cable. However, some models may be pole mounted on the side of the vessel. This device will have a potential operating frequency range of approximately 100/900 kHz in the offshore area with and 540/850 kHz in the shallower nearshore area with sound pressure levels of up to 210dB re1µPa @1 m (rms).	Array Area and Cable Corridor & Working Area
		Gradiometer/Magnetometer	A magnetometer is a passive device that is towed behind a survey vessel. It is used to identify magnetic anomalies and hazard mapping for metal obstructions, shipwrecks and unexploded ordnance on the surface and in the shallow subsurface. The magnetometer does not emit any sound waves into the marine environment.	Array Area and Cable Corridor & Working Area
		Sub-Bottom Profiler (SBP)	SBP is used to develop an image of the subsurface, identifying different strata encountered in the shallow sediments. This device will have a primary and secondary frequency range of 0.5 – 15 kHz and sound pressure levels of up to 245 dB re1µPa @1 m (rms), which would be used in both nearshore and offshore areas. The boomer, with sound pressure levels in the range of 208-215dB re1µPa @1 m (rms) would be used in the nearshore shallower areas while the sparker system used in sub-	Array Area and Cable Corridor & Working Area

Item	Survey Type		Description	Location
			bottom profiling, with sound pressures in the range of 204-219dB re1µPa @1 m (rms).	Array Area and Cable Corridor & Working Area
		Seismic Refraction/Reflection (2D/3DUHRS)	A seismic source is used to carry out a seismic survey which can be described as a chamber of compressed air that is released rapidly into the surrounding water to create an acoustic pulse. An air gun is the most commonly used source because the pulses are predictable, repeatable and controllable, it uses compressed air which is cheap and readily available. The seismic source system will have an expected operating frequency range of approximately 1-1000 Hz with sound pressure levels of up to 224dB Peak re1µPa @1 m (rms).	
3	Metocean	Floating LiDAR	Floating LiDAR buoys will be deployed to measure the wind resource within the Array Area. Deployment of these buoys will include anchor points on the seabed.	Array Area
		Acoustic Doppler Current Profiler (ADCP)	ADCPs will be used to examine wave and current conditions. This equipment is installed on the seabed and anchored with a suitable mooring structure. It is generally a short-term deployment used to gather seasonal data (e.g. winter storm data) however may be deployed for longer.	Array Area
		Wave Buoy	Wave rider buoys may be deployed to measure wave heights within the Array Area. They will be moored to the seabed by a suitably sized mooring structure.	Array Area
4	Environmental	Benthic Ecology (subtidal benthic survey)	This survey is designed to confirm the predicted benthic communities and habitats at the site. Subtidal sample locations may be subject to drop down video in advance of sampling.	Array Area and Cable Corridor & Working Area
		Cetacean Porpoise Detectors (CPOD) / Sound Traps	Marine mammal acoustic monitoring will be undertaken using CPODs (click detectors). If used, the CPODs will be deployed on the seabed.	

Item	Survey Type		Description	Location
			Sound Trap hydrophones may be deployed alongside the CPODs for periods throughout the site survey campaign.	Array Area and Cable Corridor & Working Area
		Habitat Surveys (Sabellaria & Mussel Beds)	The data from the confirmatory Geophysical Surveys will be assessed by a benthic ecologist to identify potential habitat locations and inform the transect locations for drop down camera surveys if required. The Drop down camera surveys (video and images) will confirm if the predicted benthic communities and habitats are present within the boundaries of the Proposed Development. A benthic ecologist will be on board the vessel carrying out the drop down camera survey. The drop down camera survey will be carried out in suitable metocean conditions in order to mitigate against the risk of poor visibility / image quality. The drop down camera survey will be carried out a maximum of 18 months in advance of commencement of construction due to the mobile nature of the habitat.	Array Area and Cable Corridor & Working Area
5	Corrosion	Microbial Induced Corrosion Frames	Microbial Induced Corrosion Frames are metal frames used to measure the rate of deterioration of a metal by corrosion processes that occurs directly or indirectly because of the metabolic activity of microorganisms in cold water systems. This type of corrosion results in severe pitting of metals, leading to rapid failures. The type of bacteria that cause this type of corrosion are anaerobic, they can only thrive in oxygen-deprived regions under deposit (Ibraheem, 2011). The outcome of this monitoring will feed into the turbine and OSP foundation design and allow suitable protection measures to be employed to prevent microbial induced corrosion of the turbine infrastructure.	Array Area
6	Sediment Dynamics	Benthic Flume & Benthic Lander	Benthic flumes and benthic landers are marine instruments which collect measurements on sediment transport processes and parameters directly in the sea.	Array Area and Cable Corridor & Working Area

Item	Survey Type		Description	Location
			Benthic flumes collect information on entrainment-deposition parameters and the sediment transport rate coefficients which can be fed into the sediment transport model to improve the parameterisation of these variables within the model. Benthic landers are intermediate scale seabed frames equipped with sensors such as ADCP’s, single point current meters, turbidity sensors and marine altimeters to measure seabed sediment transport. They provide an open area beneath an upper frame in which sensors are suspended and provide improved measures specifically of near bed hydrodynamic and sedimentary processes.	
7	ROV - Post-installation / as-built / O&M	MBES, General Visual Inspections (GVI), Non – Invasive Visual Inspections, Cable Depth of Lowering Surveys	Using a Remotely Operated Vehicle(s) to carry out post installation / as built / O&M surveys for export / IAC / interconnector cables, these could include: MBES, General non-invasive visual inspections and cable depth of lowering surveys with pipeline/cable tracking equipment. These systems monitor or induce magnetic fields in the cable which are then used to determine cable position and vertical displacement. These may take place at cable crossings, substructure base inspections, cathodic protection systems and any planned/remedial rock dumping that may take place.	Array Area and Cable Corridor & Working Area

4.4 Construction

4.4.1 Health and Safety

4.4.1.1 All project personnel and contractors will be required to be fully compliant with their responsibilities as defined by:

- The Safety, Health and Welfare at Work Act 2005;
- The Safety, Health and Welfare at Work (General Application) Regulations 2007 (as amended);
- The Safety, Health and Welfare at Work (Construction) Regulations 2013 (as amended);
- The Safety, Health and Welfare at Work (Diving) Regulations 2018 (as amended);
- The Safety, Health and Welfare at Work (Reporting of Accidents and Dangerous Occurrences) Regulations 2016 (S.I. No. 370 of 2016);
- The European Communities (EC) Act 1972 and related Regulations;
- The Chemicals Act 2008 and The Safety, Health and Welfare at Work (Chemical Agents) Regulations 2001 (S.I. No. 619/2001) as amended;
- The Merchant Shipping Act 1894 & The Merchant Shipping (Investigation of Marine Casualties) Act, 2000;
- The Health & Safety Authority (HSA) Approved Codes of Practice (ACoPS) and Guidance publications;
- Wind Energy Ireland ACoPS and Guidance publications;
- G+ Offshore Wind Health & Safety Association guidance documents;
- Code of practice for safe use of cranes BS 7121-1:2016; and
- Other applicable industry standards/best practice such as ISO, DNV, etc.

4.4.2 Methodology

4.4.2.1 The Proposed Development is proposed to be constructed according to the general sequence below, although the final sequence may vary from this;

- Step 1 – As detailed in Section 4.3 confirmatory surveys;
- Step 2 – Seabed preparation;
- Step 3 – Foundation installation and scour protection installation;
- Step 4 – OSP topside installation/commissioning;
- Step 5 – Offshore export cable – landfall installation;
- Step 6 – Offshore export cable – offshore installation and cable protection installation;
- Step 7 – Inter-array and interconnector cable installation and cable protection installation; and
- Step 8 – WTG installation/commissioning and post completion surveys.

4.4.2.2 Each stage is outlined in further detail in the following sections.

Step 1 – Confirmatory surveys

4.4.2.3 A number of confirmatory surveys will be completed before the construction phase of the offshore infrastructure. Surveys may also be carried out during the construction phase in advance of specific activities such as jack-up vessel deployment. Surveys will include those outlined in Table 4.10.

4.4.2.4 The geophysical surveys will be carried out on a survey vessel whereas the geotechnical surveys will be undertaken on either a jack-up barge or DP vessel. A small jack-up vessel will be used for works in the nearshore/intertidal area.

4.4.2.5 In the event that potential Unexploded Ordnances (pUXO) are identified through magnetometer survey activities, all efforts will be undertaken to avoid them. Should avoidance not be possible, those identified will be further investigated by a Remotely Operated Vehicle (ROV) or specialist divers and avoided where possible by the Proposed Development infrastructure and associated installation activities. The following methodologies are considered for UXO avoidance/clearance:

- avoid and leave in situ;
- relocation of UXO to avoid detonation;
- low order detonation (e.g. deflagration); and
- high order detonation.

4.4.2.6 Annex I reef and mussel bed surveys will also take place pre-construction, as described in Volume II, Chapter 9: Benthic Subtidal and Intertidal Ecology and Volume II, Chapter 10: Fish, Shellfish and Sea Turtle Ecology. This will include analysis of geophysical survey data and drop-down video survey if required to confirm the presence, extent, distribution and quality/condition of any reef habitats or seed mussel beds.

Step 2 – Seabed preparation

4.4.2.7 Seabed preparation activities will be required in advance of installation activities, and in advance of jack-up vessel placement, to reposition any boulders/debris and to clear seabed features from the seabed. This will include boulder clearance, seabed lowering/feature clearance followed by a pre-lay grapnel run, as described below.

BOULDER CLEARANCE

4.4.2.8 Boulder clearance is commonly required during OWF cable route and site clearance. Cable routes, WTG and OSP positions will be designed to avoid known boulder locations where possible, the entire route and each WTG position will be surveyed for boulders and where required the boulders will be cleared, likely in multiple discrete locations. A boulder is typically defined as being over 200 mm in diameter/length. Boulder clearance will be required in order to avoid risk to infrastructure during installation activities and to ensure stability for the jack-up vessel. If boulder clearance is required the boulder clearance width shown in Table 4.11 will depend on presence and size of boulders as well as installation spread and seabed conditions.

Table 4.11: Anticipated boulder clearance removal limits

	Offshore Export Cables & OSPs	Inter-Array Cables & WTGs	Interconnector Cable
Boulder clearance width (m)	15	15	15
*Total footprint of boulder clearance (m^2)	600,000	1,830,000	420,000

**Note that the area of seabed will be the same area subsequently impacted by seabed lowering / clearance and installation activities.*

4.4.2.9 Typically, boulder clearance will involve the use of a ROV to survey the construction area to identify any boulders, followed by deployment of a grab or plough to remove and relocate localised boulders. Where extensive boulders exist a boulder plough will be used to push boulders aside and clear the route for cable installation activities. Boulder ploughs are specialised tools used to prepare the seabed for cable installation. They are towed along the seabed using dynamically positioned vessels, employing a seabed surface plough to displace any surface boulders along the cable route. This provides for a clear path for safe cable installation.

SEABED LOWERING/FEATURES CLEARANCE

4.4.2.10 Given seabed levels can vary on the Arklow Bank, local seabed lowering in the vicinity of foundations and cables may be required to ensure they can be installed at the required design seabed level. Furthermore, seabed features, including mobile sand waves, are present on the Arklow Bank. Seabed features clearance will therefore be required in the vicinity of the foundations and along the inter-array, interconnector and offshore export cable routes, to create a relatively flat surface for the installation of infrastructure (and associated installation tools and equipment) and to ensure that cables are buried and protected sufficiently under mobile features for the lifetime of the Proposed Development. Seabed lowering/feature clearance parameters shown below will depend on local water depths at time of installation and seabed conditions, therefore anticipated parameters are presented in Table 4.12 and Table 4.13.

Table 4.12: Anticipated seabed lowering/features clearance limits for WTG and OSP installation

	56 WTG Option and 2 OSP	47 WTG Option and 2 OSP
Number of structures	58	49
Total footprint of seabed clearance for scour protection (m^2)	215,540	180,900
Total volume of seabed clearance for scour protection (m^3)	1,000,000	1,000,000
Total footprint of seabed clearance for WTG/OSP installation (m^2)	13,920	11,760
Total volume of seabed clearance for WTG/OSP installation (m^3)	139,200	117,600

Table 4.13: Anticipated seabed lowering/features clearance limits for cable installation

	Offshore Export Cables	Inter-Array Cables	Interconnector Cable
Seabed clearance width (m)	70	70	70
Percentage of cable length requiring seabed clearance (%)	30	30	30
Total footprint of seabed clearance (m^2)	840,000	2,562,000	588,000
Total volume of seabed clearance (m^3)	500,000	1,000,000	500,000

4.4.2.11 Seabed lowering/features clearance will involve removal of material from seabed features (such as sandwaves or megaripples) by techniques such as dredging, mass flow excavation, water injection dredging or utilisation of pre-lay route clearance ploughs. Any material recovered as part of these operations will be deposited in locations within the Array Area. This activity is carried out for a number of reasons including:

- To ensure the cable burial tool can safely move along the cable route without encountering excessive slopes or disturbances that would impede operation of the tool.
- Seabed lowering/features clearance may need to be carried out to ensure the cable can be buried to target depth to ensure sufficient protection.
- To ensure that the seabed is sufficiently clear and level for jack-up vessels to jack-up.
- To ensure the area within which scour protection is to be installed is sufficiently level.
- To ensure the level of potential future seabed lowering from installation seabed level to potential Lowest Seabed Level is within the bounds accommodated for by the scour protection design.

4.4.2.12 A specialist dredging vessel will be required to complete the seabed lowering/features clearance during the seabed preparation phase. An example of a dredging vessel is shown in Figure 4.20. The dredging vessel, using a suction hopper or similar, will dredge as required, recovering material to the vessel, and once full the material will be redeposited within the Array Area. The movement of material and associated relocation will require a Dumping at Sea Permit, which the Developer will secure from the Environmental Protection Agency (EPA). An overview of the techniques used for seabed lowering/features clearance are summarised in Table 4.14.

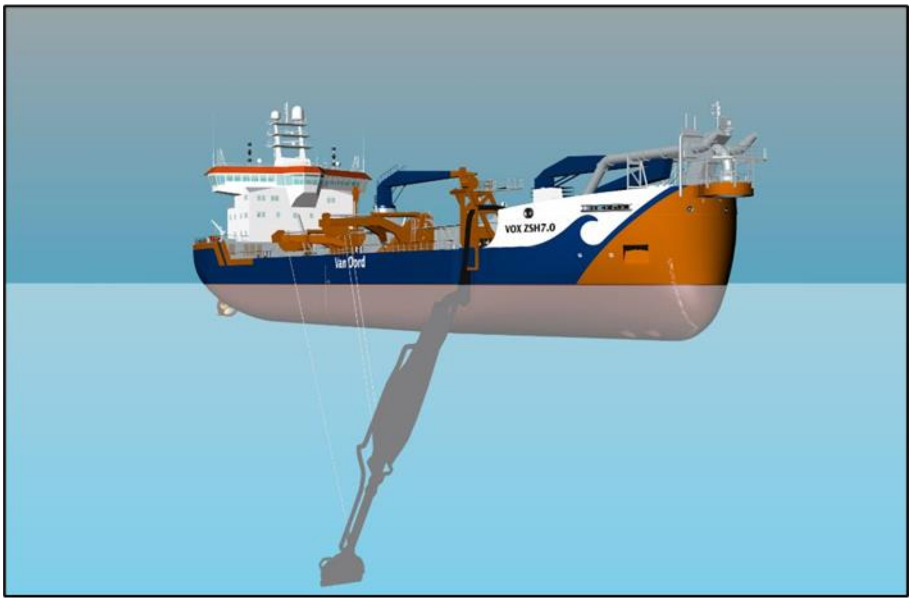


Figure 4.20:Example of a seabed lowering/features clearance dredging vessel (Photo courtesy of Van Oord)

Table 4.14: Overview of the techniques used for seabed lowering/features clearance

Seabed Lowering/Features Clearance Technique		Description
1	Backhoe Dredging / Grab or Clamshell Dredging	Lowering of seabed via use of backhoe excavators or clamshell grab equipment deployed from shallow draft barge or vessel.
2	Mass Flow Excavation / Water Injection Dredging	Fluidisation / suspension of sediments by pumping water into the seabed via fixed or suspended equipment deployed from multicat, SOV or dedicated dredging vessel.
3	Suction Hopper	Seabed lowering by means of typical dredging equipment such as trailing suction hopper dredgers.
4	Pre-lay Plough	Seabed features can be smoothed by pulling clearance pre-lay ploughs along the route prior to cable installation.

PRE-LAY GRAPNEL RUN (PLGR)

4.4.2.13 A PLGR is conducted on cable routes prior to installation activities. This process includes trailing several linked grapnels to clear the cable installation route of debris.

Step 3 – Foundation installation and scour protection installation

MONOPILE FOUNDATIONS

4.4.2.14 WTG and OSP foundations will be transported to the Array Area by vessel from the fabrication site or marshalling port facility.

4.4.2.15 Monopiles will be installed into the seabed by either piling or drilling techniques, or a combination of both (drive-drill-drive), depending on seabed conditions.

4.4.2.16 Piling the monopiles using a hydraulic impact hammer is the basecase method for monopile installation. Hydraulic impact hammering may in some instances be fully replaced or complimented by use of a vibro-hammer. In the complimentary use case, the vibrohammer would be used to install the monopile in the upper less competent soil layers. After monopile refusal (monopile ceases to penetrate further into the seabed) the vibrohammer would be replaced with an impact hammer in order to advance the pile to target embedment depth. As the name suggests a vibro-hammer imparts vibration on the pile and immediate surrounding soil. This vibration locally decreases soil resistance thereby allowing the monopile to penetrate through the soil. Vibrohammers are only effective in suitable soil conditions and have limited effect in high strength soils.

Figure 4.21: Monopile Installation (Photo courtesy of Dogger Bank Windfarm)

4.4.2.17 Impact hammer piling characteristics for monopiles are presented in Table 4.15. When piling a monopile using a hydraulic impact hammer, the monopile is lowered to seabed level using a crane and kept in position using a pile gripper. The hydraulic impact hammer is then positioned onto the monopile and the monopile is driven to target depth. Although a hammer energy of 6,600 kJ is considered as the maximum for the purposes of assessment, the actual energy used when piling will be significantly lower for the majority of the time and locations. The hammer energy is only raised to that maximum value when/if absolutely necessary (i.e. toeing into rock). In all cases piling will commence with a lower prescribed soft-start hammer energy during a 30 minute soft start. This is followed by a period, of up to 147 minutes, where the hammer energy applied is that required for optimum pile advancement to target depth.

Table 4.15: Anticipated Monopile piling characteristics

Parameter	56 WTG Option	47 WTG Option	OSPs
Number of Structures	56	47	2

Parameter	56 WTG Option	47 WTG Option	OSPs
Number of piles requiring piling	56	47	2
Maximum hammer energy (kJ)	4,000 (north & centre of Array Area) 6,600 (south of Array Area)	4,000 (north & centre of Array Area) 6,600 (south of Array Area)	4,000 (north of Array Area) 6,600 (south of Array Area)
Max Soft start energy (kJ)	825	825	825
Soft start duration (minutes)	30	30	30
Maximum strike rate (strikes per minute) – soft start	0.6 bl/min for 10 minutes followed by 30 bl/min for 20 minutes at the same hammer energy	0.6 bl/min for 10 minutes followed by 30 bl/min for 20 minutes at the same hammer energy	0.6 bl/min for 10 minutes followed by 30 bl/min for 20 minutes at the same hammer energy
Number of piles impact hammered over 24 hours	1	1	1
Maximum duration of piling per day over construction period (hours)	5 hrs 10 mins	5 hrs 10 mins	5 hrs 10 mins
*Total number of days when piling may occur over construction period	75	63	4

**Total number of days when piling may occur is greater than the number of structures, due to the possibility of pile refusal, weather delay or equipment and vessel malfunction. This may require piling to be carried out at a single location over multiple days.*

4.4.2.18 Where very challenging ground conditions are encountered, such as shallow competent bedrock occurring shallower than target monopile embedment depth, drilling techniques may need to be used.

4.4.2.19 Drilling characteristics for monopiles are presented in Table 4.16. If drilling is required (i.e. in the event that piling may not be suitable due to hard ground) then a Drive-Drill-Drive (DDD) methodology is preferred, although other methodologies (i.e. drilled and grouted) may be considered if more optimal and is described below. For locations where ground conditions are marginal for MP installation to target depth by driving, the DDD method can be used as contingency. For locations where ground conditions dictate drilling will be required the selection of the drilled and grouted technique over DDD would be dictated by a complex assessment of the strength and integrity of rock being drilled into, the depth below seabed at which rock will be encountered, and the depth of rock which needs to be drilled into.

4.4.2.20 DDD involves driving the monopile until it hits first refusal (i.e. rate of monopile advancement is below pre-determined threshold). If refusal has occurred above the required installation depth a decision is taken to deploy an under-reaming drill, which would be lowered down through the monopile. The drill would initially drill out the soil plug within the monopile. The drill continues to drill beyond monopile toe depth scrabbling away the underlying rocks / dense material layer(s) which are causing excessive resistance to pile driving. When the drill has reached the predetermined target depth it is recovered through the monopile. The impact hammer is redeployed on top of the monopile and driving resumes until the monopile is driven to target penetration depth. This DDD cycle may occur more than once as required.

4.4.2.21 The drilled and grouted technique requires a large caisson to be pre-installed above the rock layer in order to hold back superficial deposits. The drill drills through the caisson and into the underlying rock to target depth forming a rock socket under the caisson. The drill is then recovered and the MP is installed into the socket formed by the caisson and drilled out rock and overburden. The annulus between the MP and caisson/rock is filled with structural grout to allow load transfer from the monopile into the surrounding soil. Allowance has been made for grout wastage in case of any fissures within the rock, which are not anticipated in the initial net grout volume calculation.

4.4.2.22 Drilling, DDD or drilled and grouted will result in the release of seabed material, which will be deposited adjacent to each drilled foundation location. Characteristics associated with the foundations requiring drilling are shown below.

Table 4.16: Anticipated Monopile drilling characteristics

	56 WTG Option	47 WTG Option	OSPs
Number of Structures	56	47	2
Number of piles requiring drilling	25	25	2
Drilling rate	0.2 m/hr - 0.4 m/hr (in rock), 0.6 m/hr - 1.0 m/hr (in sand) and 0.2 m/hr - 0.6 m/hr (in clay)		
Drilling depth (m)	37	37	45
Volume of drill arisings per pile (m^3)	5,280	7,040	13,860
Total volume of drill arisings for component type (m^3)	132,000	176,000	27,720

GROUT

4.4.2.23 Grout volumes which will be used for the Proposed Development are presented in Table 4.17.

Table 4.17: Grout characteristics for monopile foundations

Grout characteristics	56 WTG Option	47 WTG Option	OSPs
Total Proposed Development Grout volumes (m^3)	90,720	76,140	5,140

4.4.2.24 A TP may be installed over the monopile foundation and secured via inert grout or bolts. Where a TP is used, the secondary steel will be pre-installed onto the TP at the fabrication site or port facility. Alternatively, the monopile may be connected directly to the turbine tower using a bolted connection (TP-Less solution). If a TP-Less solution is progressed the secondary steel will likely be installed offshore, either as a single caged solution or as individual secondary steel components. Secondary steel means steel that does not form the primary load path in an offshore structure and includes platforms, hand rails, ladders, boat landings, j-tubes, equipment attachment points and associated appurtenances. For the OSPs a j-tube cage will be installed over the monopile prior to the installation of the TP. A second installation vessel may be used for this offshore secondary steel installation.

Figure 4.22: Offshore TP installation (Photo courtesy of Dogger Bank Windfarm)

4.4.2.25 Grout can be used in the MP-TP connection, or OSP TP to OSP Topsides connection, either as a structural or sealing component.

Figure 4.23: Installed offshore WTG with Monopile and TP installations in background (Photo courtesy of Dogger Bank Windfarm)

SCOUR PROTECTION

4.4.2.26 Where scour protection is required, this will be achieved using one or more of the solutions previously described in section 4.2.4. Should loose rock be used, this will be installed using a rock installation vessel equipped with a fall pipe for rock placement. The other solutions described in section 4.2.4 would be installed on the seabed using the crane of an installation vessel.

Step 4 – OSP topside installation/commissioning

4.4.2.27 The OSP topsides will be transported to the Array Area by vessel either from the fabrication yard or the pre-assembly harbour. The OSP will be transported by the installation vessel or on a barge towed by a tug. Once on site, the lift rigging for the OSP will be installed, and the seafastening removed before being lifted and installed onto the foundation. The OSP topside will then be welded, grouted or bolted to the foundation. Once the structural joint is completed, the corrosion protection system will be re-instated to protect the joint. The installation vessel will mobilise with all the required equipment including rigging, welding, bolting equipment and corrosion protection system repair equipment.

4.4.2.28 All necessary cable connecting and commissioning works are expected to be carried out with the assistance of a jack-up, commissioning service operation vessel or similar vessel, with assisting support and supply vessels as required. Due to the proximity to shore it is likely that Crew Transfer Vessels (CTVs) will be used to transfer personnel to and from the installation vessel or similar vessel. When the final commissioning and testing works along with any outstanding snagging items have been completed and operated for a period of c.18 months, the OSP will then be handed over to EirGrid. From this point EirGrid will be responsible for the operations and maintenance of the vast majority of the OSP.

Step 5 – Offshore export cable – landfall installation

4.4.2.29 At the landfall, the offshore export cables will be connected to the consented ABWP2 Onshore Grid Infrastructure (OGI) landward of the HWM. The Proposed Development extends to the HWM point however as the trenchless methodologies for transiting the cables from sea to land is a single operation and includes land based works (subject to a separate consent) a full description is provided for context. Consent is only being sought for works associated with the Proposed Development seaward of the HWM. Trenchless technology involves drilling an underground pathway from one point to another, through which the offshore export cable is installed, without the need to excavate an open trench. A working area will be established (onshore) containing the drill rig, electrical generator, water tank, mud recycling unit and temporary site offices.

4.4.2.30 Two trenchless installation methods have been assessed and a preferred method will be selected based on a number of considerations including ground conditions, topography, cable design parameters, met ocean conditions and cable installation method. The following sections describe the methods for horizontal directional drilling (HDD) and steerable direct pipe thrusting (“Direct Pipe”). Offshore export cable routes as they approach the landfall and trenchless arrangements for both techniques are shown in Planning Drawing AW-SSE-000-CVL-PEV-0031-000 (Landfall Trenchless Arrangement Horizontal Directional Drill) and Planning Drawing AW-SSE-000-CVL-PEV-0032-000 (Landfall Trenchless Arrangement Direct Pipe).

4.4.2.31 With regards to HDD methodology, the drilling equipment will be located inland of the landfall with installation commencing from above the HWM and with the HDD exit point located seaward of the intertidal zone. As such, no works are planned to take place in the intertidal zone. Drilling fluid comprising a mixture of bentonite and water is pumped to the drilling head during the drilling process to stabilise the hole and retrieve the drilled material. During the drilling process some drilled material will be deposited at the HDD exit point. Once the drilling is complete, cable ducts will be installed either from land and pushed out using specialised pipe pushing equipment, or towed into position by a vessel offshore and pulled in through the bore using land based winches. A supporting marine spread including vessels and divers may be required to assist with the drilling and installation of the ducts. The offshore export cables will be installed from a vessel offshore and pulled through the pre-installed ducts by land-based winches.

4.4.2.32 The HDD exit pits will be located in a suitable water depth to facilitate both drilling operations and cable installation / protection operations.

4.4.2.33 The HDD works comprise the following main stages:

1. A pilot hole will be drilled from onshore to offshore, without breaking out on the seabed;
2. Once the pilot hole has been completed, the reaming process will commence, increasing the diameter of the pilot hole to accommodate the safe installation of HDD duct. The reaming process will continue back and forth for a number of passes to achieve a bore diameter suitable for the installation of the duct. The bore will be larger than the duct diameter to allow the duct to pass through the bore. During the drilling procedure, drilling fluid is continuously pumped to the drill head to act as a lubricant. Solids will be settled out from the returning drilling mud/cuttings, and the spoil is transported off site;
3. A jack-up vessel or dredger or offshore support vessel will be used at the HDD exit point;
4. An exit pit will be created at the HDD exit point. This will be achieved using a combination of dredging, air lift and long reach excavators;
5. The last forward HDD reamer exits the seabed at the exit pit. Upon completion of the bore reaming, the drilling head will punch through the seabed where it will be

recovered. At this point in the process, drilling fluid will be released into the water column as a function of the head of fluid above the water level;

6. The HDD reamer will then be disconnected from the drill pipe and recovered;
7. A High-Density Polyethylene (HDPE) liner pipe will be pre-assembled and then floated in, connected to the drill pipe, and pulled onshore from the offshore end through the pre-drilled bore into position. Alternatively, the duct may be assembled near the onshore HDD entry point and installed by means of specialised pipe pushing equipment;

4.4.2.34 Steps 1 to 7 will then be repeated for the second cable circuit;

8. Trenches will then be excavated from the HDD entry points above the HWM to the Transition Joint Bay (TJB) and ducts installed and backfilled;
9. HDD construction equipment and plant will then be demobilised from the onshore site;
10. The ducts are then proved ready for cable installation with installation of pull-in wires;
11. Cables will then be installed in the ducts by pulling onshore through the ducts from the offshore delivery vessel to the TJBs;
12. Once cables are installed, the HDD offshore exit pits may be backfilled or stabilised with soil, rock, filter bags or mattresses as required.

Figure 4.24: Example of HDD Rig

4.4.2.35 As noted above the Proposed Development extends to the HWM point however as the trenchless methodologies for transiting the cables from sea to land is a single operation and includes land based works (subject to a separate consent). A full description is provided for context. Consent is only being sought for works associated with the Proposed Development seaward of the HWM. For direct steerable pipe thrusting, the drilling installation will commence from above the HWM, with the exit point seaward of the intertidal zone. As such, no works are planned to take place in the intertidal zone. Due to the required size of machinery, the bore diameter as a result of this method is larger than that produced by HDD.

4.4.2.36 Temporary earthworks are required onshore to align the pipe thruster machine to the initial path of the drill trajectory. An exit pit is required subsea to allow recovery of the micro tunnel bore machine (MTBM). This will be supported by offshore support vessels, assisted by remotely operated vehicle (ROV) and/or divers. The exit pit will require preparation via dredging, use of excavators or air lifting.

4.4.2.37 The Direct Pipe works comprise the following main stages

1. A shallow entry pit will be excavated above the HWM to facilitate the required conduit entry angle and provide anchorage to the pipe thruster typically comprising sheet piles and bracing.
2. The pipe thruster will then push a MTBM into the ground using lengths of steel casing/conduit. An internal belt system will return drilling mud / cuttings to the surface which will then be transported offsite for disposal;
3. Marine support vessels such as a Jack Up Vessel (JUV), anchor barge or other will be required at the MTBM exit point in order to prepare the exit pit and assist with recovery of the MTBM.
4. The Direct Pipe drive will be completed by MTBM punching out into exit pit.
5. The MTBM will then be disconnected from the pipe with diver or ROV assistance and recovered.
6. The direct pipe conduit will be capped in preparation for cable installation.

4.4.2.38 Steps 1 to 6 will then be repeated for the second cable circuit:

7. Pipe thrusting construction equipment and plant will then be demobilised from the onshore site.
8. The conduits are then proved ready for cable installation and pull-in wires installed.
9. Cables will then be installed by pulling the cable through the conduits from the cable installation vessel by means of an onshore winch.
10. Trenches will be excavated from the conduits entry points above the HWM to the TJB.
11. Remaining length of cable will be installed from the conduit to the TJB and trenches backfilled.
12. Once cables are installed the offshore exit pits will be backfilled or stabilised with soil, rock, filter bags or mattresses as required.

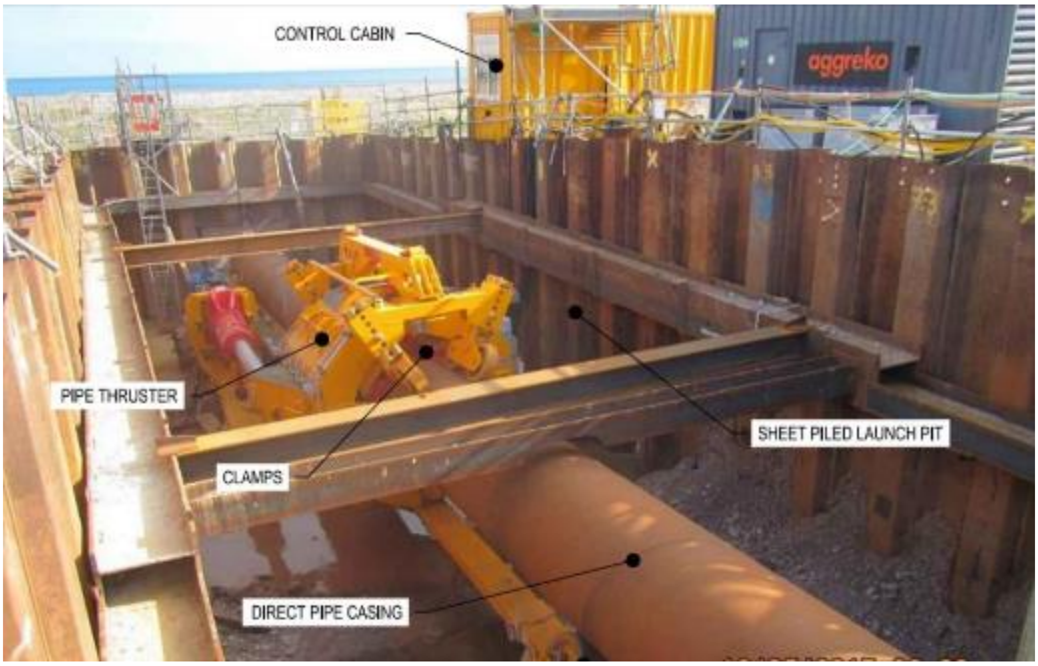


Figure 4.25: Direct Pipe Installation

4.4.2.39 Once commenced, the trenchless drilling activities will be required to operate continuously (24 hours / day) until each bore is complete. This 24-hour operation is to reduce the risk of drilling complications arising, including bore collapse and the drilling head becoming stuck. Subject to further construction planning and availability of drilling rigs, drilling may be carried out simultaneously (for both circuits).

4.4.2.40 Offshore export cable landfall installation parameters are presented in Table 4.18. The exit pits will have anticipated dimensions of 75 m (length) and 5 m (width) resulting in a volume of material excavated from each exit pit of 937.5 m^3.

Table 4.18: Offshore export cable – landfall parameters

Parameter	Value
No of cable circuits	2
Length of each bore from HWM to exit pit	350-880 m
Voltage	220 kV
Transmission system	HVAC
Burial depth (between HWM and exit pits) (m)	0-17

4.4.2.41 Drilling Fluid usually comprises 95% water and 5% bentonite clay which is a non-toxic, natural substance. Biodegradable bentonite drilling fluid is non-toxic and can be commonly used in farming practices. Every endeavour will be made to avoid a breakout (loss of drilling fluid to the surface). The standard procedure for managing a breakout under water will include:

- Stop drilling immediately;
- Pump lost circulation material (mica), which will swell and plug any fissures;
- Check and monitor mud volumes and pressures as the works recommence; and
- Repeat process as necessary until the breakout has been sealed.

Step 6 – Offshore export cable – offshore installation and cable protection installation

OFFSHORE EXPORT CABLE INSTALLATION

4.4.2.42 There are two pull in techniques considered for the cable installation through the landfall transition. The first being direct pull in, where the cable vessel will sit a short stand-off distance from the landfall transition exit point where the cable is pulled directly and unreeled from the vessel. The second being a floated pull in, where the vessel will stand-off at a suitable water depth for its safe operation and float the cable toward the duct, with a second vessel or jack up barge assisting located above the landfall transition exit point to guide the cable through the duct. The preferred pull-in method will depend on the final location of the landfall transition exit point, site conditions and characteristics of the marine installation spread with higher draft vessels required to be positioned in deeper waters.

4.4.2.43 For the direct pull in method, a shallow draft vessel with DP or anchor spread will be used. These vessels can operate in shallow waters in the nearshore area. For the direct pull in method an additional support vessel may be required to prepare the landfall transition duct and exit point for the cable pull in. These activities will include removal of temporary stabilisation such as rock bags, removal of duct end caps and installation of pull-in accessories such as bellmouths. Once the preparations are complete, the cable installation vessel will position near the duct exit location and deploy the cable overboard via a chute and tensioners with the cable pulled through the landfall transition duct by means of an onshore pull-in winch.

4.4.2.44 For the floated pull in method, a larger draft vessel will be used which would position a few hundred metres away from the landfall transition exit point. At the landfall transition exit point a ‘spud pontoon’/small jack up or an anchored multicat vessel will be positioned. The larger draft vessel will then deploy the offshore export cables with suitable flotation devices, such as pillow floats, which support the cable in the water and keep it buoyant. The floated cable will be guided toward the pontoon via a small vessel where it will then be connected to a pull rope through the landfall transition on the pontoon. The purpose of the pontoon is to act as a working platform to remove the flotation devices, take load of the cable through tensioners, guide the cable over a chute, which will then guide the cable down to the seabed into the landfall transition duct.

4.4.2.45 Following pull in and anchoring of the offshore export cables within the landfall compound onshore, the cable will be laid along a predefined route between the offshore exit pit and OSP. The cable will be over boarded from the stern of the cable lay vessel (CLV), either free laid on the seabed surface or simultaneously laid and buried via a plough as described in the cable plough methodology below. Free laid cable will require protection from incident until buried. This will be managed by guard vessels, the total number will be defined by the anticipated risk associated with the routes in the interim period (i.e. following being laid and before burial).

Figure 4.26: Offshore Cable Pull Operation (Photo courtesy of Beatrice OWF)

4.4.2.46 There are various types of installation tools that may be used to bury the offshore export cables. It is expected that the majority of the cable route will be buried with the use of jet trenching or jet ploughing tools, however use of mechanical cutting tools or pre-cut trenching equipment may be required depending on soil conditions. For areas with significant mobile sediments, a vertical injector system is proposed to be deployed in order to achieve the required burial depth below Lowest Seabed Level. The typical installation tools/methodologies are jet trenching, cable plough, mechanical trenching, pre-lay plough, vertical injector and controlled flow excavation.

4.4.2.47 The following techniques are proposed for cable burial;

- The **jet trenching** methodology uses a jetting tool that injects water at high pressure into the sediment surrounding the cable to temporarily fluidise it allowing the cable to sink to the required burial depth;
- The **cable plough** methodology uses a towed plough to open a narrow trench in the seabed into which the cable is inserted simultaneously. Typically, the cable plough shear is fitted with a jet system. This reduces the high tow force generally exhibited in sands during ploughing;
- The **mechanical trenching** tools use mechanical means to excavate a trench in the seabed. Numerous cutting boom and chain/pick configurations with varying levels of power are available. The mechanical cutting tools are generally fitted with a depressor which guides the cable through the fluidised materials in the excavated trench;
- The **pre-lay plough** methodology is similar to the cable plough method described above however the pre-lay option uses a larger plough, which creates a "V" shaped trench prior to cable lay operations. The trench is created to the required depth, with the cable laid into the trench, normally by another vessel; followed by a second pass of the plough to return sediment over the cable and trench;
- The **vertical injector** tool uses pressurised water to trench through soils and the cable is fed through the tool. Therefore, it is a simultaneous trenching and laying tool. The tool is either vessel mounted or mounted on skids; and
- The **controlled flow excavation** method is where a low-pressure, high-volume flow of water is concentrated around the cable, fluidising the seabed and allowing the cable to drop through sediments to the required depth. A number of passes may be required to achieve the burial depth.

CABLE PROTECTION INSTALLATION

4.4.2.48 Cable protection will be used where sufficient burial depth within the seabed is not achieved during installation, due to difficult ground conditions being encountered, and at cable crossings. Cable protection is also used as cables approach and enter the WTGs and OSPs.

4.4.2.49 The installation of cable protection typically consists of:

- For **CPS,** the product (i.e. ducts) is assembled around the cable on the vessel during the cable laying campaign. The cable enclosed in the CPS is then lowered into the water and installed. Alternatively, the CPS is pre-installed on the WTG or OSP foundation and the cable is then pulled through the CPS during installation;
- **Concrete mattresses** are constructed using high strength concrete blocks and U.V. stabilised polypropylene rope. They are usually supplied in standard 6 x 3 x 0.3 m units of standard density. The mattresses are installed above the cables with a standard Multicat type DP vessel and free-swimming installation frame. The mattresses are lowered to the seabed and once the correct position is confirmed, a frame release mechanism is triggered and the mattress is deployed on the seabed;
- **Rock installation** is achieved using a vessel with equipment such as a 'fall pipe' which allows installation of rock close to the seabed. The rock installation is designed to provide protection from anchor strike and anchor dragging, and to allow over trawl by fishing vessels. Alternatively, pre-filled rock bags can be placed above the cables with specialist installation beams.

4.4.2.50 On approach to WTGs and OSPs, the cable will exit the seabed within CPS, and run for a short distance before entering the J-tube attached to the WTG or OSP foundation. The CPS at both the OSP and WTG substructure will be stabilised with rock or rock bags or mattresses to the point of full burial of the cable within the seabed.

CABLE CROSSING INSTALLATION

4.4.2.51 As noted in paragraph 4.2.5.19, cable crossings will be required where cables associated with the Proposed Development cross each other and/or the existing ABWP1 export cable. The crossings will be completed using one of the protection technologies as described in paragraph 4.4.2.49. In all instances, a crossing angle close to 90 degrees relative to the existing cable, will be considered.

4.4.2.52 A separation layer between seabed and the crossing cable is required ahead of cable laying. A separation of 500 mm is required and can be created either through a rock berm or concrete mattress installation.

4.4.2.53 Upon completion of the cable lay on top of the separation layer, a vessel will return to place the post lay mattresses on top of the newly installed offshore export cables, these will cover the full transition of the cable from buried depth to surface.

4.4.2.54 Completing the crossing using rock placement, the offshore export cables are then installed over the separation layer and post installation the rock placement vessel returns to install the berm from the transition points over the crossing.

Step 7 – Inter-array and interconnector cable installation and cable protection installation

4.4.2.55 The installation techniques as described in step 6 for export cable installation will also be employed for inter array and interconnector cable installation and where burial by mechanical methods is not achieved, cable protection will be used.

4.4.2.56 Cables will be pulled into OSP and WTG substructures through the associated J-tubes or aperture. The cable will be installed from a cable lay vessel, supported on OSP/WTG by teams managed from either an offshore support vessel or CTV. Cables will be free laid on the surface and either simultaneously buried using a burial tool deployed from the installation vessel or buried post-lay with a burial tool deployed from an independent vessel spread.

4.4.2.57 Cable protection installation will apply as described in paragraphs 4.4.2.48-4.4.2.50.

CABLE CROSSING INSTALLATION

4.4.2.58 As noted in paragraph 4.2.5.19, cable crossings will be required where the cables associated with the Proposed Development cross each other and/or the existing ABWP1 export cable. The crossings will be completed using one of the protection technologies as described in paragraph 4.4.2.49.

4.4.2.59 A separation layer between seabed and the crossing cable is required ahead of cable laying. A separation of 500 mm is required and will be created either through a rock berm or concrete mattress installation.

4.4.2.60 Upon completion of the cable lay on top of the separation layer, a vessel will return to place the post lay mattresses on top of the newly installed offshore export cables, these will cover the full transition of the cable from buried depth to surface.

4.4.2.61 Completing the crossing using rock placement, the offshore export cables are then installed over the separation layer and post installation the rock placement vessel returns to install the berm from the transition points over the crossing.

Step 8 – WTG installation and commissioning

4.4.2.62 The WTGs will be transported to the Array Area by vessel from the pre-assembly port where sub-assemblies (nacelle, rotor blades and towers), assembly parts, tools and equipment will be loaded onto a transport/installation vessel or support vessel. The number of WTGs transported per trip and thus exact number of trips in total will depend on the vessel selected.

4.4.2.63 At the Array Area, the WTG tower will be installed onto the foundations, followed by the nacelle and blades. Due to the height of the WTGs, this will involve the use of a crane based onboard the installation vessel. The blades will be installed one at a time or alternatively, the hub including all three blades will be installed as a pre-assembled rotor. Pressure washing may take place during WTG installation to remove any marine growth or guano that may have accumulated following installation of the foundations.

4.4.2.64 Following installation of the WTG, mechanical and electrical completion work will take place including connecting the WTG to the inter-array cabling, then a process of testing and commissioning will commence, and the energisation will be undertaken. Prior to energisation of the WTG, temporary power generation will be provided, either from a vessel, photovoltaic (PV) panels or a temporary generator, to supply power to ancillary systems (e.g. lighting, navigation aids and dehumidification, etc.)

4.4.2.65 Following energisation, the WTGs will start operating and producing/consuming power and the final works including further testing and inspections will take place. WTGs may consume power for ancillary systems in conditions when the WTG is not producing power. Some minor outstanding works may also require re-visits to the WTG during this period. In some cases where larger damage/defects during the installation/commissioning have occurred, it may be required that the installation or support vessel revisits the WTG(s), transporting the replacement component(s), tools and equipment required for the repair from port.

4.4.3 Installation vessels and helicopters

4.4.3.1 A range of installation vessels will be used for the construction of the Proposed Development. This includes main installation vessels (e.g. jack-up barges or dynamic positioning (DP) vessels with heavy lifting equipment), support vessels (including 'walk to work' vessels), tugs and anchor handlers, cable installation vessels, guard vessels, survey vessels, crew transfer vessels and scour/cable protection installation vessels. In addition, it is possible that helicopters will be used for crew transfers. Installation vessel and helicopter parameters are presented in Table 4.19 for activities associated with the installation of WTG and OSP infrastructure within the Array Area and in Table 4.20 for activities associated with site preparation and the installation of cables. These tables also provide an overview of the number of vessels/helicopters which will be on site at any one time, and the number of return trips across the entire construction period. It should be noted that these numbers are presented are anticipated likely numbers for assessment purposes and in reality, vessel and helicopter numbers are likely to be considerably less than this. The anticipated likely return trips per year numbers are provided in Table 4.21. The anticipated return trips per year will not always directly equate to the average yearly trips multiplied by the construction period. For example, all trips for a given vessel/craft type may be contained within a period that is shorter than the complete construction period, with the vessel not used outside of this period.

Figure 4.27: Helicopter operating at OWF (Photo courtesy of Beatrice OWF)

Table 4.19: Total installation vessels anticipated on site at one time

Total Installation Vessels (on site at one time)	WTG	Site Prep	WTG Foundation	OSP Topside	OSP Foundation	IAC	Export Cables	Landfall	Total
Main Installation Vessels (Jack-up Barge/DP vessel)	1		2	1	1	1	1		7
Cargo barge			2	1					3
Support vessels (SOV / W2W / Commissioning JUVs)	1		1	1		2	1		6
Tug/Anchor Handlers			4	4	4			2	10
Cable Installation Vessels						1	1	2	4
Guard Vessels	2		2			2	2		8
Survey Vessels			1			2	1	2	6
Crew Transfer Vessels	2		2	2	1	2	2	1	12
Scour/Cable Protection Installation Vessels			1		1	1	2		5
Helicopters	1		1			1			3
Pre-installation boulder removal/clearing vessels		1				2	2		5
Seabed lowering/feature clearance vessel		1				1			2
UXO clearance vessel		1							**1**

Table 4.20: Total anticipated installation vessel return trips during construction

Installation Vessel Movements (Return Trips) (across construction period)	WTG	Site Prep	WTG Foundation	OSP Topside	OSP Foundation	IAC	Export Cables	Landfall	Total
Main Installation Vessels (Jack-up Barge/DP vessel)	37	0	74	10	10	10	5	5	**151**
Support vessels (SOV / W2W / Construction Support Vessels (CSV) / Commissioning JUVs)	68		68	20	0	136	34		**326**
Tug/Anchor Handlers			222	12	12			10	**256**
Cable Installation Vessels						10	5	5	**20**
Guard Vessels	158		158	20	4	136	68	17	**561**
Survey Vessels			73			10	5	30	**118**
Crew Transfer Vessels	822		822	210	14	180	180	40	**2268**
Scour/Cable Protection Installation Vessels			46		2				**48**
Helicopters	79		79			136			**294**
Pre-installation boulder removal/clearing vessels			73			79	79		**231**

Installation Vessel Movements (Return Trips) (across construction period)	WTG	Site Prep	WTG Foundation	OSP Topside	OSP Foundation	IAC	Export Cables	Landfall	Total
Seabed lowering/feature clearance vessel						79	79		**158**
UXO clearance vessel		13							**13**

Table 4.21: Total anticipated installation vessel return trips per year

Installation Vessel Movements (Return Trips) (per year)	Total
Main Installation Vessels (Jack-up Barge/DP vessel)	**76**
Support vessels (SOV / W2W / Commissioning JUVs)	**163**
Tug/Anchor Handlers	**128**
Cable Installation Vessels	**10**
Guard Vessels	**281**
Survey Vessels	**48**
Crew Transfer Vessels	**908**
Scour/Cable Protection Installation Vessels	**20**

Installation Vessel Movements (Return Trips) (per year)	Total
Helicopters	**118**
Pre-installation boulder removal/clearing vessels	**93**
Seabed lowering/feature clearance vessel	**64**
UXO clearance vessel	**6**

4.4.3.2 Jack-up vessels/barges make contact with the seabed when their jack-up spud cans (base structure of each leg) are lowered into place. Total impacted area during construction is dependent on the chosen installation vessel and associated spud can dimensions and number of legs, therefore for the purposes of the EIAR anticipated jack-up vessel parameters are presented in Table 4.22 below.

Table 4.22: Anticipated Jack-up vessel parameters

Jack-up Barge Footprints	
Number of legs per vessel (total spud can/leg area will be largest with a 4 legged jack up barge)	3/4/6
Combined leg area (m2)	1200
Leg penetration range (m)	0-20
Total Impacted Area during Construction (m2)	278,400

4.4.4 Construction ports

4.4.4.1 It is likely that the Proposed Development components will be fabricated at a number of manufacturing sites across Europe or elsewhere. Components may be transported directly to the Proposed Development from where they are manufactured, or may be delivered to a port where they are stored in line with the day to day practice of that port, before onward transport to the Array Area. This will be determined as part of competitive tendering processes.

4.4.4.2 All large components for the Proposed Development will be transported via sea transport to the Array Area and/or Cable Corridor and Working Area for installation via vessels and associated equipment. Therefore there is no requirement for large components (e.g. WTG blades, foundations etc) to be transported via road in the vicinity of Arklow.

4.4.4.3 The construction port for the storage, fabrication, pre-assembly and delivery of Proposed Development infrastructure has not yet been confirmed at the time of writing this EIAR. Suitable ports which have appropriate facilities to handle and process OWF components will be selected. All activities carried out within port will fall under established port licences and operational controls.

Figure 4.28: Construction Port at Nigg (Photo courtesy of Seagreen OWF)

4.4.4.4 Construction personnel will transit from shore to the location of the Proposed Development on the installation vessels or other vessels and / or helicopters listed in Table 4.19 to Table 4.21.

4.4.5 Construction programme

4.4.5.1 A high-level construction programme is provided in Figure 4.29. and a construction period of five years has been assumed and assessed. The programme illustrates the likely duration of the installation activities associated with each of the major components, and how they may progress in relation to each other.

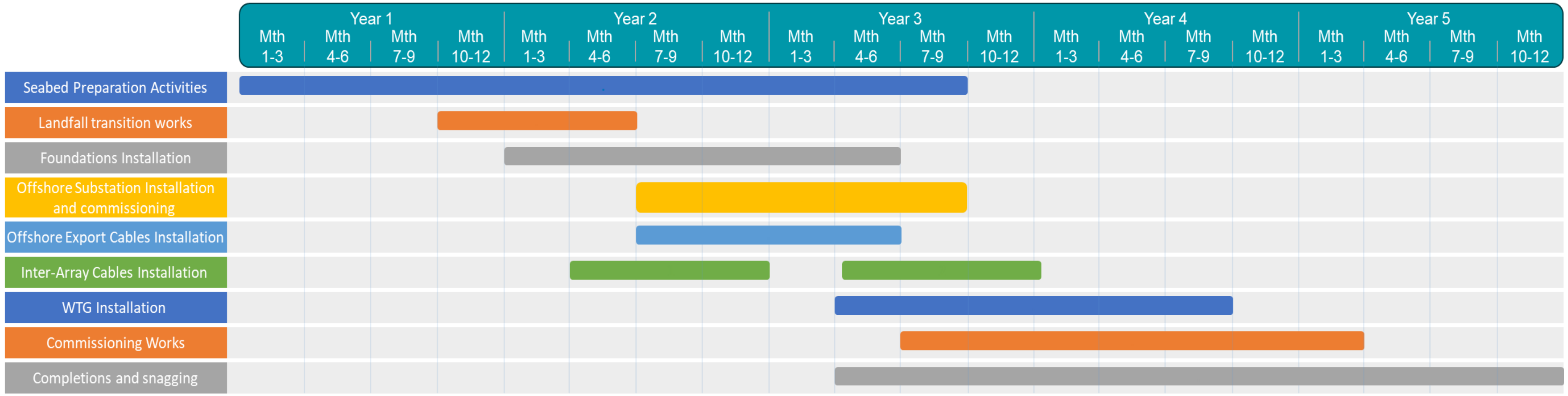


Figure 4.29: High-level construction programme

4.4.5.2 The timing of commencement of the construction programme for the Proposed Development will depend on a number of factors, including:

- Secure a route to market in accordance with the requirements within the Proposed Development's Maritime Area Consent (2022-MAC-002).
- Successful grid connection application to EirGrid and subsequent programme for connection;
- The availability and lead times associated with procuring and installing the Proposed Development components; and
- Securing planning consent for the Proposed Development.

4.5 Operational and maintenance activities

4.5.1 Health and Safety

4.5.1.1 All project personnel and contractors will be required to be fully compliant with their responsibilities as defined by:

- The Safety, Health and Welfare at Work Act 2005;
- The Safety, Health and Welfare at Work (General Application) Regulations 2007 (as amended);
- The Safety, Health and Welfare at Work (Construction) Regulations 2013 (as amended);
- The Safety, Health and Welfare at Work (Diving) Regulations 2018 (as amended);
- The Safety, Health and Welfare at Work (Reporting of Accidents and Dangerous Occurrences) Regulations 2016 (S.I. No. 370 of 2016);
- The Chemicals Act 2008 and The Safety, Health and Welfare at Work (Chemical Agents) Regulations 2001 (S.I. No. 619/2001) as amended;
- The Merchant Shipping Act 1894 & The Merchant Shipping (Investigation of Marine Casualties) Act, 2000;
- The HSA ACoPS;
- Wind Energy Ireland ACoPS;
- G+ Offshore Wind Health & Safety Association guidance documents;
- Code of practice for safe use of cranes BS 7121-1:2016; and
- Other applicable industry standards/best practice such as ISO, DNV, etc.

4.5.2 Operational lifetime

4.5.2.1 The operational life of the Proposed Development will be limited by the 45 year term as currently outlined in the MAC which commenced in December 2022. This means that decommissioning / rehabilitation activities of the Proposed Development will be completed by December 2067. For the purposes of assessment an operational period of up to 36.5 years is assumed.

4.5.2.2 EirGrid will take over ownership and related operational and maintenance activities of the transmission assets i.e. the OSPs, offshore export cables including the interconnector cable approximately 18 months post energisation of the onshore grid infrastructure.

4.5.3 Security and control systems

4.5.3.1 During the operational lifetime of the Proposed Development, regular inspection and maintenance activities will be required, coordinated by a team based at the ABWP2 Operations and Maintenance Facility (OMF) at Arklow Harbour. In June 2022, the Developer received planning permission from Wicklow County Council (Planning Register Reference:

21/1316) to develop the ABWP2 OMF at South Dock, Arklow Harbour. The building and associated pontoon and ancillary infrastructure as shown in Figure 4.30 will serve as the support base for ABWP2 throughout its operational lifetime and will support around 60-80 long term local jobs. Potential cumulative impacts arising from the ABWP2 OMF and the Proposed Development are considered within the relevant technical Chapters of this EIAR.

Figure 4.30: Consented ABWP2 OMF

4.5.3.2 The WTGs will be remotely monitored and controlled by a central Supervisory Control and Data Acquisition (SCADA) system, which will be connected via fibre optic link. This will facilitate remote operation of the WTGs. Each WTG has its own control system which can enable, for example, yaw control and shut down in high wind speeds. Each WTG also can be manually controlled from within the WTG itself.

4.5.3.3 The WTG control and communication systems will each be connected via fibre cable to the OSP, which forms part of the inter-array cable circuit (see section 4.2.3.1). The OSP in turn is connected back to the onshore substation via microwave link and fibre link as part of the offshore export cable circuits.

4.5.3.4 The principal windfarm management and marine coordination systems will be located at the OMF. This will include an emergency response control centre. Closed-circuit television (CCTV) systems will also be installed offshore to provide coverage and visibility of the assets offshore.

4.5.4 Methodology

4.5.4.1 Generally, inspection and day-to-day maintenance will be carried out by a team/teams of technicians transiting to and from the Array Area in the CTVs which will be based at the OMF. Other maintenance vessels, such as Service Operation Vessels (SOVs), may also be used to support maintenance activities. Occasionally, in the event of a fault or in order to maintain larger components, maintenance will be carried out by larger vessels, such as jack-up vessels. Any major component replacement activities will be undertaken by larger vessels operating from suitable port facilities; the OMF will not be used for storage or transport of major components such as blades. Inspection and maintenance activities will ensure that the Proposed Development is closely monitored and maintained in good working order.

4.5.4.2 Table 4.23 to Table 4.26 provide a description of the reasonably foreseeable maintenance activities anticipated to be required over the lifetime of the Proposed Development associated with the WTGs and OSPs, and their foundations.

4.5.4.3 Table 4.27 to Table 4.29 provide a description of the reasonably foreseeable maintenance activities associated with the inter-array, interconnector and offshore export cables anticipated to be required over the lifetime of the Proposed Development. It should be noted that cable failure is considered to be a rare occurrence.

Table 4.23: Operational and maintenance activities – WTG Foundations

Activity	Description	Methodology	Frequency
Routine Inspections	Inspections of foundations, including TPs and ancillary structures (e.g. J-tubes), above and below sea level	Small team access by CTV	Every six months for first two years and annually thereafter
Geophysical surveys	Survey of seabed and assets	Survey vessel(s) or Unmanned Surface Vehicles (USV)	Every six months for first two years and annually thereafter
Repairs and replacements of navigational equipment	Repairs and replacements of electrical equipment such as lighting, fog horns, navigation lights and transponders	Small team access by CTV	Once every two years
Removal of marine growth	Removal of marine growth from foundations, TPs and access ladders	Pressure washer from CTV	Annual removal of area above water and two subsea removals across operational life of Proposed Development.
Removal of guano	Removal of guano from foundations, TPs and access ladders	Pressure washer from CTV	One to two times per year
Replacement of corrosion protection anodes	Remove and replace anodes required for corrosion protection	Divers or ROV usually deployed from a DP vessel	Four per year across windfarm
Painting	Application of paint or other coatings to protect the foundations from corrosion (internal/external), including surface preparation	Small Team access by CTV	25% of assets annually
Replacement or modifications of ancillary structures (if required)	Removal and replacement of ancillary structures such as Davit Cranes	Small Team access by CTV	all assets every 5 years
Scour protection repair and maintenance	Including remedial works, replacement of scour protection and removal of excess seabed sediment (not to exceed parameters included in Table 4.4), where required.	See section 4.4, Step 3 – Foundation installation and scour protection installation. Specialist dredging vessel.	All assets every 5 years
Modifications to/replacement of J-tubes	Modifications to/ replacement of J-tubes e.g. during inter-array cable repair works.	Divers or ROV usually deployed from a DP2 vessel	1 every 5 years

Table 4.24: Operational and maintenance activities – OSP Foundations

Activity	Description	Methodology	Frequency
Routine Inspections	Inspections of foundations, including platforms and ancillary structures (e.g. J-tubes), above and below sea level	Small team access by CTV	Every six months for first two years and annually thereafter
Geophysical surveys	Survey of seabed and assets	Survey vessel(s) or Unmanned Surface Vehicles (USV)	Every six months for first two years and annually thereafter
Removal of marine growth	Removal of marine growth from foundations or access ladders.	Ad hoc pressure washer from CTV/SOV	Removal occurring on every OSP twice over the lifecycle of the project
Removal of guano	Removal of guano from foundations, transition pieces, or access ladders.	Pressure washer from CTV	One to two times per year
Replacement of corrosion protection anodes	Remove and replace anodes required for corrosion protection.	Divers or ROV usually deployed from DP vessel	Sacrificial anode system: 1 complete system replacement in the design life of the OSP Impressed Current Cathodic Protection System: 1 system repair every 5 years
Painting	Application of paint or other coatings to protect the foundations from corrosion (internal/external), including surface preparation.	Small team access by CTV/SOV	Touch up painting carried out annually
Replacement of ancillary structures	Removal and replacement of ancillary structures such as Davit cranes.	Small team access by CTV/SOV	All assets every 5 years

Scour protection repair and maintenance	Including remedial works, replacement of scour protection and removal of excess seabed sediment (not to exceed parameters included in Table 4.4), where required.	See section 4.4, Step 3 – Foundation installation and scour protection installation. Specialist dredging vessel.	All assets every 5 years
Modifications to/replacement of J-tubes, boat landings and access ladders	Modifications to/ replacement of J-tubes, boat landings and access ladders e.g. during inter-array or export cable repair works.	Small Jack-up vessel, divers or ROV usually deployed from a DP2 vessel	1 every 5 years

Table 4.25: Operational and maintenance activities – WTGs

Activity	Description	Methodology	Frequency
Routine inspections	Internal and external inspections of the WTGs	Small team access by CTV	Rolling campaign, Percentage of site / year based on site size. Undertaken from site-based CTV's
Replacement of consumables	Replacement of consumables within the WTG (e.g. filters, oils, lubricants)	Small team access by CTV	Oils/filters annually. Gearbox oil minimum 5 yearly
Removal of marine growth/guano	Removal of marine growth and guano from access platforms	Pressure washer	one to two times per year
Minor repairs and replacements within the WTG	Minor repairs and replacements within the WTG (e.g. motors, pumps, small electric equipment, circuit breakers, fuses)	Small team access by CTV	As required
Major component replacement	Replacement of blades, gearboxes, transformers or generators	Jack-up vessel	14 Jack up events / annum
Painting	Application of paint or other coatings. Coatings on the blades and minor paint repairs to tower and nacelle	Technicians access by CTV	Yearly

Table 4.26: Operational and maintenance activities – OSPs

Activity	Description	Methodology	Frequency
Routine inspections	Internal and external inspections of the OSP	Technicians access by CTV	Monthly visual inspection – One day per structure
Removal of guano	Removal of guano from the OSP	Pressure washer	One to two times per year
Replacement of consumables and minor components	Replacement of consumables (e.g. oils, lubricants) and minor components within the OSP	Technicians access by CTV	Replacement both on condition and on time basis
Major component replacement	Replacement of transformers, switchgear etc.	Jack-up barge or CTV	One to two replacements every 10 years.
Painting	Application of paint or other coatings	Technicians access by CTV	One visit per year

Table 4.27: Operational and maintenance activities – inter-array cables

Activity	Description	Methodology	Frequency
Routine inspections	Inspections of the cable and any cable protection including at their entry into J-tubes on offshore structures	Survey vessel or USV/ROV	Annually
Geophysical surveys	Survey of seabed and any cable protection	Survey vessel(s) or USV	Every six months for first two years and annually thereafter
Inter-array cable repair	Repair, reburial and replacement of inter-array cable	Cable vessel of Jack Up	1 every 3 years
Inter-array cable maintenance	Removal of excess seabed sediment	Vessels include Cable, Dredging and Support vessel	300,000 m^3 every 5 years

Table 4.28: Operational and maintenance activities – interconnector cable

Activity	Description	Methodology	Frequency
Routine inspections	Inspections of the cable and any cable protection including at their entry into J-tubes on offshore structures	Survey vessel or USV/ROV	Annually
Geophysical surveys	Survey of seabed and cable protection (if present).	Survey vessel or USV	Every six months for first two years and annually thereafter
Interconnector cable repair	Repair and replacement of interconnector cable	Cable vessel	1 every 3 years
Interconnector cable maintenance	Reburial / stabilisation of exposed interconnector cable section or removal of excess seabed sediment	Vessels include Cable, Dredging and Support vessel	100,000 m^3 every 5 years (across the interconnector cable and export cable)

Table 4.29: Operational and maintenance activities – offshore export cables

Activity	Description	Methodology	Frequency
Routine inspections	Inspections of the cable and any cable protection including at their entry into J-tubes on offshore structures	Survey vessel or USV/ROV	Annually
Geophysical surveys	Survey of seabed and any cable protection	Survey vessel or USV	Every six months for first two years and annually thereafter
Offshore export cable repair	Repair, reburial and replacement of offshore export cable	Shallow barges, amphibious solutions, Jack-Up or DP2 Vessel	1 every 5 years
Offshore export cable maintenance	Reburial / stabilisation of exposed offshore export cable section or removal of excess seabed sediment	Shallow barges, offshore support vessel, dredging vessel or amphibious solutions	100,000 m^3 every 5 years (across the interconnector cable and export cable)

4.5.5 Maintenance vessels and helicopters

A range of maintenance vessels will be used over the lifetime of the Proposed Development. In addition, it is possible that helicopters (operating from a licenced airfield) will be used for crew and equipment transfers, and for emergency response. Maintenance vessel and helicopter numbers are presented in

4.5.5.1 Table 4.30. This provides an overview of the number of return trips per year during the operational and maintenance phase. Jack-up vessel footprint parameters for the operational and maintenance activities are as presented in Table 4.22.

Figure 4.31: Crew Transfer Vessel (Courtesy of Beatrice OWF)

Table 4.30: Anticipated Maintenance vessel and helicopter parameters

Parameter	Number on site at any given time	Return trips (per year)
Vessels		
Crew Transfer Vessels/Workboats	10	1,225
Jack-up vessels	3	9
Cable repair vessels	3	6
Service Operation Vessels (SOV))	3	40
SOV daughter craft	4	8
Survey vessels	3	21
Excavators, rock dumper or dredger	4	50
Total Vessels	**30**	**1359**
Helicopters		
Helicopters	2	485
Total Helicopters	**2**	**485**

4.6 Decommissioning

4.6.1 Health and Safety

4.6.1.1 All project personnel and contractors will be required to be fully compliant with their responsibilities as defined by:

- The Safety, Health and Welfare at Work Act 2005;
- The Safety, Health and Welfare at Work (General Application) Regulations 2007 (as amended);
- The Safety, Health and Welfare at Work (Construction) Regulations 2013 (as amended);
- The Safety, Health and Welfare at Work (Diving) Regulations 2018 (as amended);
- The Safety, Health and Welfare at Work (Reporting of Accidents and Dangerous Occurrences) Regulations 2016 (S.I. No. 370 of 2016);
- The European Communities (EC) Act 1972 and related Regulations;
- The Chemicals Act 2008 and The Safety, Health and Welfare at Work (Chemical Agents) Regulations 2001 (S.I. No. 619/2001) as amended;
- The Merchant Shipping Act 1894 & The Merchant Shipping (Investigation of Marine Casualties) Act, 2000;
- The HSA ACoPS and Guidance publications;
- Wind Energy Ireland ACoPS and Guidance publications;
- G+ Offshore Wind Health & Safety Association guidance documents;
- Code of practice for safe use of cranes BS 7121-1:2016; and
- Other applicable industry standards/best practice such as ISO, DNV, etc.

4.6.2 Removal of infrastructure

4.6.2.1 At the end of the operational lifetime of the Proposed Development, all monopiles will be cut 2 m below seabed level.

4.6.2.2 The scour protection system will remain in place to prevent seabed lowering in the vicinity of the monopile location.

4.6.2.3 The Developer will, before the expiration of its MAC Consent (December 2067) rehabilitate the consent area and any other part of the maritime area adversely affected by the Proposed Development and the application for Development Permission has attached to it a Rehabilitation Schedule (see Volume III, Appendix 4.1: Rehabilitation Schedule).

4.6.2.4 Table 4.31 sets out the anticipated decommissioning activities for the Proposed Development as set out in Volume III, Appendix 4.1: Rehabilitation Schedule. These activities have been assessed within the individual EIAR topic Chapter where applicable.

Table 4.31: Decommissioning activities

Component	Decommissioning strategy
WTG components (tower, nacelle, blades)	Removed
OSP Topside	Removed
Foundations (WTG / OSP)	To be cut 2 m below seabed level
Scour protection	To be left *in situ*
Inter-array, interconnector and offshore export cables	To be left *in situ*
Cable protection	To be left *in situ*

4.7 Advisory safety zones

4.7.1.1 During the construction and operational phases of the Proposed Development, it is standard practice to advise other mariners of clearance distances to be maintained around construction, operation and maintenance and decommissioning activities. A Vessel Management Plan (VMP) has been submitted with this Application (Volume III, Appendix 25.7).

4.8 Layout, lighting and marking

4.8.1 Layout

4.8.1.1 WTG layouts have been provided for the two WTG options for the purposes of the impact assessment. Within the EIAR, both layout options have been fully assessed.

4.8.1.2 The proposed layouts have been optimised through consideration of geological features, ground conditions, buildable constraints, such as available water depth for installation vessels, and environmental considerations, such as avoidance of archaeological exclusion zones.

4.8.2 Lighting and marking

4.8.2.1 The lighting and marking of WTG and OSP structures will be defined in consultation with the Commissioners of Irish Lights (CIL), Irish Coast Guard (IRCG), the Marine Survey Office (MSO), the Irish Aviation Authority (IAA) and the Department of Defence (DoD). All relevant notifications on lighting and marking will also be made to the authorities as appropriate prior to the commencement of operations.

4.8.2.2 Full details on lighting and marking can be found within the Lighting and Marking Plan (LMP) (Volume III, Appendix 25.6).

4.9 Factored-in measures

4.9.1.1 The Proposed Development includes a number of designed-in measures and management measures (or controls) which have been factored into the Proposed Development, and are committed to be delivered by the Developer as part of the Proposed Development. These factored-in measures are standard measures applied to offshore wind development, including lighting and marking of the Proposed Development, use of 'soft-starts' for piling operations etc, to reduce the potential for impacts. A summary of the factored-in measures are presented in Volume II, Chapter 25: Summary of Factored-in Measures, Mitigation and Monitoring. These measures are integrated into the description of development and have therefore been considered in the assessments presented in Chapters 6 to 20. This is in line with the Environment Protection Agency (EPA) guidance which states that 'in an EIAR it may be useful to describe avoidance measures that have been integrated into the project proposal' (EPA, 2022).

4.9.1.2 A number of consents management plans have been prepared to support the EIAR, and are provided as appendices to Chapter 25: Summary of Factored-in Measures, Mitigation and Monitoring. These plans will be further developed pre-construction, where required. These are summarised in Table 4.32. Final consents management plans will be submitted for approval prior to construction, as indicated in Table 4.32.

Table 4.32: Consents management plans

Reference	Consents Management Plan	Submission stage	Purpose
Volume III, Appendix 4.1	Rehabilitation Schedule	Submitted with the Application for the Proposed Development in line with provisions in the Maritime Area Planning Act 2021.	The Rehabilitation Schedule sets out the decommissioning strategy for the Proposed Development.
Volume III, Appendix 25.1	Environmental Management Plan (EMP) (including Marine Pollution Contingency Plan (MPCP) and Invasive Non-Indigenous Species Management Plan (INISMP))	Submitted with the Application for the Proposed Development	The EMP provides the overarching framework for environmental management during the construction and operational phases of the Proposed Development.
Volume III, Appendix 25.2	Marine Mammal Mitigation Plan (MMMP)	Submitted with the Application for the Proposed Development	The Marine Mammal Mitigation Plan includes details of the refined piling methodology and anticipated duration of piling, details of soft-start piling procedures and anticipated maximum piling energy required, and details of any mitigation and monitoring to be employed during piling.

Reference	Consents Management Plan	Submission stage	Purpose
Volume III, Appendix 25.3	Fisheries Management and Mitigation Strategy (FMMS)	Submitted with the Application for the Proposed Development	The FMMS provides an overview of the Developer's approach to fisheries liaison, including an outline of the measures proposed to be implemented to facilitate co-existence with commercial fishing and to minimise potential impacts.
Volume III, Appendix 25.5	Emergency Response and Cooperation Plan (ERCoP)	Submitted with the Application for the Proposed Development.	The ERCoP addresses emergency response and coordination arrangements for the construction, operational and maintenance and decommissioning phases of the Proposed Development.
Volume III, Appendix 25.6	Lighting and Marking Plan (LMP)	Submitted with the Application for the Proposed Development.	The LMP provides the aviation and navigational lighting and marking arrangements for the Proposed Development.
Volume III, Appendix 25.7	Vessel Management Plan (VMP)	Submitted with the Application for the Proposed Development	The VMP will set out the refined number, types and specification of vessels required during construction and operation, including vessel management procedures and marine coordination, and location of ports and vessel transit corridors.
Volume III, Appendix 25.8	Construction Noise Management Plan (CNMP)	Submitted with the Application for the Proposed Development	The Construction Noise Management Plan provides the airborne noise management measures to be implemented during the construction phase of the Proposed Development
Volume III, Appendix 25.9	Archaeological Management Plan (AMP)	Submitted with the Application for the Proposed Development	The AMP sets out the procedure for the recording and reporting of any archaeological material discovered during the construction phase.
Volume III, Appendix 25.10	Environmental Vessel Management Plan (EVMP)	Submitted with the Application for the Proposed Development	The objective of this EVMP document is to: • Minimise the risk of collision and injury to marine wildlife; • Minimise the risk of disturbance to marine wildlife; • Prescribe measures to be implemented by contractors conducting activities on behalf of the Developer in proximity to wildlife; and • Provide contractors with the procedures for reporting vessel collisions with marine wildlife.

4.10 Residues, emissions and waste

4.10.1.1 The EIA Directive requires a description of the expected residues and emissions and wastes arising from the Proposed Development and a description of the likely significant effects resulting from the emission of pollutants, noise, vibration, light, heat and radiation, the creation of nuisances, and the disposal and recovery of waste. Table 4.33 sets out where this is addressed in the EIAR.

Table 4.33: Residues and emissions

EIAR Requirement	How and where considered in the EIAR
Annex IV 1(d) Description of the project, including in particular: an estimate, by type and quantity, of expected residues and emissions (such as water, air, soil and subsoil pollution, noise, vibration, light, heat, radiation) and quantities and types of waste produced during the construction and operation phases; and **Annex IV 5(c)** description of the likely significant effects of the project on the environment resulting from, the emission of pollutants, noise, vibration, light, heat and radiation, the creation of nuisances, and the disposal and recovery of waste.	A RWMP has been submitted with the Application (Volume III, Appendix 25.1, Annex 5) The potential impacts associated with the emission of noise and vibration and associated nuisances are assessed in: • Chapter 8: Airborne Noise; • Volume III, Appendix 11.1: Underwater Noise Assessment; • Chapter 10: Fish, Shellfish and Sea Turtle Ecology; • Chapter 11: Marine Mammals. The potential impacts associated with emissions to air are addressed in: • Chapter 20: Air Quality and Climate. The potential impacts associated with the emissions of pollutants are assessed in: • Chapter 9: Benthic Subtidal and Intertidal Ecology, • Chapter 10: Fish, Shellfish and Sea Turtle Ecology; • Chapter 11: Marine Mammals. The potential impacts associated with the emission of light are assessed in: • Chapter 17: Seascape, Landscape and Visual Impact. The potential impacts associated with electromagnetic fields are assessed in: • Chapter 10: Fish, Shellfish and Sea Turtle Ecology; • Chapter 11: Marine Mammals. The emission of radiation is not applicable to the Proposed Development and is therefore not considered within the EIAR. The disposal and recovery of waste is considered in: • Volume III, Appendix 25.1: Environmental Management Plan.

4.11 Natural resources

4.11.1.1 The EIA Directive requires a description of the likely significant effects resulting from the use of natural resources. Table 4.34 sets out where this is addressed in the EIAR.

Table 4.34: Natural resources

EIAR Requirement	How and where considered in the EIAR
Annex IV 5(b) A description of the likely significant effects of the project on the environment resulting from, the use of natural resources, in particular land, soil, water and biodiversity, considering as far as possible the sustainable availability of these resources	The use of natural resources is outlined in this Chapter. Seabed disturbance (land and soil) is assessed in: • Chapter 6: Coastal Processes; • Chapter 9: Benthic Subtidal and Intertidal Ecology; • Chapter 10: Fish, Shellfish and Sea Turtle Ecology; • Chapter 11: Marine Mammals.

4.12 Risks of major accidents and natural disasters

4.12.1.1 A description of the risk of accidents is provided in Chapter 22: Major Accidents and Natural Disasters.

Annex 1 – WTG and OSP Coordinates

Table 4.35 Project Design Option 1 WTG and OSP Coordinates

ID	Easting (m) ITM IRENET95	Northing (m) ITM IRENET95	Latitude (dd) WGS84	Longitude (dd) WGS84
WTG01	739065.964	687060.180	52.916356	-5.932130
WTG02	741014.280	686789.648	52.913418	-5.903297
WTG03	740041.160	686925.476	52.914893	-5.917697
WTG04	738873.777	685581.454	52.903124	-5.935617
WTG05	741049.393	685610.393	52.902818	-5.903287
WTG06	740134.642	684967.499	52.897282	-5.917152
WTG07	739036.799	684511.679	52.893473	-5.933653
WTG08	740876.577	684305.703	52.891145	-5.906420
WTG09	740077.376	683482.206	52.883957	-5.918642
WTG10	738582.229	683367.474	52.883314	-5.940891
WTG11	740646.340	682660.842	52.876431	-5.910549
WTG12	739036.454	682452.420	52.874978	-5.934538
WTG13	739898.978	681764.400	52.868575	-5.922029
WTG14	738463.539	681408.939	52.865753	-5.943486
WTG15	740395.654	680854.502	52.860273	-5.915049
WTG16	738783.948	680405.475	52.856657	-5.939158
WTG17	739712.492	679832.772	52.851273	-5.925625
WTG18	738173.508	679381.037	52.847613	-5.948650
WTG19	740116.397	678843.680	52.842285	-5.920057
WTG20	738514.810	678349.094	52.838256	-5.944025
WTG21	737825.260	677459.189	52.830440	-5.954628
WTG22	739563.386	677756.421	52.832663	-5.928725
WTG23	738383.889	676593.795	52.822524	-5.946710
WTG24	739817.095	676690.132	52.823020	-5.925419

WTG25	737585.480	675745.115	52.815106	-5.958906
WTG26	739412.991	675534.006	52.812740	-5.931904
WTG27	738229.982	674976.187	52.808034	-5.949677
WTG28	739497.789	674403.436	52.802564	-5.931129
WTG29	737375.553	674169.767	52.801009	-5.962680
WTG30	737836.953	673180.297	52.792004	-5.956259
WTG31	739141.145	673335.406	52.793063	-5.936869
WTG32	737303.598	672159.848	52.782974	-5.964589
WTG33	739173.213	672269.254	52.783478	-5.936847
WTG34	737446.387	671001.149	52.772530	-5.962960
WTG35	738773.943	671086.490	52.772958	-5.943263
WTG36	736868.501	669970.066	52.763416	-5.971950
WTG37	738721.153	669861.314	52.761967	-5.944563
WTG38	737059.423	668848.529	52.753293	-5.969591
WTG39	738500.181	668689.335	52.751496	-5.948330
WTG40	736617.540	667767.360	52.743694	-5.976583
WTG41	738064.320	667531.557	52.741209	-5.955269
WTG42	736614.539	666578.790	52.733019	-5.977122
WTG43	737690.500	666410.690	52.731236	-5.961271
WTG44	736313.421	665502.138	52.723424	-5.982024
WTG45	737795.194	665256.263	52.720840	-5.960206
WTG46	736260.805	664294.042	52.712586	-5.983304
WTG47	737365.511	664198.376	52.711447	-5.967005
WTG48	735951.474	663185.921	52.702710	-5.988337
WTG49	737392.463	662959.998	52.700317	-5.967123
WTG50	735747.701	661844.682	52.690713	-5.991903

WTG51	736862.175	661853.732	52.690514	-5.975424
WTG52	737664.359	661320.102	52.685518	-5.963789
WTG53	735802.586	660787.736	52.681206	-5.991527
WTG54	736765.759	660567.843	52.678988	-5.977383
WTG55	739045.990	679105.889	52.844917	-5.935824
WTG56	737517.386	660312.199	52.676502	-5.966382
Northern OSP	739296.742	686284.672	52.909331	-5.929033
Southern OSP	736478.393	661288.018	52.685530	-5.981332

Table 4.36 Project Design Option 2 WTG and OSP Coordinates

ID	Easting (m) ITM IRENET95	Northing (m) ITM IRENET95	Latitude (dd) WGS84	Longitude (dd) WGS84
WTG01	739708.930	686969.992	52.915379	-5.922615
WTG02	741215.450	686773.450	52.913220	-5.900316
WTG03	740222.791	685650.263	52.903392	-5.915549
WTG04	738870.411	685526.287	52.902629	-5.935691
WTG05	740099.051	683572.846	52.884765	-5.918282
WTG06	740913.943	684579.259	52.893592	-5.905746
WTG07	738582.229	683367.474	52.883314	-5.940891
WTG08	740628.339	682578.611	52.875697	-5.910852
WTG09	739018.864	682283.106	52.873461	-5.934871
WTG10	739870.518	681500.670	52.866213	-5.922565
WTG11	739316.810	684440.423	52.892761	-5.929525
WTG12	740336.906	680432.093	52.856494	-5.916103
WTG13	738457.015	681108.588	52.863057	-5.943711
WTG14	739711.199	679195.513	52.845550	-5.925917
WTG15	738711.775	679906.456	52.852194	-5.940441
WTG16	739969.632	677966.587	52.834445	-5.922610
WTG17	738106.744	678738.888	52.841862	-5.949912
WTG18	738426.192	677588.229	52.831445	-5.945662
WTG19	739807.279	676626.857	52.822454	-5.925592
WTG20	737946.004	676421.559	52.821089	-5.953276
WTG21	739618.819	675300.085	52.810586	-5.928953
WTG22	738309.785	675326.026	52.811156	-5.948346
WTG23	739435.167	673976.393	52.798744	-5.932239
WTG24	737727.528	674190.614	52.801107	-5.957455

WTG25	739248.823	672611.013	52.786529	-5.935582
WTG26	737777.775	672944.125	52.789898	-5.957235
WTG27	738780.647	671378.003	52.775574	-5.943040
WTG28	737241.694	671765.304	52.779446	-5.965672
WTG29	738768.866	670123.947	52.764313	-5.943745
WTG30	737329.090	670500.016	52.768059	-5.964908
WTG31	738500.181	668689.335	52.751496	-5.948330
WTG32	736742.345	669323.879	52.757643	-5.974087
WTG33	738034.455	667466.429	52.740631	-5.955738
WTG34	736864.303	668092.032	52.746548	-5.972795
WTG35	737771.509	666188.917	52.729223	-5.960166
WTG36	736448.318	666847.338	52.735473	-5.979470
WTG37	736466.682	665547.210	52.723790	-5.979738
WTG38	737666.167	664895.601	52.717633	-5.962266
WTG39	736211.874	664299.533	52.712647	-5.984025
WTG40	737465.133	663503.948	52.705184	-5.965822
WTG41	735908.650	663012.253	52.701161	-5.989042
WTG42	739023.451	678404.043	52.838619	-5.936457
WTG43	735899.111	660549.218	52.679039	-5.990199
WTG44	736999.949	662248.457	52.694025	-5.973223
WTG45	737626.119	669034.995	52.754824	-5.961124
WTG46	735747.701	661844.682	52.690713	-5.991903
WTG47	736980.861	660862.037	52.681577	-5.974082
Northern OSP	739296.742	686284.672	52.909331	-5.929033
Southern OSP	736478.393	661288.018	52.685530	-5.981332