ossian

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Part 1: Introduction

Report to Inform Appropriate Assessment (RIAA)

2024

Version	Purpose of Document	Authored by	Reviewed by	Approved by
FINAL	Final	RPS	RPS	RPS

Approval for Issue		
For and on behalf of Ossian OWFL	Rich Morris	28 June 2024

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GLOSSARY

Term	Definition
Acoustic Deterrent Device (ADD)	A tool deployed to emit high-frequency sounds to deter marine mammals from areas where their presence may pose a risk, such as construction sites or fishing operations.
Adult-type	A seabird that appears to have adult plumage, but has not yet reached sexual maturity. For example, kittiwake show an adult-type plumage in their second or third year, but do not typically breed until four or five years of age (Coulson, 2019).
Ampullary Electroreceptors	Organs which can detect weak electric fields produced by other animals.
Annex I Habitat	A natural habitat type of community interest, defined in Annex I of the Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora (Habitats Directive). The designation of Special Areas of Conservation (SAC) is required in the United Kingdom (UK) to ensure the conservation of these habitats. The protection afforded to sites designated prior to European Union (EU) Exit persists in UK law.
Annex II Species	Animal or plant species of community interest, defined in Annex II of the Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora (Habitats Directive). The designation of Special Areas of Conservation (SAC) is required in the UK to ensure the conservation of these species. The protection afforded to sites designated prior to EU Exit persists in UK law.
Apparently Occupied Nests	A census method in the Seabird Monitoring Programme, where the colony count is expressed with nests as the unit.
Applicant	Ossian Offshore Wind Farm Ltd
Application	The consents and licences being sought by the Applicant for the Offshore Development of the Ossian Project. As a minimum these include: A Section 36 Consent application under the Electricity Act 1989 for the wind farm generating station; and A Marine Licence application under the Marine and Coastal Access Act 2009 for the offshore works (12 to 200 nm) in the Renewable Energy Zone (REZ) and under the Marine (Scotland) Act 2010 for the works within 12 nm of the coast.
Apportioning	A method that assigns unknown entities to known entities based on weighing factors. In this report, it refers to birds of unknown origin within the study area that are assigned to colonies based on distance to colony and colony size.
Appropriate Assessment	An assessment to determine the implications of a plan or project on a European site in view of that site’s conservation objectives. An Appropriate Assessment forms part of the Habitats Regulations Appraisal (HRA) and is required when a plan or project (either alone or in combination with other plans or projects) is likely to have a significant effect on a European site.
Appropriate AssessmentAppropriate Assessment	An assessment to determine the implications of a plan or project on a European site in view of that site’s conservation objectives. An Appropriate Assessment forms part of the Habitats Regulations Appraisal (HRA) and is required when a plan or project (either alone or in combination with other plans or projects) is likely to have a significant effect on a European site.An assessment to determine the implications of a plan or project on a European site in view of that site’s conservation objectives. An Appropriate Assessment forms part of the Habitats Regulations Appraisal (HRA) and is required when a plan or project (either alone or in combination with other plans or projects) is likely to have a significant effect on a European site.
Array	Offshore components of Ossian, including infrastructure such as wind turbines and associated foundations, moorings and anchors, offshore substation platforms, and inter-array/interconnector cables.
Array	Offshore components of Ossian, including infrastructure such as wind turbines and associated foundations, moorings and anchors, Offshore Substation Platforms (OSPs), and inter-array/interconnector cables.
B Field	Magnetic field.
Baleen Whales	A group of marine mammals characterised by the presence of baleen plates in their mouths, which they use to filter small organisms such as krill and plankton from the water for feeding.
Berwick Bank Offshore Wind Farm	The offshore wind farm which is to be located within the Agreement for Lease area for Berwick Bank Offshore Wind Farm (formerly Seagreen 2 Offshore Wind Farm) and the Agreement for Lease area for Marr Bank (formerly Seagreen 3 Offshore Wind Farm) - together now referred to as Berwick Bank Offshore Wind Farm.
Biologically Defined Minimum Population Scales	Seasonal subdivisions of bird population size. The rationale behind these subdivisions is that the likely origin of a bird in a particular location depends on the time of year.
Breeding Adults	Adults at breeding age proportion of a population.
Bycatch	Fish and seabirds that are caught which are retained and sold but are not the target species for the fishery.
Capital Breeder	A species that primarily relies on stored energy reserves, such as fat, to support reproduction and survival during periods of food scarcity or limited foraging opportunities.
Click	A short, high frequency sound pulse emitted by certain marine mammals, particularly toothed whales such as dolphins and sperm whales, used for echo location, communication, and navigation underwater.
Compensation/Compensatory Measures	If an Adverse Effect on the Integrity (AEoI) on a designated site is determined during the Appropriate Assessment, compensatory measures for the impacted site (and relevant features) will be required. The term compensatory measures is not defined in the Habitats Regulations. Compensatory measures are however, considered to comprise those measures which are independent of the project, including any associated mitigation measures, and are intended to offset the adverse effects of the plan or project so that the overall ecological coherence of the national site network is maintained.
Competent Authority	The term derives from the Habitats Regulations and relates to the exercise of the functions and duties under those Regulations. Competent authorities are defined in the Habitat Regulations as including "any Minister, government department, public or statutory undertaker, public body of any description or person holding a public office". In the context of a plan or project, the competent authority is the authority with the power or duty to determine whether or not the proposal can proceed (SNH, 2014).
Connectivity	The degree to which ecological habitats or populations are interconnected and functionally linked, influencing the exchange of genetic material, movement of organisms, and overall resilience of ecosystems.
Counterfactual of Growth Rate	The ratio of impacted to unimpacted annual growth rate.
Counterfactual of Population Size	The ratio of impacted to unimpacted population size.
Cumulative Effects	As applied in the Environmental Impact Assessment Report (EIA Report), the combined effect of the Ossian Project with the effects from a number of different projects, on the same single receptor/resource.

Term	Definition
Cumulative Impact	As applied in the Environmental Impact Assessment Report (EIA Report), impacts that result from changes caused by other past, present or reasonably foreseeable actions together with the Ossian Project.
Deflagration	A rapid chemical reaction characterised by subsonic propagation of flame front through a combustible substance, such as an explosive material or flammable gas, typically resulting in the release of heat and pressure.
Demographic Parameter	A factor that determines the population size.
Design Envelope	A description of the range of possible elements that make up the Ossian Project design options under consideration, as set out in detail in the project description. This envelope is used to define Ossian Project for Environmental Impact Assessment (EIA) purposes when the exact engineering parameters are not yet known.
Designed In Measures	Measures included in the design of a proposed development that help to reduce the impact of the development.
Development Area	The Development Area (Offshore) and Development Area (Onshore) combined.
Diadromous Fish	A species which migrates between freshwater and seawater as part of its life cycle.
E Field	An electrical field which physically surrounds electrically charged particles.
Echolocation	The biological process by which certain animals emit high-frequency sound waves and interpret the returning echoes to perceive their surroundings, typically used for navigation, locating prey, and communicating in aquatic environments.
EIA Regulations	The Marine Works (Environmental Impact Assessment) Regulations 2007 and the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017.
Ensonification	To fill an area with sound.
Environmental Impact Assessment (EIA)	Assessment of the likely significant effects of a plan, project or activity on the environment, in accordance with the EIA Regulations.
Environmental Impact Assessment (EIA) Regulations	The term used to refer to The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 and The Marine Works (Environmental Impact Assessment) Regulations 2007.
EU Exit	The withdrawal of the UK from the EU.
EU Exit Regulations	The EU (Withdrawal) Act 2018, as amended as by the EU (Withdrawal Agreement) Act 2020, gives Ministers in the UK Government and in the devolved administrations of Northern Ireland, Scotland and Wales, powers to make subordinate legislation amending laws that otherwise would not work appropriately as a result of the UK leaving EU, or to implement the Withdrawal Agreement.
EU Exit	The withdrawal of the UK from the EU. The withdrawal of the United Kingdom from the European Union (EU).
European Site	A Special Area of Conservation (SAC), or candidate SAC, (cSAC), a Special Protection Area (SPA), a site listed as a site of community importance (SCI), or, as per Scottish Planning Policy (SPP), a possible SAC (pSAC) or potential SPA (pSPA). All Ramsar sites are also Natura 2000 sites and are protected under the relevant statutory regimes' (Scottish Government, 2014) as confirmed by Scottish Government (2020). A SAC, or candidate SAC, (cSAC), a Special Protection Area (SPA), a site listed as a Site of Community Importance (SCI), or, as per Scottish Planning Policy (SPP), a possible SAC (pSAC) or potential SPA (pSPA).
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Foundation	The load carrying support structure for the wind turbine generator tower or OSP topside. The foundation is the part of the structure from the interfacing flange with the wind turbine tower or topside-foundation interface, down to/below mudline. This includes any secondary steel items associated with the structure.
Ghost Fishing	The phenomenon where lost or discarded fishing gear, such as nets or traps, continues to capture and kill marine organisms, contributing to marine debris and ecosystem degradation.
Gillnets	Fishing nets designed to capture fish by entangling them in the mesh, typically suspended vertically in the water to intercept swimming fish.
Habitat	The environment that a plant or animal lives in.
Habitats Appraisal	A process required by the Habitats Regulations of identifying likely significant effects of a plan or project on a European site and (where likely significant effects are predicted or cannot be discounted) carrying out an appropriate assessment to ascertain whether the plan or project will adversely affect the integrity of the European site. If adverse effects on integrity cannot be ruled out, the latter stages of Regulations the process require consideration of the derogation provisions in the Habitats Regulations.
Habitats Directive	The Habitats Directive is the short name for European Union Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora. The Directive led to the establishing of European sites and setting out how they should be protected, it also extends to other topics such as European protected species.
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Habitats Regulations	The Conservation (Natural Habitats, &c.) Regulations 1994, the Conservation of Habitats and Species Regulations 2017 and the Conservation of Offshore Marine Habitats and Species 2017.
Habitats Regulations Appraisal	A process required by the Habitats Regulations of identifying likely significant effects of a plan or project on a European site and (where likely significant effects are predicted or cannot be discounted) carrying out an appropriate assessment to ascertain whether the plan or project will adversely affect the integrity of the European site. If adverse effects on integrity cannot be ruled out, the latter stages of Regulations the process require consideration of the derogation provisions in the Habitats Regulations.

Term	Definition
Hammer Energy	The amount of energy available to be transmitted from the hammer to the pile during piling.
Haul Out	When seals (or similar marine mammals) come out of the water to spend time on land.
High Order	Detonation of unexploded ordnance as a clearance method.
Impulsive Noise	Noise which is very brief and with a high rise time and high peak level compared to the energy averaged noise level.
In-combination Effect	The combined effect of the Array in-combination with the effects from a number of different plans or projects on the same feature/receptor as defined by the HRA Regulations.
Income Breeder	A species that relies primarily on current food intake rather than stored energy reserves for reproduction and survival.
Inter-array Cables	Cables connecting wind turbines to each other and to OSPs.
Interconnector Cable	Cable connecting OSPs to each other.
Leslie Matrix	Discrete, age-structured model of population growth used in population ecology. This matrix is often used to describe the growth of populations (and their population age distribution) in which a population is closed to migration, growing in an unlimited environment, and where only one sex, usually female, is considered.
Likely Significant Effect (LSE[1])	With respect to the Electricity Works (EIA (Scotland) Regulations 2017 and The Marine Works (EIA) Regulations 2007, a significant effect that may reasonably be predicted as a consequence of a plan or project, on the receiving environment.
Likely Significant Effect (LSE[2])	In HRA terms, an LSE is any effect that may reasonably be predicted as a consequence of a plan or project that may affect the conservation objectives of the features for which the European site was designated but excluding trivial or inconsequential effects. An LSE is one that cannot be ruled out on the basis of objective information. A 'significant' effect is a test of whether a plan or project could undermine the site's conservation objectives. With respective to Habitat Regulation Appraisals, any effect that may reasonably be predicted as a consequence of a plan or project that may affect the conservation objectives of the features for which the European site was designated but excluding trivial or inconsequential effects. A likely effect is one that cannot be ruled out on the basis of objective information. A 'significant' effect is a test of whether a plan or project could undermine the site's conservation objectives (SNH, 2014).
Low Order	Use of techniques such as deflagration to clear unexploded ordnance (UXOs) without resulting in a high order explosion, leading to lower noise levels.
Lowest Astronomical Tide	The highest level of the sea surface with respect to the land.
Management Unit	Management units (MUs) for marine mammals in UK waters that provide an indication of the spatial scales at which impacts of plans and projects alone, cumulatively and in combination, need to be assessed for the key cetacean species in UK waters, with consistency across the UK. For cetaceans, these MUs are defined by the Inter-Agency Marine Mammal Working Group (IAMMWG). For seal species (harbour and grey seal), seal MUs are defined by the Special Committee on Seals (SCOS).
Marine Directorate	Organisation whose purpose is to manage Scotland's seas (formerly known as Marine Scotland).
Marine Licence	Licence granted under either the Marine and Coastal Access Act 2009 or the Marine (Scotland) Act 2010 in Scottish territorial waters.
Maximum Design Scenario (MDS)	The maximum design parameters of the Array considered to be a worst case for any given assessment but within the range of the Project Description Envelope (PDE).
Micrositing	Movement of infrastructure (for example, wind turbines and OSPs) by small distances within the overall wind farm layout.
Migration	Seasonal movement of animals from one region to another.
Mysticetes	Large whales from the taxonomic group Mysticeti that feed using a filtering mechanism comprised of baleen plates.
National Site Network (NSN)	The network of European Sites in the UK. Prior to the UK's exit from the EU and the coming into force of the Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019 these sites formed part of the EU ecological network knows as "Natura 2000".
Natura 2000 Site	Nature conservation sites in Europe designated under the Habitats or Birds Directives.
NatureScot	Formally called Scottish Natural Heritage (SNH), NatureScot is an executive non-departmental public body of the Scottish Government responsible for the country's natural heritage, especially its natural, genetic and scenic diversity.
nepva	R package designed to undertake population viability analysis (PVA) for seabird species.
Noise	Vibration of molecules in a liquid or gas.
Non-Impulsive (or Continuous) Noise	Noise which is either continuous or intermittent but without the characteristics described for impulsive noise.
Odontocetes	A marine mammal of the suborder Odontoceti, characterised by an asymmetrical skull, a single blowhole, and rows of teeth, feeding primarily on fish, squid, and crustaceans.
Offshore Export Cable	High voltage cables used for exporting power from the OSPs to an onshore landfall.
Offshore Substation Platform (OSP)	Offshore substation platform used to convert and transfer the energy collected by the wind turbines to landfall.
Ornithology	A branch of zoology that concerns the study of birds.
Ossian	All components of the offshore wind farm, including the Array, the Proposed offshore export cable corridor(s), and Proposed onshore transmission infrastructure (comprising the Proposed onshore export cable corridor(s) and Proposed onshore converter station at the Proposed landfall location(s))
Ossian Offshore Wind Farm Limited (OWFL)	Joint venture between SSE Renewables (SSER), Copenhagen Infrastructure Partners (CIP) and Marubeni Corporation (Marubeni).
Particle Motion	Movement of particles within the water or sediment.
Permanent Threshold Shift (PTS)	Change (deterioration) in hearing of an animal which does not recover with time.
Phocid	Seals of the Family Phocidae, represented in the UK by two species: grey seal and harbour seal.
Phototaxis	The response of birds to nocturnal lighting resulting in disorientation and attraction
Pingers	Acoustic devices emitting high-frequency sounds designed to deter marine mammals from areas of potential harm, such as fishing nets or underwater construction sites, reducing the risk of bycatch or disturbance.

Term	Definition
Pinniped	Marine mammals that have front and rear flippers and live in the ocean but can come to land for long periods of time. This group includes seals, sea lions and walruses.
Population Viability Analysis (PVA)	The process of determining the probability that a population will persist over a specified time period.
Productivity	The annual population estimate of number of chicks fledged per pair.
Project Design Envelope (PDE)	Project parameters that are assessed as part of the Environmental Impact Assessment (EIA) for the Array
Proposed Landfall Location(s)	Where the Proposed offshore export cable(s) carrying power from the Array are brought ashore to connect the offshore and onshore infrastructure.
Proposed Offshore Export Cable Corridor(s)	Area within which the offshore export cable(s) will be located between the Array and MHWS.
Proposed Onshore Converter Station(s)	The onshore electricity transmission buildings encompassing a high voltage direct current (HVDC) converter substation comprising of converter buildings, HV internal and/or external equipment.
Proposed Onshore Export Cable Corridor(s)	Proposed Onshore Export Cable Corridor(s) Area within which the Proposed onshore export cable(s) will be located between the Proposed landfall location(s) at MLWS and the Proposed onshore converter substation(s).
Proposed Onshore Transmission Infrastructure	Term used to refer collectively to the Proposed onshore export cable corridor(s) and Proposed onshore converter station(s).
Ramsar Site	Wetlands of international importance designated under the Ramsar Convention.
Received Level	The noise level of the acoustic signal recorded (or modelled) at a given location.
Receptor	Any physical, biological or anthropogenic element of the environment that may be affected or impacted by the Ossian Project. For the purposes of the current report, such receptors are designated features of an SAC, SPA or Ramsar (or supporting habitats or species of those) and are addressed in groups, specifically benthic ecology, marine mammals, migratory fish (including freshwater pearl mussel) and ornithology .
Report to Inform Appropriate Assessment (RIAA)	The information that the Competent Authority needs to inform an Appropriate Assessment at Stage 2 of the HRA process.
RPS	RPS Energy Consultants Ltd.
Sabbatical	In some seabird populations subject to extreme environmental stresses, some breeders within the population will take sabbatical years where they do not breed for that particular year.
Sand Wave	Sand waves are a low ridge of sand formed through the action of the wind or water (through waves or tidal currents).
Scare Charges	Small explosive charges used as a soft-start to high-order disposal of UXO, incrementally increased in size (and subsequent sound level) to provide an auditory deterrent and reduce the risk of injury to marine mammals (and other marine megafauna). Often used following deployment of Acoustic Deterrent Device (ADD) to provide an initial, lower-sound energy deterrent.
Scoping	An early part of the EIA process by which the key potential significant impacts of the Ossian Project are identified, and methodologies identified for how these should be assessed. This process gives the relevant authorities and key consultees opportunity to comment and define the scope and level of detail to be provided as part of the EIA Report – which can also then be tailored through the consultation process.
Scoping Opinion	A report presenting the written opinion of the Scottish Ministers as to the scope and level of detail of information to be provided in the Environmental Impact Assessment (EIA) for a development.
Scottish Government	The devolved government of Scotland.
Scottish Ministers	The Scottish Government consists of Scottish Ministers.
ScotWind	Programme which will lease areas of the seabed around Scotland for wind farm developments.
SeaBORD	A tool that estimates the cost to individual seabirds, in terms of changes in adult survival and productivity, of displacement and barrier effects resulting from offshore renewable developments.
Secondary Mitigation	Actions that will require further activity in order to achieve the anticipated outcome. These may be imposed as part of the planning consent, or through inclusion in the EIA Report.
Service Operation Vessel (SOV)	Field-based vessel to ensure that offshore wind turbines operate safely and to accommodate personnel.
Site Boundary	The offshore area in which the Array will be constructed.
Site of Community Importance (SCI)	Defined in the Habitats Directive as a site which, in the biogeographical region or regions to which it belongs, contributes significantly to the maintenance or restoration at a favourable conservation status of a natural habitat type in Annex I, or of a species in Annex II, of the Habitats Directive and may also contribute significantly to the coherence of the Natura 2000 network. The site may also contribute significantly to the maintenance of biological diversity within the biogeographic region or regions concerned. For animal species ranging over wide areas, SCIs shall correspond to the places within the natural range of such species which represent the physical or biological factors essential to their life and reproduction.
Snagging	When part of a vessel or gear gets stuck on a feature beneath the surface of the water.
Soft Start (Geophysical Surveys)	The gradual build up in airgun power in uniform stages from a low energy start up to the required higher energy levels. This is specific to the survey and/or equipment type.
Soft Start (UXO Clearance)	A sequence of small charges deployed prior to the detonation of the UXO.
Soft Start and Ramp Up (Piling)	The gradual increase in hammer energy and strike rate from approximately 15% of the maximum hammer energy at the beginning of the piling sequence, before energy input is ‘ramped up’ (increased) at pre-defined intervals to required higher levels.
Sound Exposure Level	Metric used to measure the cumulative noise energy to which a receiver receptor is exposed.
Sound Pressure	Measure of the resultant change in pressure due to vibration of particles in a fluid or gas.
Spar-Buoys	Floating structures typically anchored to the seafloor, used to support marine equipment or infrastructure such as sensors, navigation aid, or offshore platforms.
Special Area of Conservation (SAC)	A site designation specified in the Habitats Directive (Council Directive 92/43/EEC). Each site is designated for one or more of the habitats and species listed in the Directive. The Directive requires that a management plan be prepared and implemented for each SAC to ensure the favourable conservation status of the habitats or species for which it was designated. In combination with SPAs, these sites contribute to the ‘Natura 2000’ or ‘European’ Sites network.

Term	Definition
Special Protected Area (SPA)	A site designation under the European Union Directive on the Conservation of Wild Birds. Under the Directive, Member States of the European Union (EU) have a duty to safeguard the habitats of migratory birds and certain particularly threatened species.
Species	A group of living organisms consisting of similar individuals capable of exchanging genes or interbreeding.
Stochasticity	The lack of any predictable order or plan.
Survival Rate	The probability of an individual to survive from one breeding season to the next.
Telemetry	The use of animal-borne sensors to collect and record information on the animals or the environment. In the case of marine mammals this may include data on the location, movement, behaviour or physiological state of the individual, and information on water temperature, salinity, or light levels.
Temporary Threshold Shift (TTS)	Change (deterioration) in hearing of an animal which recovers after some time.
The Applicant	Ossian Offshore Wind Farm Limited (Ossian OWFL).
Unexploded Ordnance (UXO)	Explosive weapons that did not explode when they were employed and still pose a risk of detonation.
United Kingdom (UK)	Political unit consisting of England, Northern Ireland, Scotland and Wales.
Wind Turbine	A machine that converts kinetic energy from the wind into electricity comprising the following main parts: nacelle, hub, blades, tower and drivetrain.

ACRONYMS

Acronym	Description
2D	Two Dimensional
AC	Alternating Current
ACAP	Agreement on the Conservation of Albatrosses and Petrels
ADD	Acoustic Deterrent Device
AEOI	Adverse Effect on Integrity
AfL	Agreement for Lease
AOB	Apparently Occupied Burrows
AON	Apparently Occupied Nests (bird census)
AOS	Apparently Occupied Sites
AOT	Apparently Occupied Territories
ASA	Acoustical Society of America
BDMPS	Biologically Defined Minimum Population Scale
B-Field	Magnetic Field
BP-EnBW	British Petroleum Energie Baden-Württemberg
BTO	British Trust for Ornithology
CAA	Civil Aviation Authority
CAP	Civil Aviation Publication
CAP	Conservation Advice Package
CBRA	Cable Burial Risk Assessment
CEA	Cumualtive Effects Assessment
CGR	Counterfactual of Growth Rate
CIP	Copenhagen Infrastructure Partners
CJEU	The Court of Justice of the European Union
CMA	Conservation and Management Advice
CMACS	Centre for Marine and Coastal Studies
CPS	Counterfactual of Population Size
CPT	Cone Penetration Test
CRH	Collision Risk Height
CRM	Collision Risk Modelling
cSAC	Candidate Special Areas of Conservation
CSV	Construction Support Vessel
CTV	Crew Transfer Vessels
DAS	Digital Aerial Survey
DC	Direct Current
DEA	Drag Embedment Anchor
Defra	Department for Environment, Food and Rural Affairs
DESNZ	Department for Energy Security & Net Zero
DP[1]	Dynamic Positioning
DP[2]	Decommissioning Programme
DSV	Dive Support Vessel
EDR	Effective Deterrence Range
E-Field	Electrical Field
EIA	Environmental Impact Assessment
EMF	Electromagnetic Field
EMODnet	European Marine Observation and Data Network
EMP	Environmental Management Plan
EPS	European Protected Species
ESO	Electricity System Operator Limited
EU	European Union
FCS	Favourable Conservation Status
FFC	Flamborough and Filey Coast

Acronym	Description
FHD	Flight Height Distribution
GBS	Gravity Based Structures
GIS	Geographic Information System
HF	High Frequency
HND	Holistic Network Design
HNDFUE	National Grid Holistic Network Design Follow Up Exercise
HPAI	Highly Pathogenic Avian Influenza
HRA	Habitats Regulations Appraisal
HTV	Heavy Transport Vessel
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
IAMMWG	Inter Agency Marine Mammal Working Group
ICES	International Council for the Exploration of the Sea
iE-Field	Induced Electrical Field
IND	Number of individuals counted (bird census)
INNS	Invasive Non Native Species
INNSMP	Invasive Non-Native Species Management Plan
INTOG	Innovation and Targeted Oil and Gas
iPCoD	Interim Population Consequences of Disturbance
IRC	Intermediate Reactive Compensation
IROPI	Imperative Reasons of Overriding Public Interest
IUCN	International Union for the Conservation of Nature and Natural Resources
JNCC	Joint Nature Conservation Committee
LAT	Lowest Astronomical Tide
LDP	Local Development Plan

Acronym	Description
LMP	Lighting and Marking Plan
LSE[1]	Likely Significant Effect (as defined by the EIA Regulations)
LSE[2]	Likely Significant Effect (as defined by the Habitat Regulations)
LTM	Long Term Mooring
MAG	Magnetometer
MBES	Multibeam Echosounder
MCA	Maritime and Coastguard Agency
mCRM	Migration Collision Risk Modelling
MD-LOT	Marine Directorate – Licensing Operations Team
MDS	Maximum Design Scenario
MD-SED	Marine Directorate – Science, Evidence, Data and Digital
MGN	Marine Guidance Note
MHWS	Mean High Water Springs
MLWS	Mean Low Water Springs
MMMP	Marine Mammal Mitigation Plan
MMO[1]	Marine Mammal Observer
MOD	Ministry of Defence
MPCP	Marine Pollution Contingency Plan
MRE	Marine Renewable Energy
MU	Management Unit
NAS	Noise Abatement System
nepva	Natural England Population Viability Analysis
NEQ	Net Explosive Quantity
NG	National Grid
NLB	Northern Lighthouse Board
NMFS	National Marine Fisheries Service

Acronym	Description
NO AEOI	Adverse Effect on Integrity
NRW	Natural Resources Wales
NSN	National Site Network
NSVMP	Navigational Safety and Vessel Management Plan
NtMs	Notice to Mariners
OCIMP	Ossian Compensation Implementation and Monitoring Plan
OEM	Original Equipment Manufacturer
OSP	Offshore Substation Platform
OSPAR	Oslo Paris Convention
Ossian OWFL	Ossian Offshore Wind farm Limited
OTNR	Offshore Transmission Network Review
PAM	Passive Acoustic Monitoring
PCW	Phocid Carnivores in Water
PDE	Project Design Envelope
PEMP	Project Environmental Monitoring Programme
PLGR	Pre Lay Grapnel Run
PO	Plan Option
p-p	Peak to Peak
PS	Piling Strategy
pSAC	Possible Special Area of Conservation
pSPA	Potential Special Protection Areas
PTS	Permanent Threshold Shift
PVA	Population Viability Analysis
RIAA	Report to Inform Appropriate Assessment
ROV	Remotely Operated Vehicle
RSPB	Royal Society for the Protection of Birds

Acronym	Description
SAC	Special Area of Conservation
SAR	Search and Rescue
SBP	Sub-bottom Profiler
SCANS	Small Cetaceans in European Atlantic Waters and the North Sea
SCI	Sites of Community Importance
SCO	Site of Community Importance
SCOS	Special Committee on Seals
sCRM	Stochastic Collision Risk Model
SD	Standard Deviation
SE	Standard Error
SEL	Sound Exposure Level
SEL_{cum}	Cumulative Sound Exposure Level
SEL_{ss}	Sound Exposure Level Single Strike
SEPA	Scottish Environmental Protection Agency
SEPLA	Suction Embedded Plate Anchor
SFF	Scottish Fishermen's Federation
SMU	Seal Management Unit
SNCB	Statutory Nature Conservation Body
SNH	Scottish Natural Heritage
SOSSMAT	Strategic Ornithological Support Services Migration Assessment Tool
SOV	Service Operation Vessel
SPA	Special Protection Area
SPL	Sound Pressure Level
SPL_{pk}	Peak Sound Pressure Level
SPMP	Scour Protection Management Plan
SSER	SSE Renewables Limited

Acronym	Description
SSS	Side-scan Sonar
SSSI	Sites of Special Scientific Interest
SWMP	Site Waste Management Plan
TADS	Thermal Animal Detection System
TCSNP	Transitional Centralised Strategic Network Plan
TLP	Tension Leg Platform
TTS	Temporary Threshold Shift
UHRS	Ultra High-Resolution Seismic
UK	United Kingdom
UKCEH	UK Centre for Ecology and Hydrology
US	United States
USV	Uncrewed Surface Vessel
UV	Ultraviolet
UXO	Unexploded Ordnance
VHF	Very High Frequency
VLA	Vertical Loading Anchor
WFD	Water Framework Directive
WSDOT	Washington State Department of Transport
WWT	Wildfowl & Wetlands Trust
ZoI	Zone of Influence

UNITS

Unit	Description
AOB	Apparently Occupied Burrows – Census Unit for Breeding Puffin
AON	Apparently Occupied Nest – Census Unit for Breeding Kittiwake and Gannet
cm	Centimetre (distance)
m^3	Cubic metres
dB	Decibel (noise)
°	Degrees
Gauss	Gauss (magnetic flux density)
Ha	Hectare (area)
Hz	Hertz (frequency)
Hrs	Hours
kg	Kilograms (mass)
kHz	Kilohertz (frequency)
kJ	Kilojoule (energy)
km	Kilometres (distance)
kPa	Kilopascal (pressure)
kV	Kilovolt (potential difference)
knots	Knots (speed)
MW	Megawatt (power)
m	Metre (distance)
m/h	Metres per hour
m/s	Metres per second (speed)
µPa	Micro Pascal (10^{-6}) (pressure)
µT	Microtesla (magnetic flux)
µV/m	Microvolts per metre (electric field strength)
mG	MilliGauss (magnetic flux density)

Unit	Description
mg/L	Milligrams per litre (concentration)
mm	Millimetre (distance)
mT	Millitesla (magnetic flux)
nm	Nautical mile (distance)
IND	Number of Individuals Counted at the Colony – Census Unit for Breeding Guillemot and Razorbill
%	Percentage
lb	Pound (mass)
rms	Root Mean Square
rpm	Revolutions per minute
s	Second (time)
knots	Speed (nautical miles per hour)
km^2	Square kilometres (area)
m^2	Square metres (area)
SD	Standard deviation
v/m	Volts per metre (electric field strength)

1. INTRODUCTION

1.1. OVERVIEW OF THE ARRAY

1. In January 2022, Ossian Offshore Wind Farm Limited (Ossian OWFL) (hereafter referred to as the ‘Applicant’) was awarded an Option to Lease Agreement to develop Ossian, an offshore wind farm within the E1 East Plan Option (PO) Area as part of the ScotWind Leasing Round. This project (hereafter referred to as ‘Ossian’) is a joint venture between SSE Renewables Limited (SSER), Copenhagen Infrastructure Partners (CIP) and Marubeni Corporation.

2. Ossian is a proposed offshore wind farm located off the east coast of Scotland, approximately 80 km south-east from the nearest point of Aberdeen (see Figure 1.1). The Array is located within the site boundary and includes the offshore infrastructure required to generate electricity including the wind turbines (including their floating substructures, as well as the mooring and anchoring systems), the fixed bottom Offshore Substation Platforms (OSPs), and inter-array and interconnector cables. The Array is the subject of this Report to Inform Appropriate Assessment (RIAA).

3. In March 2024, as part of the ongoing National Grid Holistic Network Design Follow Up Exercise (HNDFUE), National Grid Electricity System Operator (ESO) published their Transitional Centralised Strategic Network Plan (TCSNP) in the ‘Beyond 2030’ report (National Grid ESO, 2024). Beyond 2030 sets out National Grid ESO’s recommendations to achieve a decarbonised electricity network.

4. The proposed grid design aims to facilitate transmission of a number of offshore wind farm projects. Within this publication it was confirmed that Ossian will be offered two grid connection locations in Lincolnshire, one at Weston Marsh and one at the Lincolnshire Connection Node.

5. Onshore and offshore route optioneering work has now commenced to determine appropriate offshore and onshore export cable corridors, and locations for proposed substation locations. As part of this Ossian has initiated engagement with key stakeholders in Lincolnshire to inform early design and site selection considerations

6. Therefore, the Proposed offshore export cable corridor(s) and Proposed onshore transmission infrastructure (comprising the Proposed onshore export cable corridor(s), Proposed onshore converter station and the Proposed landfall location(s)) will be subject to separate consent applications in due course, including separate Likely Significant Effects (LSE[2]) Screening Reports and associated RIAAs. In-combination effects of the Proposed offshore export cable corridor(s) and Proposed onshore transmission infrastructure will be considered insofar as practicable on the basis of available information in the in-combination assessment forming part of the RIAA.

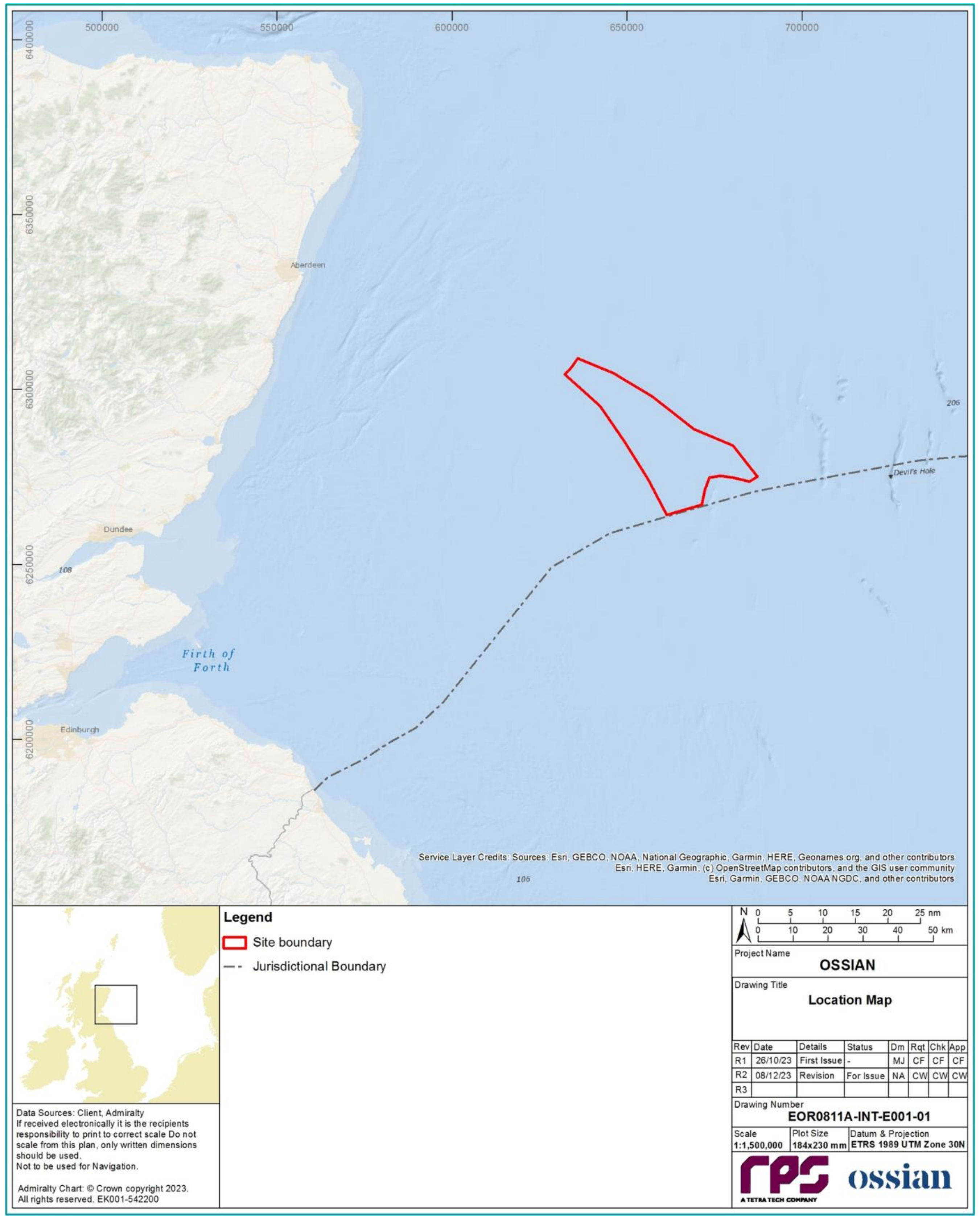

Figure 1.1: Location of the Site Boundary, where the Array will be Located

1.2. HABITATS REGULATIONS APPRAISAL OVERVIEW

7. Following the departure of the United Kingdom (UK) from the European Union (EU) on 31 December 2020 (EU Exit), the UK is no longer an EU Member State. Notwithstanding, the Habitats Regulations, which implemented the EU Habitats Directive (92/43/EEC) in the UK,, continues to form the legislative basis for the domestic HRA regime. The changes implemented by EU Exit Regulations have implemented only minor changes to the HRA regime compared to before EU Exit. These changes are not considered to have material implications on the requirement or process for a HRA in relation to the Array.

8. The Habitats Regulations require that an Appropriate Assessment must be carried out on all plans and projects that are likely to have a significant effect on a European site. European sites include Special Areas of Conservation (SACs), candidate SACs (cSACs), Sites of Community Importance (SCI), Special Protection Areas (SPAs) and, as a matter of policy (Scottish Government, 2020), possible SACs (pSACs), potential SPAs (pSPAs) and Ramsar Sites (listed under the Ramsar Convention on Wetlands of International Importance – where also designated as a European site).

9. In this RIAA, and in accordance with EU Exit guidance issued by the Scottish Government, the term “European site” has been retained to refer to the above sites protected in European Member States, Scotland and the rest of the UK (Scottish Government, 2020). However, where these sites are located in the UK, they now form part of the National Site Network. Post EU-Exit, the Habitats Regulations continue to refer to Annexes I and II of the Habitats Directive and Annex I of the Birds Directive and as such, reference is made to the annexes of the Habitats and Birds Directives in this report.

1.3. PURPOSE OF THIS RIAA

10. This RIAA has been prepared by RPS and Niras on behalf of the Applicant to support the HRA of the Array in the determination of the implications upon European sites. This RIAA builds upon the Array HRA Stage One LSE^2 Screening Report (appendix 1A), completed in March 2023, and the subsequent advice from stakeholders received in the Ossian Array Scoping Opinion from May to June 2023 (Marine Directorate – Licensing Operations Team (MD-LOT, 2023)). This RIAA represents Stage Two of the HRA process and assesses the LSE^{2}s of the Array as they relate to the integrity of the relevant European sites. This RIAA will provide the competent authority with the information required to undertake a HRA Stage Two Appropriate Assessment (see section 2.3 for more detail on the HRA process).

11. The scope of this RIAA covers all relevant European sites and relevant qualifying interest features where LSE^{2}s have been identified due to impacts arising from the Array. This includes both ‘offshore’ European site and features (seaward of Mean High Water Springs (MHWS) and ‘onshore’ European sites (landward of Mean Low Water Springs (MLWS) where appropriate.

1.4. PROGRESS TO DATE

12. A Array HRA Stage One LSE^2 Screening Report has been produced for the Array in accordance with the Habitats Regulations (appendix 1A). The purpose of the LSE^2 Screening exercise was to determine whether the Array could result in a LSE^2 on any European site, with reference to its conservation objectives. The LSE^2 Screening exercise determined that LSEs from impacts associated with the Array could not be discounted at Stage One, and European sites where LSE^{2}s could not be ruled out were carried forward to Stage Two.

13. The Array HRA Stage One LSE^2 Screening Report (appendix 1A) presents the LSE^2 Screening exercise, the purpose of which is summarised below:

- Identification of the relevant European sites which may include features (e.g. Annex I habitats, ornithology features, Annex II diadromous fish, and Annex II marine mammals) which may be sensitive or vulnerable to potential impacts arising from all phases of the Array;
- Consideration of the features of relevant European sites and identification of those which are not considered likely to be at risk of significant effects arising from the array, either alone or in-combination with other plans and projects, so that they could be eliminated from further assessment within the HRA process;
- Consideration of features of relevant European sites and identification of those which are considered likely to be at risk of significant effects so that they could be carried forwards to HRA Stage Two Appropriate Assessment in this RIAA; and
- Consideration of which of the potential impacts arising from the Array (alone or in-combination with other plans and projects) were likely to result in LSE^{2}s to features of European sites and which impacts could be eliminated from further assessment in the HRA process[1].

14. The HRA process is iterative. Since the Array HRA Stage One LSE^2 Screening Report was shared with consultees in March 2023, aspects of the design of the Array have evolved (see section 4). Consultation representation and advice with respect to the Array HRA Stage One LSE^2 Screening Report were received along with the Ossian Array Scoping Opinion in June 2023 (MD-LOT, 2023). The potential implications of design changes on the LSE^2 Screening exercise have been considered and a summary of the LSE^2 Screening exercise for the Array is provided in the relevant sections of this RIAA (i.e. Part 2 for SACs and Part 3 for SPAs). Any changes to the LSE^2 Screening outcomes presented in the Array HRA Stage One LSE^2 Screening Report (appendix 1A) have been made as a result of consultation are highlighted in the relevant Parts of the RIAA, with all consultation to date presented, where relevant to SACs and SPAs, in Part 2 and Part 3, respectively.

1.5. STRUCTURE OF THIS RIAA

15. For clarity and ease of navigation, this RIAA has been structured and reported in the below ‘Parts’, as follows:

- Executive Summary;
- Part 1 (this document): Introduction ;
- Part 2: SAC assessments; and
- Part 3: SPA and Ramsar site assessments.

1.6. STRUCTURE OF THIS DOCUMENT

16. As stated in paragraph 15, this document constitutes Part 1 of the RIAA, and provides an introduction to the Array and the HRA process. This document is structured as follows:

- Section 1: Introduction (this section) which describes the Array and establishes the requirement for, the purpose, and the structure of the RIAA;
- Section 2: The HRA Process, which sets out the process, principles, tests, and guidance applied to the RIAA;
- Section 3: Consultation, which provides a summary of the relevant consultation undertaken to date; and
- Section 4: Information on the Array, which provides information about the design of the Array relevant to the RIAA, including relevant maximum design parameters and any design updates since the Array HRA Stage One LSE^2 Screening.

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[1] Recognising the potential for non-significant effects to accumulate or act in-combination.

2. THE HRA PROCESS

2.1. LEGISLATIVE CONTEXT

17. The EU Habitats Directive (92/43/EEC) on the conservation of natural habitats and of wild fauna and flora, protects habitats and species of European nature conservation importance. Together with Council Directive (2009/147/EC) on the conservation of wild birds (the ‘Birds Directive’), the Habitats Directive establishes a network of internationally important sites, designated for their ecological status. This network of designated sites is comprised of the following:

- SACS, which are designated under the Habitats Directive and promote the protection of flora, fauna and habitats; and
- SPAs, which are designated under the Birds Directive in order to protect rare, vulnerable and migratory birds.

18. SACs are designated for the conservation of Annex I habitats (including priority habitat types which are in danger of disappearing) and Annex II species (including diadromous fish and marine mammals). SPAs are designated for the conservation of Annex I birds and other regularly occurring migratory birds and their habitats. The habitats and species that a European site is designated for are referred to as its ‘qualifying interest features’. The conservation objectives of a European site are set for each qualifying interest feature of each site. and aim to ensure that a qualifying habitat or species is maintained or restored in a favourable conservation status (FCS) .

19. As introduced in section 1.2, although the UK is no longer an EU Member State, the Habitats Directive as implemented by the Habitats Regulations continue to provide the legislative backdrop for HRA in the UK. The HRA process implemented under the Habitats Regulations continues to apply (subject to minor changes effected by the EU Exit Regulations) and the UK is currently bound by HRA judgments handed down by The Court of Justice of the European Union (CJEU) prior to 31 December 2020.

20. In addition to sites formally defined as European sites in the Habitats Regulations, Scottish Planning Policy acknowledges that Ramsar sites are afforded the same protection where they are also designated as a European site (Scottish Government, 2020). The Scottish Government also states that authorities should afford the same level of protection to proposed SACs and SPAs (i.e. sites which have been approved by Scottish Ministers for formal consultation but which have not yet been designated) as they do to sites which have been designated (Scottish Government, 2020).

21. Under the Habitats Regulations, before granting approval (i.e. planning permissions, licenses and consents) for a development that is likely to have a significant effect on a European site, an Appropriate Assessment must be made by the Competent Authority. This assesses the proposed plan or project’s potential for adverse effects on integrity of the site in view of that European site’s conservation objectives.

2.2. EUROPEAN SITES (POST EU EXIT)

22. The National Site Network is comprised of European sites in the UK that already existed (i.e. were established under the Habitats or Birds Directives) on 31 December 2020 (or proposed to the European Commission before that date) and any new sites designated under the Habitats Regulations under an amended designation process.

2.3. THE HRA PROCESS

23. The HRA process is generally recognised as a progressive, multi-stage process built around the wording of Articles 6(3) and 6(4) of the Habitats Directive, with the outcome at each stage defining the requirement for, and scope of the next. These stages are summarised in Figure 2.1.

24. Article 6(3) of the Habitats Directive requires that: “*Any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site’s conservation objectives. In the light of the conclusions of the assessment of the implications for the site and subject to the provisions of paragraph 4, the competent national authorities shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the site concerned and if appropriate, after having obtained the opinion of the general public*”.

25. Therefore, Article 6(3) provides a two-stage process:

- the first stage, which involves a screening for LSE[2]; and
- the second stage arises where, having screened the Array, the relevant competent authority determines that an Appropriate Assessment is required, in which case it must then carry out that Appropriate Assessment (Figure 2.1).

26. This RIAA is concerned with the second stage of the process (i.e. the Appropriate Assessment), which seeks to assess and decide whether a plan or project, alone or in combination with other projects or plans, will have an adverse effect on the integrity of a European site. This RIAA also summarises the conclusions of the Array HRA Stage One LSE[2] Screening Report (appendix 1A), and updates made to the screening conclusions, since this was published in March 2023, to account for feedback received from stakeholders during consultation.

27. Article 6(4) is the third stage of the HRA process which provides for a derogation from the strict protection of European sites in certain circumstances. Where the RIAA has concluded that an adverse effect on the integrity of a European site cannot be excluded, the project will proceed to the third stage. The third stage derogation process comprises three tests which must be passed in sequence for consent to be granted (see Figure 2.1):

- Test 1: Assessment of Alternative Solutions – there are no feasible alternative solutions that would be less damaging or avoid damage to the site.
- Test 2: Assessment of Imperative Reasons of Overriding Public Interest (IROPI) - the proposal needs to be carried out for imperative reasons of overriding public interest; and
- Test 3: The necessary compensation measures can be secured.

28. The documents prepared regarding Test 3 of the Derogation, i.e. the proposed compensation measures in relation to the Array are presented as part of the Derogation Case which includes:

- Appendix 1: Ecological Evidence Report;
- Appendix 2: Compensation Plan;
- Appendix 2, Annex A: Compensation Stakeholder Consultation; and
- Appendix 3: Compensation Implementation and Monitoring Plan.

29. The EU-Exit Regulations establish management objectives for the National Site Network. These are called the network objectives. The objectives in relation to the National Site Network are to:

- maintain or restore Annexed habitats and species listed in the Habitats Directive to FCS; and
- contribute to ensuring the survival and reproduction of certain species of wild birds in their area of distribution and to maintaining their populations at levels which correspond to ecological, scientific and cultural requirements, while taking account of economic and recreational requirements.

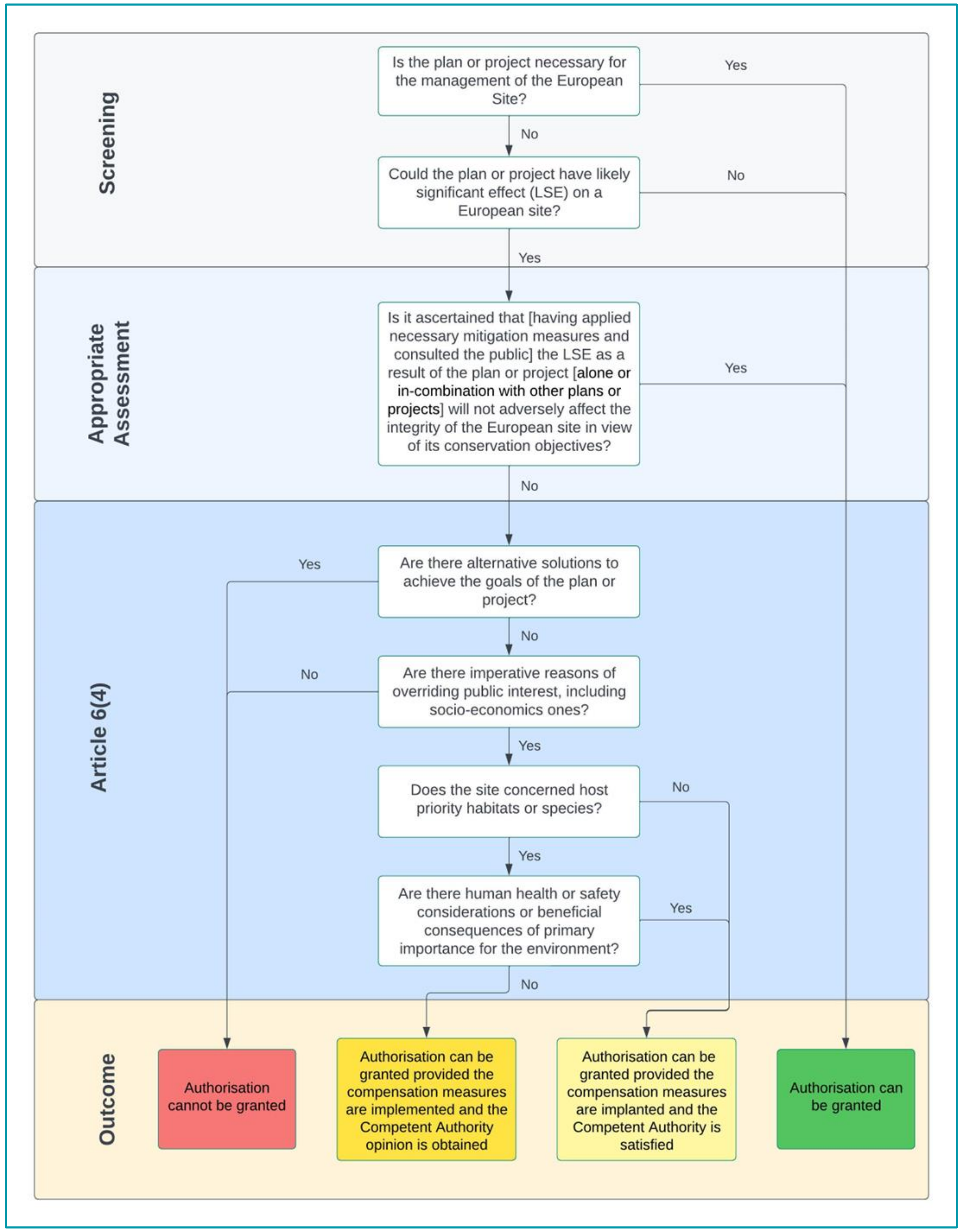

Figure 2.1: **Stages in the HRA Process (adapted from the European Commission (2021))**

2.4. GUIDANCE

30. Following the UK's departure from the EU, reference to EC guidance on the interpretation of HRA concepts continues to apply. The EU Exit Habitats Regulations in Scotland state that in the longer term, guidance may be updated and/or new guidance may be produced, to replace guidance by the European Commission (Scottish Government, 2020). However, at the time of writing, existing guidance continues to apply and should still be used. Therefore, this RIAA is undertaken in accordance with the following guidance documents:

- "Habitats Regulations Appraisal (HRA) of Local Development Plans (LDPs) - Guidance for planning authorities in Scotland" (NatureScot, 2023);
- "European Site Casework Guidance: How to consider plans and projects affecting Special Areas of Conservation (SACs) and Special Protection Areas (SPAs)" (NatureScot, 2022);
- "The Habitats Regulations Assessment Handbook" (Tyldesley *et al.*, 2021);
- "Assessment of plans and projects in relation to Natura 2000 sites - Methodological guidance on Article 6(3) and (4) of the Habitats Directive 92/43/EEC" (European Commission, 2021);
- "Guidance document on wind energy developments and EU nature legislation" (European Commission, 2020);
- "Guidance Note: The handling of mitigation in Habitats Regulations Appraisal – the People Over Wind CJEU judgement" (Scottish National Heritage (SNH, now NatureScot) (2019));
- "Managing Natura 2000 sites. The provisions of Article 6 of the 'Habitats' Directive 92/43/EEC" (European Commission, 2018);
- "Habitats Regulations Appraisal (HRA) on the Firth of Forth A Guide for developers and regulators" (SNH (2016));
- "Marine Scotland Consenting and Licensing Guidance for Offshore Wind, Wave and Tidal Energy Applications" (Scottish Government, 2018);
- "HRA Advice Sheet 1 (Version 1) - Aligning Development Planning procedures with Habitats Regulations Appraisal requirements" (Scottish Government, 2012);
- "Guidance document on Article 6(4) of the 'Habitats Directive' 92/43/EE. Clarification on the Concepts of: Alternative Solutions, Imperative Reasons of Overriding Public Interest, Compensatory Measures, Overall Coherence, Opinion of the Commission" (European Commission, 2007); and
- "Nature and Biodiversity Cases Ruling of the European Court of Justice" (European Commission, 2006).

31. This RIAA has also been undertaken in accordance with the following publications that seek to explain the changes made to the Habitats Regulations from 1 January 2021:

- "EU Exit: The Habitats Regulations in Scotland" (Scottish Government, 2020);
- "Department for Environment, Food and Rural Affairs (Defra) Policy Paper - Changes to the Habitats Regulations 2017" (Defra, 2021); and
- "Habitats Regulations Assessments: protecting a European site" (Defra *et al.*, 2023)

32. The Statutory Nature Conservation Bodies (SNCBs) have produced conservation advice for European sites under their statutory remit. This conservation advice provides information on sites and features and guidance on how to achieve FCS. Conservation advice is discussed further, where relevant, in Part 2 and Part 3 of the RIAA.

2.5. RELEVANT CASE LAW

33. The case law that defines key assessment parameters (such as the definition of "integrity" and "significance", the consideration of *ex situ* effects and the consideration of mitigation measures) are discussed in the sections 2.5.1 to 2.5.3.

2.5.1. CONSIDERATION OF MITIGATION MEASURES

34. In case C-323/17 'People Over Wind and Sweetman v Coillte Teoranta' (April 2018) (Sweetman 2), the CJEU ruled that mitigation measures could not be taken into account at the screening stage. This judgment

was taken into account in undertaking the screening exercise for the Array and no mitigation measures (secondary or additional mitigation) were considered in the HRA Stage One LSE[2] Screening Report (appendix 1A).

2.5.2. ADVERSE EFFECTS ON THE INTEGRITY OF EUROPEAN SITES

35. The European Commission's guidance on managing Natura 2000 sites (2018) advises that the purpose of the Appropriate Assessment is to assess the implications of the plan or project in respect of a European site's conservation objectives, either individually or in combination with other plans or projects. The conclusions should enable the relevant competent authorities to ascertain whether the plan or project will adversely affect the integrity of the European site concerned. The focus of the Appropriate Assessment is therefore specifically on the species and/or the habitats for which the European site is designated.

36. The European Commission (2018) also emphasises the importance of using the best scientific knowledge when carrying out the Appropriate Assessment in order to enable the competent authorities to conclude with certainty that there will be no adverse effects on the integrity of the European site. This guidance notes that it is at the time of the decision authorising implementation of the project that there must be no reasonable scientific doubt remaining as to the absence of adverse effects on the integrity of the European site in question.

37. The CJEU confirmed in its ruling in Case C-258/11 that "*Article 6(3) of the Habitats Directive must be interpreted as meaning that a plan or project not directly connected with or necessary to the management of a site will adversely affect the integrity of that site if it is liable to prevent the lasting preservation of the constitutive characteristics of the site that are connected to the presence of a priority natural habitat whose conservation was the objective justifying the designation of the site in the list of SCIs, in accordance with the directive. The precautionary principle should be applied for the purposes of that appraisal*". The European Commission (2018) advises that the logic of such an interpretation would also be relevant to non-priority habitat types and to habitats of species.

38. The "*integrity of the site*" can be usefully defined as the coherent sum of the European site's ecological structure, function and ecological processes, across its whole area, which enables it to sustain the habitats, complex of habitats and/or populations of species for which the site is designated (European Commission, 2018). In Sweetman, Ireland, Attorney General, Minister for the Environment, Heritage and Local Government v An Bord Pleanála) (C-258/11) (Sweetman 1) it was determined that the ecological structure and function of a European site would be adversely affected with reference to the site's overall ecological functions and "*the lasting preservation of the constitutive characteristics of the site*." In a dynamic ecological context, it can also be considered as having the sense of resilience and ability to evolve in ways that are favourable to conservation (European Commission, 2018).

39. The European Commission (2018) notes that if the competent authority considers the mitigation measures are sufficient to avoid the adverse effects on site integrity identified in the Appropriate Assessment, they will become an integral part of the specification of the final plan or project or may be listed as a condition for project approval.

40. The European Commission (2020) advises that it is for the competent authorities, in the light of the conclusions made in the Appropriate Assessment on the implications of a plan or project for the European site concerned, to approve the plan or project. This decision can only be taken after they have made certain that the plan or project will not adversely affect the integrity of the site. That is the case where no reasonable scientific doubt remains as to the absence of such effects.

41. The European Commission (2020) also reaffirms that the authorisation criterion laid down in the second sentence of Article 6(3) of the Habitats Directive integrates the precautionary principle and makes it possible to effectively prevent the European sites from suffering adverse effects on their integrity as the result of the plans or projects. A less stringent authorisation criterion could not as effectively ensure the fulfilment of the objective of site protection intended under that provision. The onus is therefore on demonstrating the absence of adverse effects rather than their presence, reflecting the precautionary principle. It follows that the Appropriate Assessment must be sufficiently detailed and reasoned to demonstrate the absence of adverse effects, in light of the best scientific knowledge in the field.

42. In accordance with the decision of the CJEU in the Waddenzee (C-127-02), the measure of significance is made against the conservation objectives for which the European sites were designated.

2.5.3. CONSIDERATION OF *EX SITU* EFFECTS

43. The European Commission (2018) advises that Article 6(3) and Article 6(4) safeguards be applied to European sites subject to LSE[2]s from any development pressures, including those which are external to those European site(s).

44. The CJEU developed this point when it issued a ruling in case C-461/17 ("Brian Holohan and Others v An Bord Pleanála") that determined inter alia that Article 6(3) of Directive 92/43/EEC must be interpreted as meaning that an Appropriate Assessment must on the one hand, catalogue the entirety of habitat types and species for which a European site is protected, and, on the other, identify and examine both the implications of the proposed project for the species present on that site, and for which that site has not been listed, and the implications for habitat types and species to be found outside the boundaries of that site, provided that those implications are liable to affect its conservation objectives.

45. In that regard, consideration has been given at Screening (and where necessary, based on the outcomes of that Screening) in this RIAA to implications for habitats and species located both inside and outside of the European sites with reference to their conservation objectives, where effects upon those habitats and/or species are liable to affect the conservation objectives of the sites concerned.

3. CONSULTATION TO DATE

46. To date, consultation has been undertaken with relevant statutory stakeholders during key stages of the pre-application phase of the Array.

47. Consultation was undertaken with MD-LOT, NatureScot, and Natural England, alongside various other stakeholders, such as the Scottish Fishermen's Federation (SFF) and the Scottish Environmental Protection Agency (SEPA). Consultation feedback was received in November 2022, following information presented at the Array EIA Scoping Workshop. Following this, consultation representation and advice with respect to the Array HRA Stage One LSE[2] Screening Report were received along with the Ossian Array Scoping Opinion in June 2023 (MD-LOT, 2023). Consultation applicable to this RIAA has been taken into consideration, as appropriate, and is summarised, where relevant to SACs and SPAs, in Part 2 and Part 3 of this RIAA, respectively.

48. Based on the outcomes of the Array HRA Stage One LSE[2] Screening Report, no potential significant transboundary effects, either alone or in-combination, were predicted for the Array. Therefore, no transboundary consultation has been carried out with respect to this RIAA.

4. INFORMATION ON THE ARRAY

49. This section provides an outline of the Array and describes the activities likely to be associated with the construction, operation and maintenance, and decommissioning phases of the Array. It summarises the design and components of the Array infrastructure, based on conceptual design information and refinement of the Array parameters.

4.1. PROJECT DESIGN ENVELOPE

50. The Project Design Envelope (PDE) approach (also known as the 'Rochdale Envelope') (Scottish Government, 2022) has been followed by the Applicant, meaning that parameters for the Array included in this section present the maximum extent of the design in order to assess the maximum adverse effects of the Array. The 'maximum design envelope' (e.g. the Maximum Design Scenario (MDS)) presented in this section defines the maximum range of design parameters. Through the MDS approach the Applicant has determined the maximum impacts that could occur for given receptor groups, selecting these from within the range of the 'maximum design envelope' to define the MDS for that receptor group and potential impact pathway. As a result, the predicted effects assessed in Part 2 and Part 3 of this RIAA will be no greater for any alternative parameters .

51. The final detailed design will be further developed post-consent, as additional information becomes available from site investigations and commercial availability of technologies. It should be noted that the final detailed design for the Array will be within the PDE parameters presented in this section. This is a standard approach for large scale energy projects such as the Array.

52. The PDE approach allows for flexibility in the final Array design to account for supply chain constraints and selection of the most appropriate technology for the site and conditions, while allowing for an appropriate assessment of the Array on designated sites in view of their conservation objectives, as reported within the RIAA. The PDE presents a range of potential parameter values up to and including the maximum Array design parameters.

53. The Array PDE has been designed to allow for sufficient flexibility in the final project design options and further refinement during the final design stage, where the full details of a project are not known at the point of Application submission. For each of the impacts assessed within Part 2 and Part 3 of this RIAA, the PDE has been reviewed and the MDS has been identified from the range of potential options for each parameter. The MDS approach allows the Applicant to retain some flexibility in the final design of the Array and associated offshore infrastructure, but certain maximum parameters are set and are assessed in this RIAA.

54. The MDSs, as per the PDE, are presented in Part 2 and Part 3 of this RIAA. Anything less than that set out within this section and assessed within Part 2 and Part 3 of this RIAA will have a lesser impact.

55. The PDE describes a range of parameters that apply to a Project technology design scenario (e.g. largest wind turbine option). In this example, wind turbine size and wind turbine number are inherently correlated so if larger wind turbines are selected, fewer wind turbines are likely to be required. Therefore, each design parameter set out in this section is not considered independently. The PDE has been used to develop the MDS for each impact pathway in order to determine the parameters (or combination of parameters) which are likely to result in the maximum effect (e.g. the MDS) on a particular receptor. It should be noted, however, that the largest parameters set out in this section will not necessarily comprise the MDS for any given receptor group and each of the impacts assessed in Part 2 and Part 3 of the RIAA.

56. Since the submission of the Array EIA Scoping Report (Ossian OWFL, 2023) and the Array HRA Stage One LSE[2] Screening Report (appendix 1A), the Applicant has developed and refined the PDE for the RIAA using the results of early engineering studies and information gained through consultation with stakeholders. A full description of PDE refinements for the Array is provided within volume 1, chapter 4 of the Array EIA Report, however, a summary is provided in Table 4.1.

Table 4.1: Overview of PDE Refinements for the Array

Parameter	PDE Presented Within the Array EIA Scoping Report (March 2023)	PDE Presented Within the RIAA (June 2024)
Maximum number of floating wind turbines	Up to 270	Up to 265
Maximum blade tip height Above Lowest Astronomical Tide (LAT) (m)	399	399
Maximum hub height above LAT (m)	224	224
Maximum rotor diameter for largest wind turbine option in PDE (m)	350	350
Minimum blade clearance above LAT (m)	Noted this would be confirmed post-Scoping	36 m
Anchoring systems considered	Driven piles, suction piles, Drag Embedment Anchors (DEAs), Vertical Loading Anchors (VLAs), Suction Embedded Plate Anchors (SEPLAs), gravity anchors, drilled and grouted anchors, dynamically installed anchors	Driven piles, DEAs and suction anchors. Emerging technologies may be considered where they have potential to increase efficiency of installation and operation and reduce environmental effects
Wind turbine foundation type	Semi submersible; Tension Leg Platform (TLP)	Semi submersible; TLP
Maximum number of Offshore Substation Platforms (OSPs)	Up to six OSPs (floating or fixed)	Two options for OSPs (fixed foundation only): either up to 6 large OSPs or up to 3 large OSPs and up to 12 small OSPs
Maximum number of legs per OSP foundation	Up to eight legs per foundation	12 legs per foundation for large OSPs and 6 legs per foundation for small OSPs
Maximum diameter of driven piles for OSP foundations (m)	4	4.5 m diameter driven piles required for large OSPs and 3 m diameter driven piles required for small OSPs
Maximum inter-array cable length (km)	Up to 1,515 km (maximum total cable length incorporating both inter-array and interconnector cables)	1,261
Maximum interconnector cable length (km)		236

57. The HRA process includes derogation provisions which may require the Applicant to provide measures to compensate for the adverse effects on the integrity of European sites resulting from the Array, either alone, or in combination with other plans and projects. The Applicant has undertaken an appraisal of the potential impacts of the compensatory measures proposed (without prejudice to the HRA to be conducted by the competent authority). An EIA Likely Significant Effect (LSE[1]) and HRA LSE[2] Assessment has been undertaken on the proposed compensation measures for the Array and are provided as part of the Application.

4.2. LOCATION AND SITE INFORMATION

58. The Array will be located within the site boundary, located off the east coast of Scotland, approximately 80 km south-east of Aberdeen from the nearest point, and comprising an area of approximately 859 km^2 (Figure 1.1).

59. In January 2022, as part of the ScotWind Leasing Round, the Applicant was awarded an Option to Lease Agreement to develop Ossian, an offshore wind farm project within the E1 PO Area (see volume 1, chapter 4 of the Array EIA Report for further information on the site selection process).

4.2.1. WATER DEPTHS AND SEABED WITHIN THE ARRAY

60. A geophysical survey covering the area within the site boundary was conducted between March 2022 and July 2022 to collect geophysical and bathymetric data. Across the site boundary, the maximum water depth

was recorded at 88.7 m LAT, and the shallowest area was recorded at 63.8 m LAT. The seabed across the site boundary slopes gently downwards in an approximately north-west to south-east direction (Ocean Infinity, 2022).

61. Seabed sediments within the site boundary are significantly dominated by deep circalittoral sand, with one area of limited extent comprised of deep circalittoral coarse sediment within the northern part of the site (European Marine Observation and Data Network (EMODnet), 2023). The geophysical survey indicated that the seabed comprises mainly of sand, with areas of gravel in the west of the site boundary (Ocean Infinity, 2022). The seabed within the site boundary is generally flat, with mega-ripples and sand waves observed in the north-west of the site. Furrows were observed occasionally across the site boundary, more commonly in the west (Ocean Infinity, 2022).

62. Further details of the bathymetry and seabed composition are presented within volume 2, chapters 7 and 8 of the Array EIA Report.

4.3. ARRAY INFRASTRUCTURE

4.3.1. OVERVIEW

63. The main components of the Array will include:

- up to 265 floating wind turbines (each comprising a tower section, nacelle, hub and three rotor blades) and associated floating foundations;
- mooring and anchoring systems for each floating foundation;
- connectors and ancillaries for mooring and anchoring systems, including buoyancy elements and clump weights;
- up to six large OSPs, or up to three large OSPs and up to 12 small OSPs with fixed jacket foundations;
- scour protection for wind turbine anchoring systems;
- scour protection for small and large OSP fixed foundations as required;
- a network of dynamic/static inter-array cabling linking the individual floating wind turbines to OSPs, and interconnector cables between OSPs (approximately 1,261 km of inter-array cabling and 236 km of interconnector cabling); and
- discrete condition monitoring equipment (such as sensors, cameras, dataloggers etc.), as required for safe and efficient operation of the Array infrastructure.

4.3.2. FLOATING WIND TURBINES

64. The Array will comprise up to 265 floating wind turbines, however, the final number of wind turbines will be dependent on the capacity of individual wind turbines used, as well as the environmental and engineering survey results.

65. A range of wind turbine parameters are provided which account for varying generating capacities of wind turbines considered within the PDE. This allows a degree of flexibility to account for anticipated technological developments in the future whilst allowing the MDS to be defined for each potential impact within the RIAA. Therefore, the wind turbine parameters presented in this section, and for which consent is being sought, represent the maximum wind turbine parameters as presented in the PDE, such as maximum rotor blade diameter and maximum blade tip height.

66. Table 4.2 presents the range of parameters considered for the wind turbines and considers both the maximum number of wind turbines and the largest wind turbines described within the PDE. Therefore, the parameters in combination do not represent a realistic design scenario, rather they represent the most adverse parameters of a range of wind turbine models that may be available post-consent/at the time of the Array construction.

67. Floating wind turbines will comprise a tower section, nacelle, hub and three rotor blades, and will be attached to a floating foundation. A schematic of a typical floating wind turbine is presented in Figure 4.1.

68. The maximum rotor blade diameter will be no greater than 350 m, with a maximum blade tip height of up to 399 m above LAT and minimum blade clearance of 36 m above LAT. The hub height will be no greater than 224 m above LAT. The Applicant will develop and agree a scheme for wind turbine lighting and navigation marking with the relevant consultees post-consent decision for approval by Scottish Ministers after consultation with appropriate consultees.

69. The wind turbine layout will be developed to effectively make use of the available wind resource and suitability of seabed conditions, whilst ensuring that the environmental effects and potential impacts on other marine users (e.g., fisheries and shipping routes) are reduced. If required by consent conditions, confirmation of the final layout of the wind turbines will occur at the final design stage (post-consent) in consultation with relevant stakeholders and submitted to the MD-LOT for approval. Indicative array layouts are presented in Figure 4.2 and Figure 4.3 for 265 wind turbine locations plus 15 OSP locations and 130 wind turbine locations plus 15 OSP locations, respectively. The OSPs could be sited at any of the locations shown in the figures and will be determined at the final design stage (post-consent). Further information on OSPs is provided in section 4.3.4.

Table 4.2: Maximum Design Envelope: Floating Wind Turbines

Parameter	Value
Maximum number of floating wind turbines	Up to 265
Minimum blade clearance above LAT (m)	36
Maximum blade tip height above LAT (m)	399
Maximum hub height above LAT (m)	224
Maximum rotor diameter for smallest wind turbine option in PDE (m)	236
Maximum rotor diameter for largest wind turbine option in PDE (m)	350
Maximum number of blades	3
Minimum wind turbine spacing (m)[2]	1,000 in all directions
Maximum wind turbine spacing (m)[3]	4,200 in all directions

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[2] Minimum distance measured from rotors of one wind turbine to the rotors of another wind turbine.

[3] Maximum distance measured from rotors of one wind turbine to the rotors of another wind turbine.

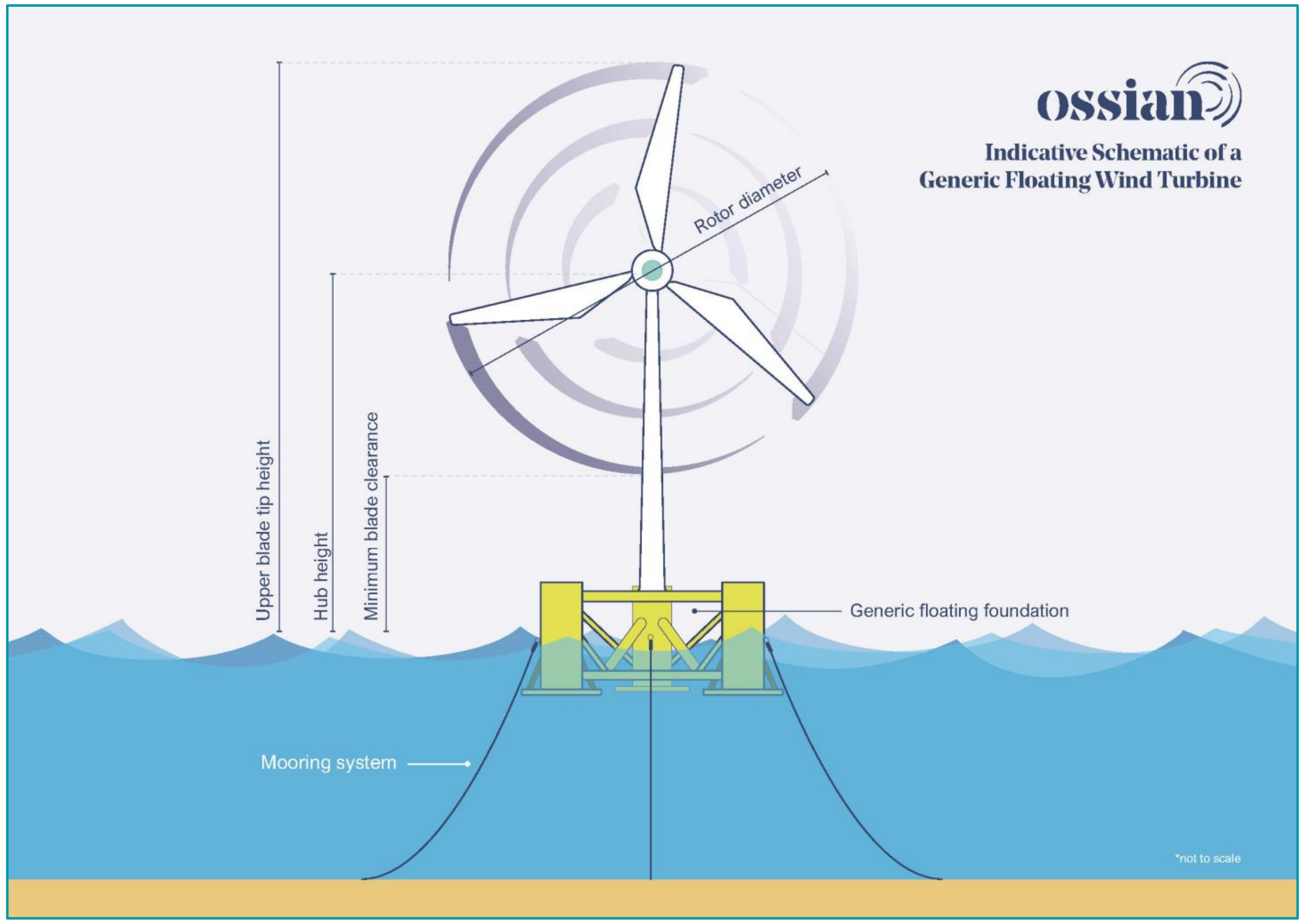

Figure 4.1: Schematic of a Typical Floating Wind Turbine

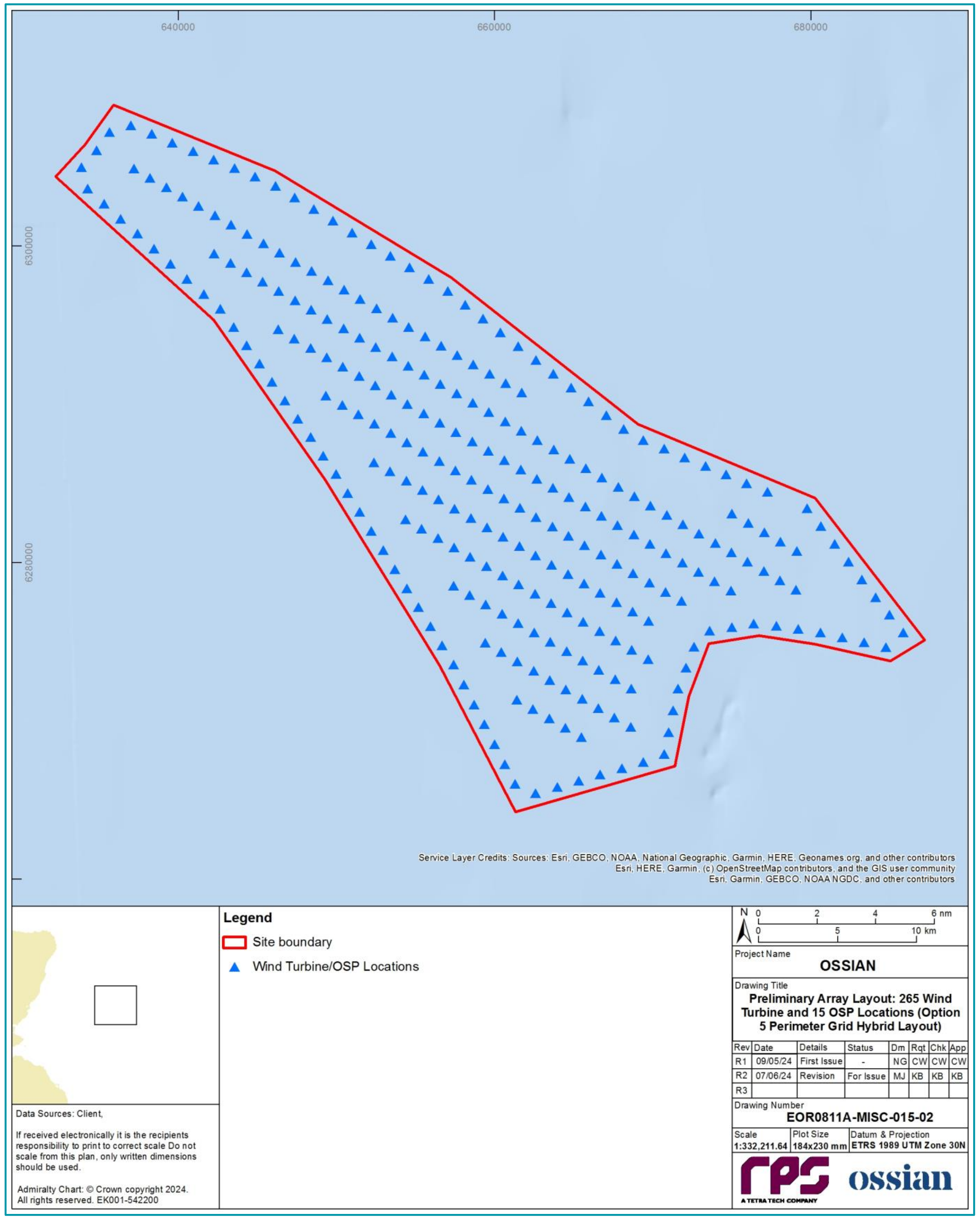

Figure 4.2: Preliminary Array Layout Comprising up to 265 Wind Turbines and up to 15 OSP Locations

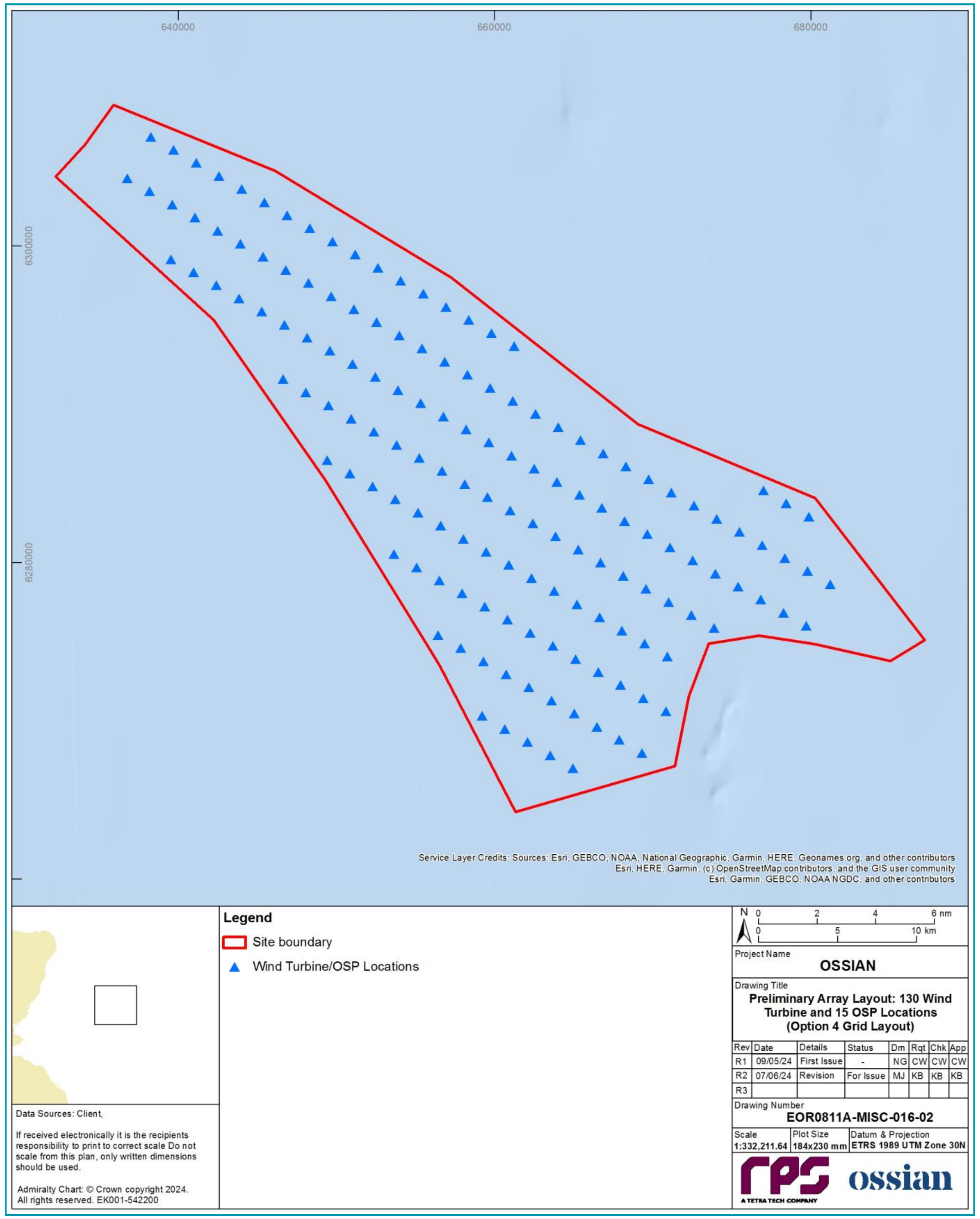

Figure 4.3: Preliminary Array Layout Comprising up to 130 Wind Turbines and up to 15 OSP Locations

70. A number of consumables will be required throughout the Array's lifecycle to improve operation, productivity and reduce wear on parts of wind turbines. These may include:

- grease;
- synthetic oil;
- hydraulic oil;
- gear oil;
- lubricants;
- nitrogen;
- water/glycerol;
- transformer silicon/ester oil;
- diesel fuel;
- Sulphur Hexafluoride; and
- glycol/coolants.

71. Required quantities of each consumable will be dependent upon the final design of the wind turbine selected. Potential release of any chemicals into the marine environment via an accidental pollution event during the construction, operation and maintenance and decommissioning phases will be reduced as far as reasonably practicable through implementation of appropriate controls and mitigation as set out in an Environmental Management Plan (EMP), including a Marine Pollution Contingency Plan (MPCP), and the Decommissioning Programme. An outline EMP, including an outline MPCP, is presented in volume 4, appendix 21 of the Array EIA Report.

4.3.3. FLOATING WIND TURBINE FOUNDATIONS AND SUPPORT STRUCTURES

72. The Array will comprise floating wind turbines supported by floating foundations which require mooring and anchoring systems to maintain station. The following subsections describe the MDS for the floating foundations, mooring systems, and anchoring systems.

Floating foundations

73. An overview of the floating foundation options considered for the Array is provided in Figure 4.4 and Table 4.3. Each floating technology has varying dimensions as a result of the differing approach to meeting the unique engineering challenges associated with floating wind turbines, floating structure site specific design, wind turbine sizes and project specific requirements. The final floating foundation design may look different to those pictured but will follow the same design principles. The following floating foundation solutions are being considered for the Array:

- Semi-submersible: A buoyancy stabilised platform which floats semi-submerged on the sea surface whilst anchored to the seabed. The structure gains its stability through the buoyancy force associated with its large footprint (relative to the spar solution) and geometry, which ensures the wind loadings on the floating foundation and wind floating turbine are countered/dampened by the equivalent buoyancy force on the opposite side of the structure. Other configurations, similar to semi-submersibles with regards to footprint, draft and mooring arrangement, like buoy floaters, are also being considered. It should be noted that semi-submersible foundations are applicable for use with catenary, semi taut and taut mooring systems.
- Tension Leg Platform (TLP): A TLP is a semi-submerged buoyant structure, anchored to the seabed with tensioned mooring lines (tendon). The combination of the structure buoyancy and tension in the anchor and mooring system provides the platform stability. This system stability (as opposed to the stability coming from the floating foundation itself) allows for a smaller and lighter floating foundation.

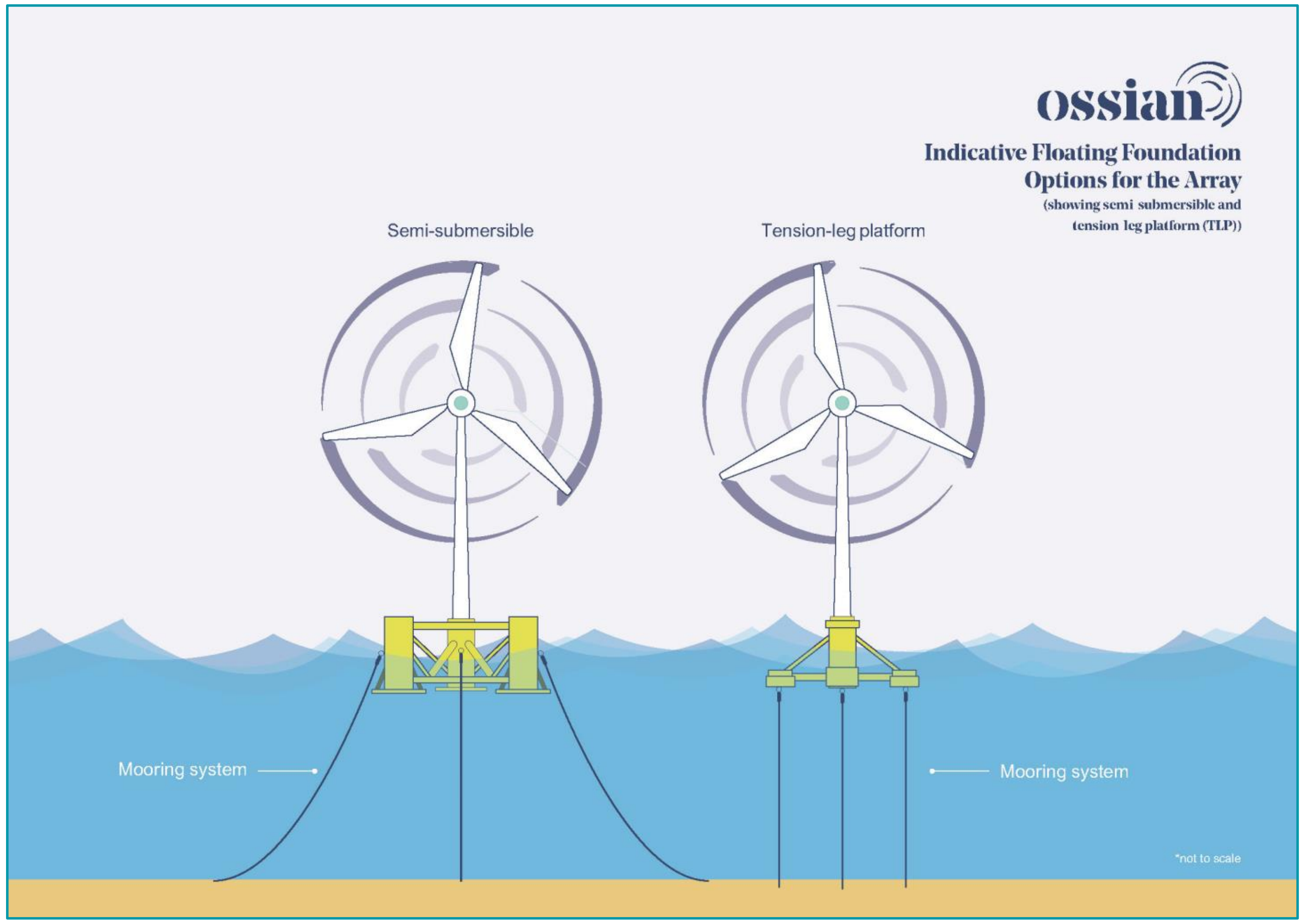

Figure 4.4: Indicative Floating Foundation Options for the Array

Table 4.3: Maximum Design Envelope: Floating Foundations

Parameter	Maximum Design Envelope
Foundation type considered	• Steel or concrete floating semi submersible substructure • TLP
Maximum number of floating foundations	265
Maximum floating foundation surface dimensions (m)	140 x 140
Maximum depth of structure (draft) in the water column (m)	40
Maximum excursion limit[4] of foundations horizontally across sea surface (m)	140
Shape of foundation	Polygonal

Mooring systems

74. The floating foundations are connected to the seabed via mooring and anchoring systems. Mooring lines run from the floating foundations, through the water column, to an anchoring system which maintains station of the floating foundation. The mooring line will connect to the floating foundation at a point below the splash zone, nominally set at 5 m below the sea surface. The point at which the mooring line reaches the seabed is referred to as the touchdown point.

75. Four mooring system options are currently being considered within the PDE, namely:

- catenary - catenary mooring lines typically comprise free hanging chains, secured to the seabed using anchors. Some designs may include the addition of clump weights to enhance the stiffness and restoring capacity.;
- semi taut - semi taut mooring lines typically use mixed materials, for example, chain and synthetic rope, secured to the seabed with anchors. Ancillary components like buoyancy modules may be required to achieve desired configuration.;
- taut - taut mooring lines use mostly synthetic ropes connected to small sections of chain at the seabed and at the top section, to prevent abrasion damage to the fibre ropes. Taut mooring lines are usually kept under tension and have a narrower mooring footprint; and
- tendons - tendons may also be used, which are tensioned mooring lines running vertically from the floating foundation to the seabed, and are only applicable for use with TLP floating foundations.

76. For catenary and semi-taut mooring systems sections of the mooring lines will lie on the seabed. During normal operations systems will be designed to minimise the excursion of floating foundations as far as practicable. However, during stronger winds and heavy sea states when floating foundations move to the edge of the excursion limits mooring lines on the windward side of the turbine will experience increased tension and may lift from the seabed. Mooring lines on the leeward side of the turbine would slacken and drop to the seabed (Figure 4.5). The greatest changes would be anticipated with the catenary mooring system followed by the semi taut mooring systems.

77. For the taut system it is anticipated that mooring lines would only interact with the seabed during extreme weather conditions. For the tendons option, mooring lines are tensioned, meaning that they run vertically from the floating foundation straight to the seabed, therefore, the mooring lines would not interact with the seabed and would not extend horizontally beyond the floating foundation footprint, unlike the catenary, semi taut and taut options (Figure 4.6, Figure 4.7 and Figure 4.8, respectively).

78. It should be noted that the final mooring line solution selected may vary across the site, and will be dependent upon the anchoring solution chosen (see paragraph 79). A schematic of the different mooring systems is provided in Figure 4.6, Figure 4.7 and Figure 4.8, respectively .

79. The mooring system will be limited to a maximum of six and nine mooring lines per wind turbine for the 130 and 265 turbine scenarios respectively. Mooring line radius is not expected to exceed 700 m, and maximum length of mooring line per foundation will be up to 750 m. A maximum of 680 m of mooring line per foundation will rest on the seabed during normal operations. The maximum design envelope for the mooring system options is presented in Table 4.4.

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[4] The extent to which a floating foundation may offset from its design coordinate (to be confirmed at final design) is dependent upon the magnitude of wind, sea, swell and current conditions. This parameter assumes the floating foundation under normal operation in the most extreme conditions that the mooring system is designed for.

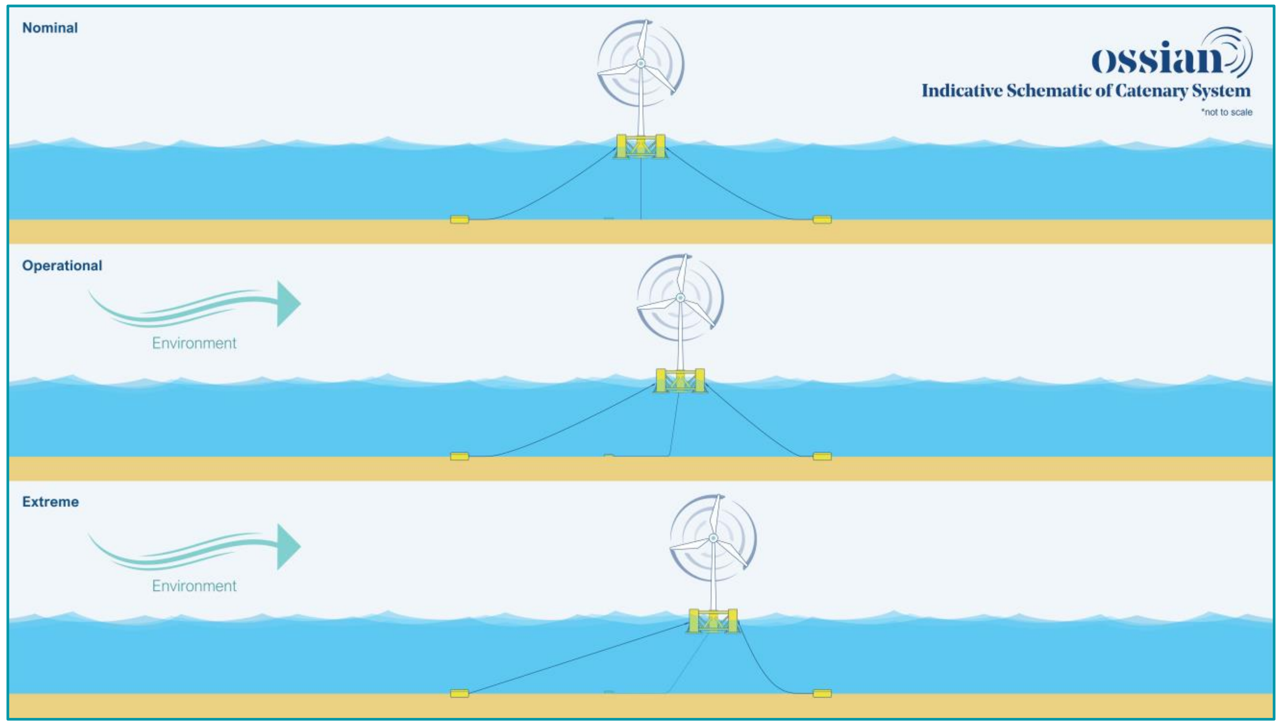

Figure 4.5: Indicative Schematic of Example Semi-Submersible Floating Foundation with Catenary Mooring System Option During Normal Operations and Extreme Conditions

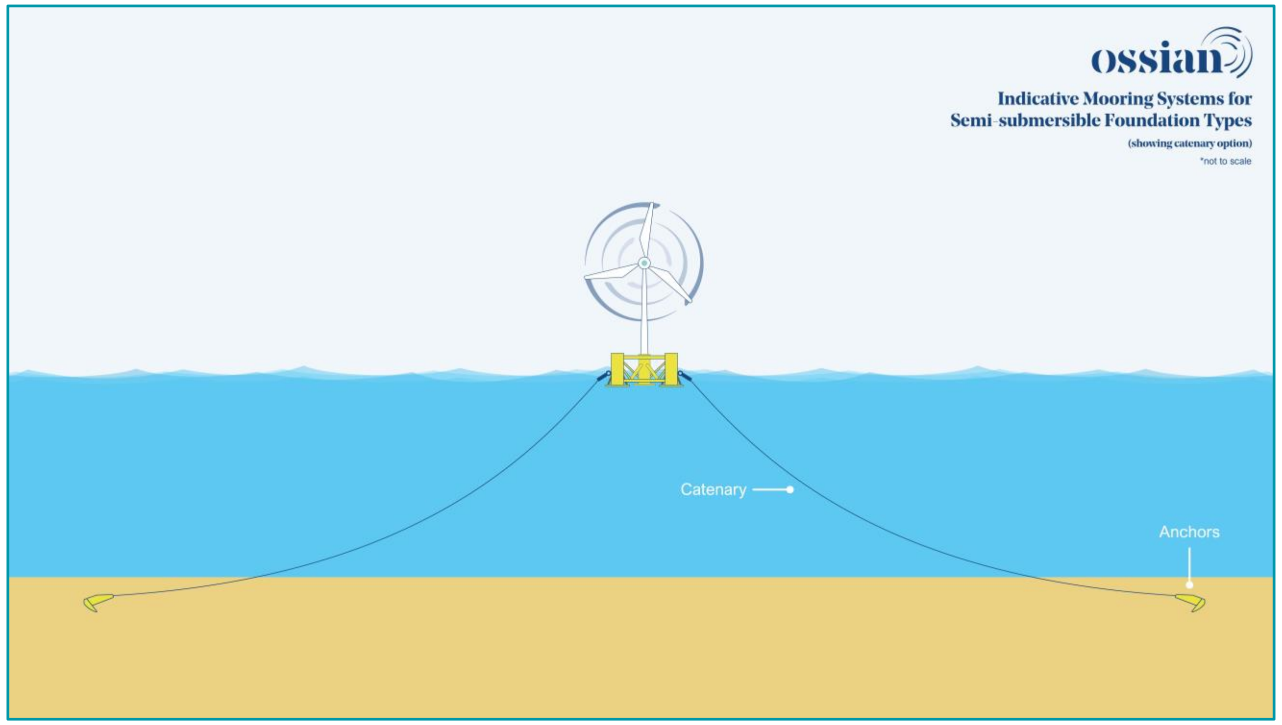

Figure 4.6: Indicative Schematic of Catenary Mooring System Option for Floating Wind Turbines on Example Semi-Submersible Floating Foundation

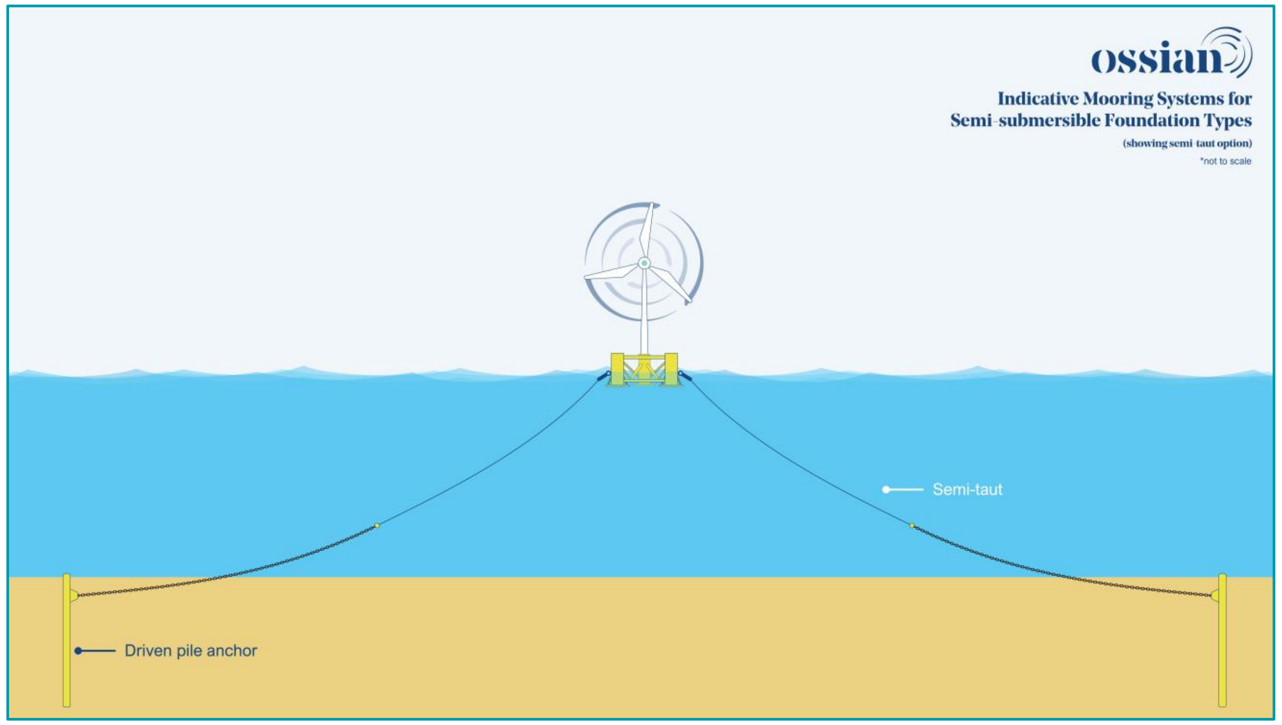

Figure 4.7: Indicative Schematic of Taut Mooring System Options for Floating Wind Turbines on Example Semi-Submersible Floating Foundation

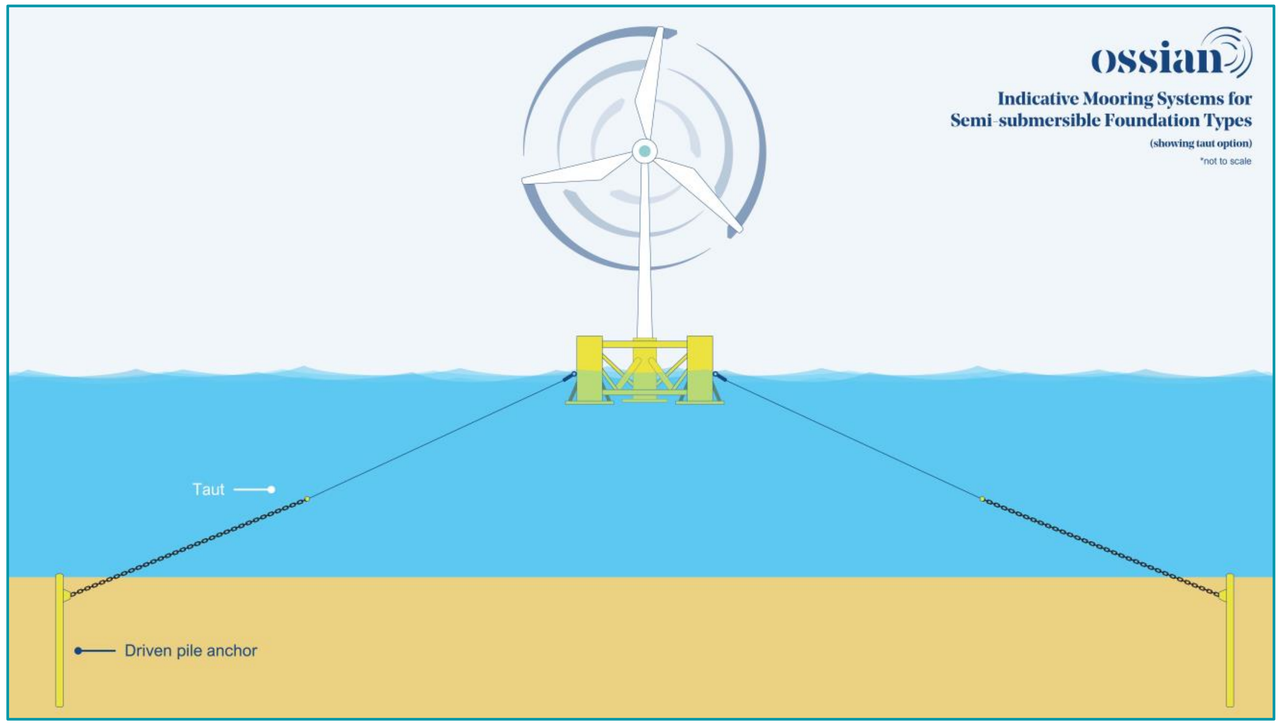

Figure 4.8: Indicative Schematic of Taut Mooring System Options for Floating Wind Turbines on Example Semi-Submersible Floating Foundation

Table 4.4: Maximum Design Envelope: Mooring Systems

Parameter	Maximum Design Envelope			
	Catenary Option	**Semi Taut Option**	**Taut Option**	**Tendons Option**
Foundation type	Semi-submersible	Semi-submersible	Semi-submersible	TLP
Maximum number of mooring lines per foundation	9	9	9	9
Maximum mooring line radius from the top connector at the foundation to the bottom connector at the anchor (m)[5]	700	700	600	0
Minimum mooring touchdown distance from foundation (m)	25	100	300	0
Maximum mooring touchdown distance from foundation (m)	150	500	600	0
Maximum mooring line point of attachment to foundation above sea surface (m)	15	15	15	0
Maximum mooring line point of attachment to foundation below sea surface (m)	-20	-20	-20	-20
Maximum length of mooring line within the water column per foundation during normal operation (m)	200	500	650	95
Maximum length of mooring line on seabed per foundation during normal operation (m)	680	250	100	0
Potential range of mooring line angles from foundation (°)	30 – 50	60- 80	75 - 82	0

Anchoring systems

80. Anchoring systems fix the mooring lines to the seabed and may include various solutions, such as driven piles, or embedded anchor types such as suction anchors and Drag Embedment Anchors (DEA). A brief description of the various anchoring types that are considered are presented in Table 4.5.

Table 4.5: Description of Anchoring Options Considered in the Maximum Design Envelope

Anchor Type	Description
Driven Piles	These are foundations which are driven into the seabed using a pile-driving hammer. Various factors influence the time and number of hammer strikes required to achieve the required penetration depth, including the type and size of hammer, pile size, and soil properties of the seabed. Note, vibropiling may be used as an alternative to percussive piling if feasible.
Suction Anchors	These anchors are installed by pumping water out of a capped steel cylinder, resulting in this being sucked into the seabed. The use of these piles is best suited to sand and clay soils.
DEA	These anchors are dragged across the seabed until required depth and holding capacity is reached. These anchors are best suited for cohesive sediments and function best when they are fully submerged into the seabed.

81. The Applicant is considering installation of up to nine anchors per floating foundation within the PDE. The final anchoring solution selected may vary across the site and will take account of the seabed conditions, detailed analysis of geotechnical data to inform engineering design, and environmental impacts. A range of scenarios has been identified based on preliminary analysis of geophysical and geotechnical data to identify possible anchoring solutions arrangements which could be installed for the purposes of undertaking a robust assessment. The Applicant has undertaken preliminary geotechnical surveys to determine feasibility of the proposed scenarios. Geotechnical samples were not taken at every turbine location; therefore, flexibility is retained within the PDE to ensure there will be feasible anchoring solutions across the site. This will be informed by detailed geotechnical surveys and engineering design to identify the most appropriate anchor technology.

82. The final design may vary from the specific scenarios outlined but the environmental impacts will be no greater than the maximum design scenario impacts resulting from these scenarios and will be confirmed post-consent within the suite of consent plans. The scenarios assessed within this RIAA are as follows:

- Anchoring Option 1 - use of driven piles to anchor all floating foundations;
- Anchoring Option 2 - use of DEAs to anchor all floating foundations;
- Anchoring Option 3 – use of a mix of driven piles and DEAs to anchor up to 65% and 35% of the floating foundations, respectively;
- Anchoring Option 4 – use of a mix of driven piles and suction anchors to anchor up to 65% and 35% of the floating foundations, respectively; and
- Anchoring Option 5 - use of driven piles, shared between the floating foundations (equating to up to 70% of the total number of piles required for Anchoring Option 1).

83. Anchoring Option 1 is considered the most likely anchoring solution for the project at this stage, with Anchoring Options 2 to 5 considered as alternative options which may be used depending upon the results of engineering and environmental studies. A description of the maximum design envelope for each Anchoring Option is presented in Table 4.6 to Table 4.10. Images of the anchoring solutions are presented in Figure 4.9. Shared anchors will be considered by the project subject to appropriate layout design. This has the potential to reduce the overall number of anchors required within the site boundary. The maximum length of mooring line detailed within Table 4.4 may be exceeded for the shared anchor solution, however, the overall length of anchor chain required across the array, including length of chain on the seabed, would be reduced by utilising shared anchors.

84. Considering all Anchoring Options, the maximum seabed footprint per foundation is 900 m^2 and maximum seabed footprint for the Array is 159,000 m^2. Scour protection may be required for the anchoring systems with up to 8,511 m^2 of scour protection to be installed per foundation, and up to 1,503,612 m^2 of scour protection to be installed across the Array.

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[5] Mooring line radius is measured from top connector (at floating foundation) to bottom connector- (at touchdown point) in static conditions.

Table 4.6: Maximum Design Envelope: Anchoring Option 1

Parameter	Maximum Design Envelope
Maximum number of foundation substructures	265
Mooring line types considered	Catenary, semi-taut, taut or tendons options (see Table 4.4)
Anchor type	Driven pile only
Maximum anchor dimension (diameter x length) (m)	4.5 x 40
Maximum number of driven piles per foundation	9
Maximum driven pile diameter (m)	4.5
Maximum pile penetration depth (m)	40
Maximum dimensions of mud mats (m)	15 x 15
Maximum seabed footprint per foundation (m^2)	144
Maximum seabed footprint for the Array (m^2)	25,288
Maximum number of anchors requiring piling per foundation	9
Maximum hammer energy (kJ)	3,000

Table 4.7: Maximum Design Envelope: Anchoring Option 2

Parameter	Maximum Design Envelope
Maximum number of foundation substructures	265
Mooring line types considered	Catenary or semi-taut options (see Table 4.4)
Anchor type	DEAs only
Maximum anchor dimension (length x width x height) (m)	10 x 10 x 5
Maximum number of DEAs per foundation	9
Maximum seabed footprint per foundation (m^2)	900
Maximum seabed footprint for the Array (m^2)	159,000

Table 4.8: Maximum Design Envelope: Anchoring Option 3

Parameter	Maximum Design Envelope
Maximum number of foundation substructures	265
Mooring line types considered	Catenary, semi-taut or taut options (see Table 4.4)
Anchor type	Driven piles and DEAs
Maximum anchor dimension (m)	Driven piles: 4.5 x 40 (diameter x length) DEAs: 10 x 10 x 5 (length x width x height)
Maximum percentage of driven piles within the Array (%)	65
Maximum percentage of DEAs within the Array (%)	35
Maximum number of anchors per foundation	9
Maximum number of driven piles across the Array	1,032
Maximum number of DEAs across the Array	558
Maximum driven pile diameter (m)	4.5
Maximum driven pile penetration depth (m)	40
Maximum seabed footprint per foundation (m^2)	408
Maximum seabed footprint for the Array (m^2)	72,088
Maximum number of driven piles requiring piling per foundation	5.85
Maximum hammer energy (kJ)	3,000

Table 4.9: Maximum Design Envelope: Anchoring Option 4

Parameter	Maximum Design Envelope
Maximum number of foundation substructures	265
Mooring line types considered	Catenary, semi-taut or taut options (see Table 4.4)
Anchor type	Driven piles and suction anchors
Maximum anchor dimension (diameter x length) (m)	Driven piles: 4.5 x 40 Suction anchors: 10 x 15
Maximum percentage of driven piles within the Array (%)	65
Maximum percentage of suction piles within the Array (%)	35
Maximum number of anchors per foundation	9
Maximum average number of driven piles across the Array [6]	1,032
Maximum average number of suction piles across the Array	558
Maximum driven pile diameter (m)	4.5
Maximum driven pile penetration depth (m)	40
Maximum suction pile diameter (m)	10
Maximum suction pile penetration depth (m)	15
Maximum seabed footprint per foundation (m^2)	340
Maximum seabed footprint for the Array (m^2)	60,144
Maximum number of driven piles requiring piling per foundation	5.85
Maximum hammer energy (kJ)	3,000

Table 4.10: Maximum Design Envelope: Anchoring Option 5

Parameter	Maximum Design Envelope
Maximum number of foundation substructures	265
Mooring line types considered	Catenary, semi-taut or taut options (see Table 4.4)
Anchor type	Driven piles only, shared anchoring between floating foundations
Maximum anchor dimension (diameter x length) (m)	4.5 x 40
Maximum driven pile diameter (m)	4.5
Maximum driven pile penetration depth (m)	40
Maximum percentage of shared driven piles within the Array (%)	70
Maximum average number of shared driven piles across the Array	1,113
Maximum seabed footprint per foundation (m^2)	101
Maximum seabed footprint for the Array (m^2)	17,702
Maximum number of driven piles requiring piling per foundation	6.3
Maximum hammer energy (kJ)	3,000

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[6] Based upon a maximum number of anchors across the Array of 1,590 (maximum number of foundation substructures of 265 multiplied by six anchors per foundation). The proportion of driven piles and suction anchors for Option 4 is 65% and 35%, respectively, equalling 1,033.5 driven piles and 556.5 suction anchors. Please note, that when this decimal is rounded up (as in Table 4.9) this totals a maximum of 1,591 anchors, however, the maximum number of anchors installed across the Array will not exceed 1,590, nor the parameters presented within Table 4.9.

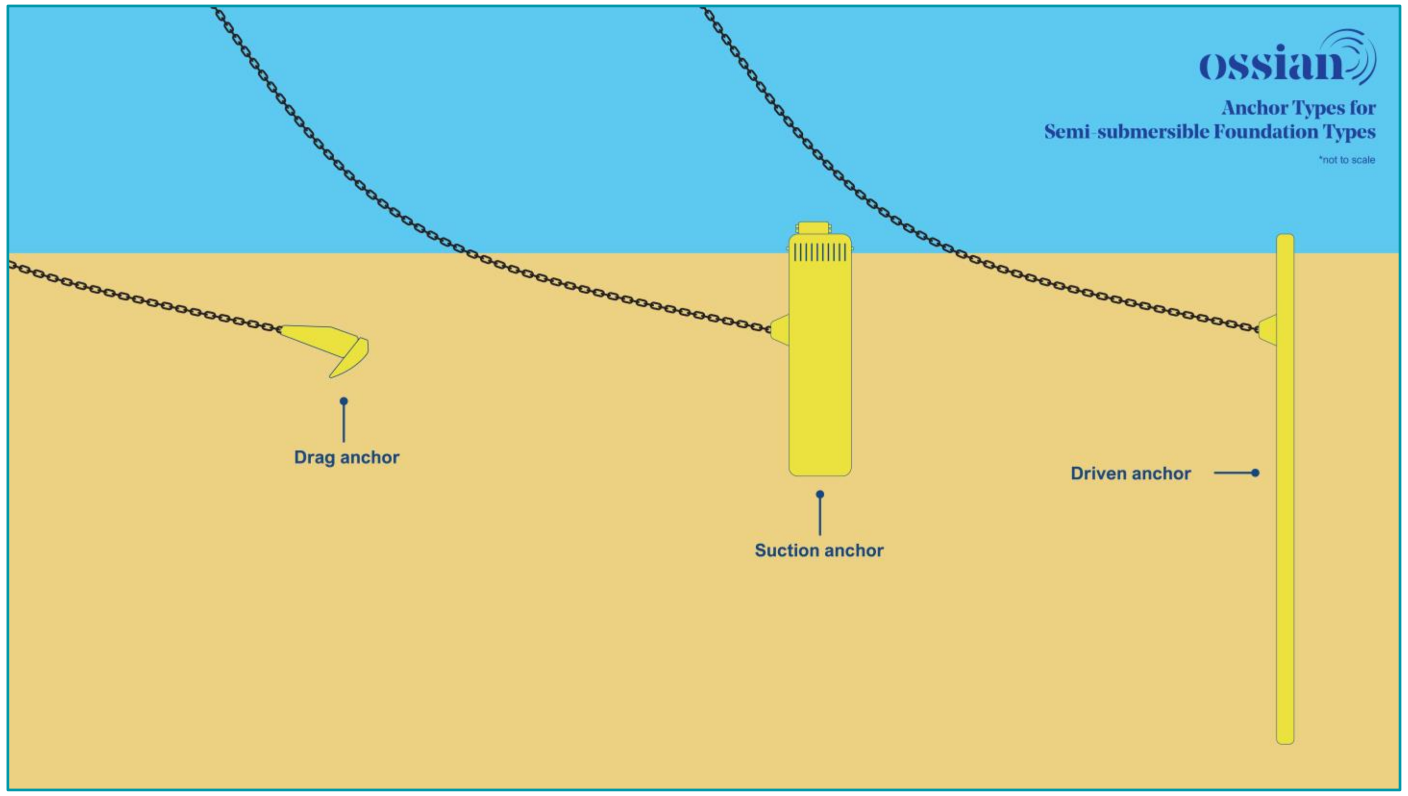

Figure 4.9: Schematic of Anchoring Options

Emerging anchor technologies

85. The Applicant is engaging with a number of suppliers who are developing innovative solutions to address some of the challenges associated with anchoring of floating offshore wind turbines. A number of emerging anchoring technologies are being considered by the Applicant.

86. These anchor technologies have the potential to increase efficiency by using less materials to achieve similar or higher loading capacities, reduce installation times and transportation requirements, mitigate supply chain constraints and further mitigate environmental effects. Innovative solutions currently being considered include using helical micro piles to fix an anchor plate to the seabed. These include helical piles that are installed through a bespoke installation tool, or drilled and grouted micro piles installed using a drilling template.

87. The Applicant will aim to use these technologies where they are feasible (depending on availability, certification, ground conditions and design performance) and where there are opportunities to reduce environmental impacts. These technologies will be presented in post-consent plans outlining how the construction and deployment falls within parameters assessed within the RIAA.

Connectors and ancillaries

88. The use of a number of different connectors and ancillaries may be required for the mooring and anchoring systems which alter the mooring system behaviour, for example, to reduce dynamic loads, and to reduce mooring line radius which limits movement of the floating foundation. The following connectors and ancillaries may be used:

- Long Term Mooring (LTM) connectors (shackles or H-links): these are used to securely connect different mooring line sections and the mooring lines to the anchoring systems.
- Clump weights: these may be added near the touchdown point of the mooring line to reduce the mooring line radius and provide additional weight. These are commonly used with catenary mooring lines and are usually installed over the chain links.
- Buoys or buoyancy elements: commonly used with semi taut mooring lines, these are used to suspend portions of the mooring line within the water column. The depth of these buoyancy elements within the water column can be altered, which allows the correct tension to be obtained.
- In-line tensioners: these may be added to the mooring line in order to install mooring lines with the correct tension.

89. The maximum design envelope for mooring line connectors and ancillaries is presented in Table 4.11 and a schematic is presented in Figure 4.10 and Figure 4.11.

Table 4.11: Maximum Design Envelope: Connectors and Ancillaries

Parameter	Maximum Design Envelope
Maximum size of clump weights (diameter x length) (m)	1.5 x 1.5
Maximum dimensions of eccentric buoyancy modules (diameter x length) (m)	5 x 7
Maximum dimensions of in-line buoyancy modules (diameter x length) (m)	5 x 7

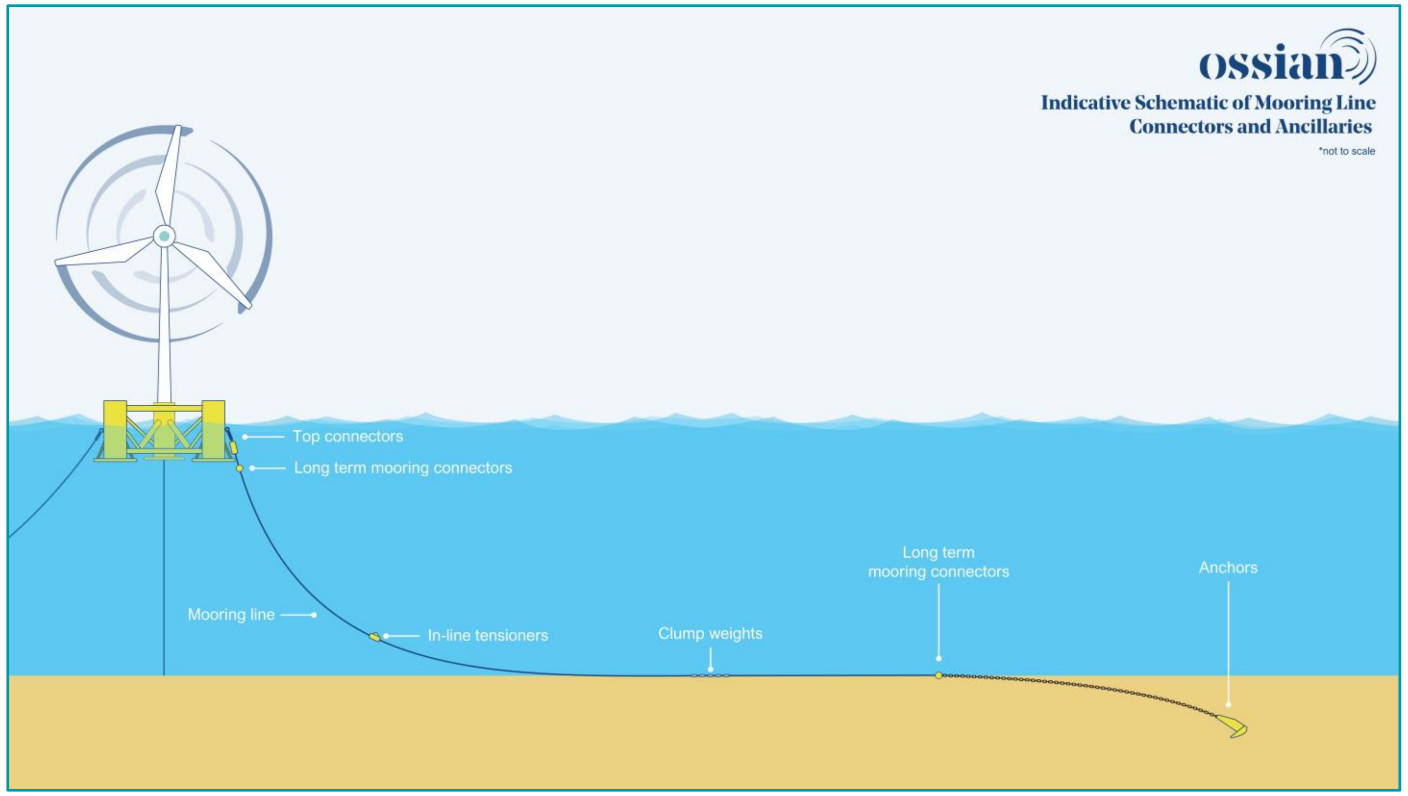

Figure 4.10: Indicative Schematic of Mooring Line Connectors and Ancillaries Showing LTM Connectors, Clump Weights, and In-Line Tensioners

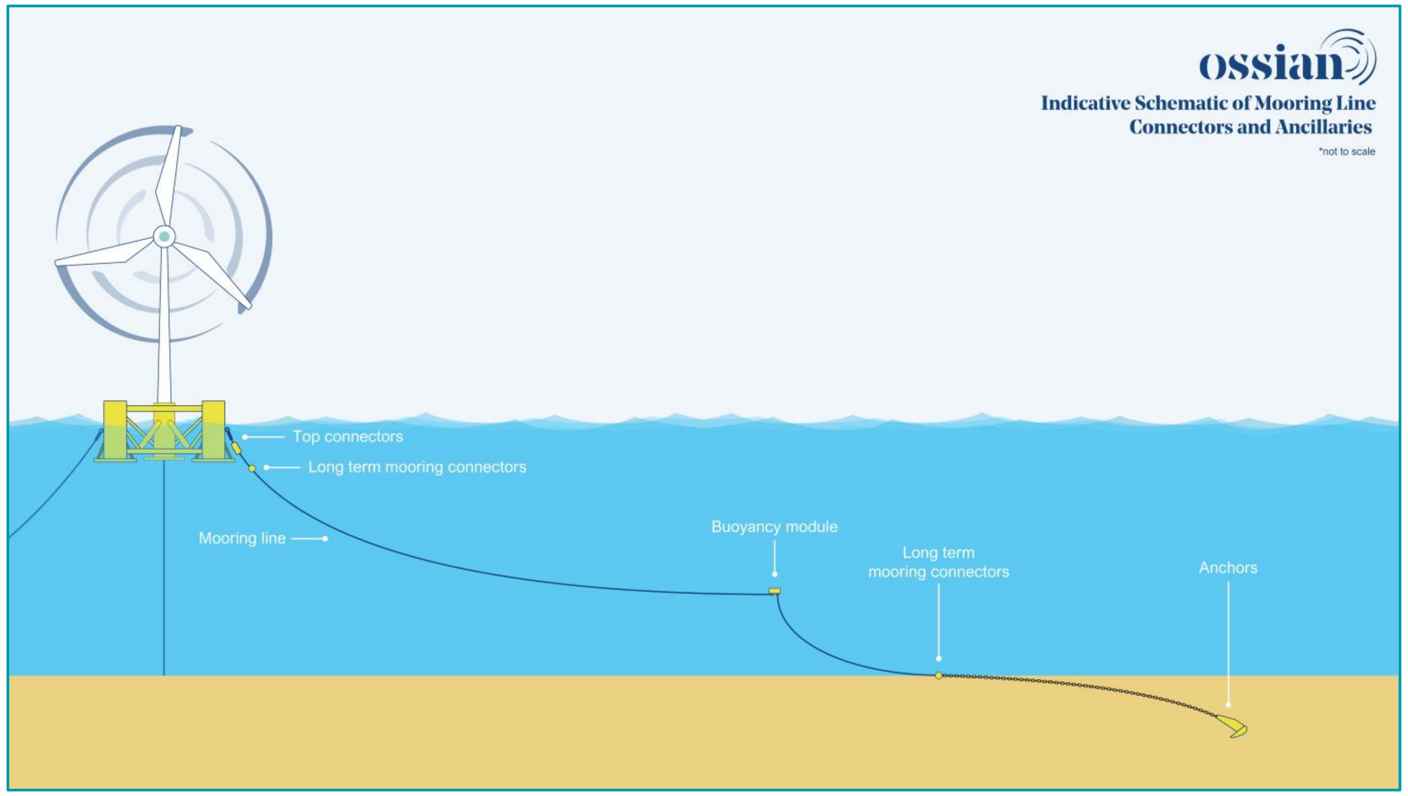

Figure 4.11: Indicative Schematic of Mooring Line Connectors and Ancillaries Showing LTM Connectors and Buoyancy Modules

4.3.4. OFFSHORE SUBSTATION PLATFORMS

90. The OSPs will transform the electricity generated by the wind turbines to a higher voltage and/or to direct current allowing the power to be efficiently transmitted directly to shore or to a wider offshore grid network.

91. The Applicant has defined two options for OSP arrangements to be assessed within the appropriate assessment. The exact number and size of OSPs will be subject to National Grid ESO final design recommendations and detailed design, however, the overall size, footprint, piling parameters and key design features will remain within the representative OSP design scenarios considered. The following OSP arrangement scenarios have been considered:

- OSP Option 1: up to six large High Voltage Alternating Current (HVAC)/High Voltage Direct Current (HVDC) OSPs; or
- OSP Option 2: a combined option comprising:
  - up to three large HVAC/HVDC OSPs; and
  - up to 12 small HVAC OSPs.

92. The following subsections describe the maximum design envelope for the topsides and foundations for these options.

Offshore platform topsides

93. Up to six large OSP topsides will be installed with maximum dimensions of up to 121 m (length) by 89 m (width) and will be approximately 93 m in height (above LAT), excluding the helideck, lightning protection and antenna structure (Table 4.12).

94. Should OSP Option 2 be selected at the final design stage, up to 12 small OSPs will be installed (alongside three large OSPs with same dimensions as mentioned previously), up to 41 m in length, 37 m in width and 50 m in height, excluding helideck, lightning protection and antenna structure (Table 4.13). The final solution chosen, and the topside sizes, will be dependent on the final electrical set up for the Array.

Table 4.12: Maximum Design Envelope: OSP Option 1 Topsides

Parameter	Maximum Design Envelope
Maximum number of OSPs	6 (HVDC or HVAC)
Maximum length of topside (m)	121
Maximum width of topside (m)	89
Maximum height of main structure above LAT (excluding helideck or lighting protection) (m)	93
Maximum weight of topside (t)	33,000
Maximum height of lightning protection above LAT (m)	104
Maximum height of helideck above LAT (m)	97
Maximum height of crane above LAT (m)	100
Maximum height of top of antenna structure above LAT (m)	109

Table 4.13: Maximum Design Envelope: OSP Option 2 Topsides

Parameter	Maximum Design Envelope	
	Large OSPs	Small OSPs
Maximum number of OSPs	3 (HVDC or HVAC)	12 (HVAC)
Maximum length of topside (m)	121	41
Maximum width of topside (m)	89	37
Maximum height of main structure above LAT (excluding helideck or lighting protection) (m)	93	50
Maximum weight of topside (t)	33,000	3,700
Maximum height of lightning protection above LAT (m)	104	60
Maximum height of helideck above LAT (m)	97	53
Maximum height of crane above LAT (m)ed	100	71
Maximum height of top of antenna structure above LAT (m)	109	71

Offshore platform foundations

95. The OSPs will be installed on fixed jacket foundations and will be located within the Array. For large OSPs, the fixed jacket foundations will have up to 12 legs, whereas fixed jacket foundations for small OSPs will have up to six legs. Up to two piles will be required per leg for both large and small OSPs.

96. For OSP Option 1, this results in a maximum of 24 piles required per foundation. Up to 144 piles will require piling for up to six large OSPs (Table 4.14). For OSP Option 2, a maximum of 24 piles will be required per foundation for three large OSPs and a maximum of 12 piles will be required per foundation for 12 small OSPs, resulting in a total number of up to 216 piles requiring piling (Table 4.15). It should be noted that diameter of piles required for large OSP fixed jacket foundations are 4.5 m, whereas small OSP fixed jacket foundations will require piles with a diameter of 3 m.

97. Table 4.14 and Table 4.15 describe the maximum design envelope for OSP Option 1 and OSP Option 2, respectively.

Table 4.14: Maximum Design Envelope: OSP Option 1 Fixed Jacket Foundations

Parameter	Maximum Design Envelope
Maximum number of platforms	6
Maximum number of legs per foundation	12
Maximum leg diameter (m)	5
Maximum number of driven piles per leg	2
Maximum number of driven piles per platform foundation	24
Maximum jacket leg spacing (at seabed) (m)	100
Maximum jacket leg spacing (at surface) (m)	100
Maximum driven pile diameter (m)	4.5
Maximum driven pile length (m)	85
Maximum driven pile penetration depth (m)	70
Maximum dimensions of mud mats (if used) (m)	20 x 20
Maximum seabed footprint per jacket foundation (m^2)	382
Maximum seabed footprint for the Array (m^2)	2,290
Maximum number of driven piles requiring piling (all platforms)	144
Maximum hammer energy (kJ)	4,400

Table 4.15: Maximum Design Envelope: OSP Option 2 Fixed Jacket Foundations

Parameter	Maximum Design Envelope	
	Large OSPs	Small OSPs
Maximum number of platforms	3	12
Maximum number of legs per foundation	12	6
Maximum leg diameter (m)	5	3.5
Maximum number of driven piles per leg	2	2
Maximum number of driven piles per platform foundation	24	12
Maximum jacket leg spacing (at seabed) (m)	100	50
Maximum jacket leg spacing (at surface) (m)	100	40
Maximum driven pile diameter (m)	4.5	3
Maximum driven pile length (m)	85	85
Maximum driven pile penetration depth (m)	70	70
Maximum dimensions of mud mats (if used) (m)	20 x 20	15 x 15
Maximum seabed footprint per jacket foundation (m^2)	382	85
Maximum seabed footprint for the Array (m^2)	1,145	1,018
Maximum number of driven piles requiring piling (all platforms)	72	144
Maximum hammer energy (kJ)	4,400	4,400

4.3.5. SCOUR PROTECTION FOR FOUNDATIONS

98. Natural hydrodynamic and sedimentary processes can lead to seabed erosion and 'scour hole' formation around anchor and mooring systems, and foundation structures. Scour hole development is influenced by the shape of the foundation structure, seabed sedimentology and site-specific metocean conditions such as waves, currents, and storms. Employing scour protection can mitigate scour around foundations. Commonly used scour protection types include:

- concrete mattresses: cast of articulated concrete blocks, several metres wide and long and linked by a polypropylene rope lattice, which are placed on and/or around structures to stabilise the seabed and inhibit erosion; or
- rock: the most frequently used scour protection method. Layers of graded stones placed on and/or around structures (e.g. foundation structures) to inhibit erosion, or rock filled mesh fibre bags which adapt to the shape of the seabed/structure as they are lowered on to it.

99. The type and volume of scour protection required will vary depending on the various wind turbine anchoring options and offshore platform options considered, and the final parameters will be decided once the design of these is finalised. This decision will consider a range of aspects including geotechnical data, meteorological and oceanographical data, water depth, foundation type, maintenance strategy, and cost.

100. Table 4.16 presents the maximum design envelope for scour protection required for the Anchoring Options described in section 4.3.3. It should be noted that Anchoring Option 2 is not included within Table 4.16 as there is no requirement for scour protection for this option. DEAs are fully embedded within the seabed (see Table 4.5) and, therefore, erosion around the structure is unlikely to occur, minimising the need for scour protection.

101. Table 4.17 presents the maximum design envelope for the OSP Options described in section 4.3.4.

Table 4.16: Maximum Design Envelope: Scour Protection for Anchoring Options[7]

Parameter	Maximum Design Envelope			
	Anchoring Option 1	Anchoring Option 3	Anchoring Option 4	Anchoring Option 5
Anchor type	Driven piles	Driven piles and DEAs	Driven piles and suction anchors	Shared driven piles
Scour protection type	Rock or mattress			
Maximum height of scour protection (m)	1.5	1.5	1.5	1.5
Maximum diameter of scour protection (including pile/anchor) (m)	22.5	50	50	50
Maximum area of scour protection per foundation (excluding pile/anchor area) (m^2)	3,436	1,918	8,171	2,405
Maximum volume of scour protection per foundation (m^3)	5,368	3,489	12,767	3,757
Maximum volume of scour protection for Array (m^3)	948,295	616,392	2,225,420	663,807

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[7] Anchoring Option 2 (DEAs only) does not require scour protection, therefore, this option has been omitted from this table.

Table 4.17: Maximum Design Envelope: Scour Protection for OSP Options

Parameter	Maximum Design Envelope		
	OSP Option 1	OSP Option 2	
Platform type	Large OSP	Large OSP	Small OSP
Maximum number of platforms	6	3	12
Scour protection type	Rock or mattress	Rock or mattress	
Maximum height of scour protection (m)	1.5	1.5	
Maximum diameter of scour protection (including pile) (m)	22.5	22.5	15
Maximum area of scour protection per foundation (excluding pile area) (m^2)	14,516	14,516	4,092
Maximum volume of scour protection per foundation (m^3)	22,346	22,346	6,265
Maximum volume of scour protection for Array (m^3)	134,078	142,220	

4.3.6. SUBSEA CABLES

Inter-array cables

102. Inter-array cables carry the electrical current produced by wind turbines to an OSP. So as not to hinder the movement of the floating foundations, it is proposed that dynamic inter-array cables will be used. There are several cable designs which may be used, however, the most likely to be used for the Array is a ‘lazy-S’ configuration which allows extension of the cables in response to the floating foundation movements. Buoyancy modules are attached to the dynamic inter-array cable to support the weight of the cable and provide the ‘lazy-S’ configuration in the water column (as demonstrated in Figure 4.12). Bend stiffeners help to reduce the fatigue in the inter-array cables and are typically used where the cable exits the floating foundation and at touch down points of the cable on the seabed.

103. Where the dynamic cable transitions to static, the transition length (dynamic touch down) would typically have protection around the cable to protect the cable from abrasion and fatigue. Tether clamps and anchor may also be required (Figure 4.12) to limit the movement at the touch down area. A tether clamp is designed to secure subsea lines to an anchor on the seabed and usually comprises a steel housing that is bolted over the cable with a padeye to secure a chain to a weighted anchor on the seabed. Where the static cable is laid on the seabed it will be protected in line with the outputs of the Cable Burial Risk Assessment (CBRA). It is anticipated that cable burial methods will be used to protect cables, with external cable protection employed where target burial depths cannot be achieved. A schematic of the dynamic/static inter-array cabling system is presented in Figure 4.12.

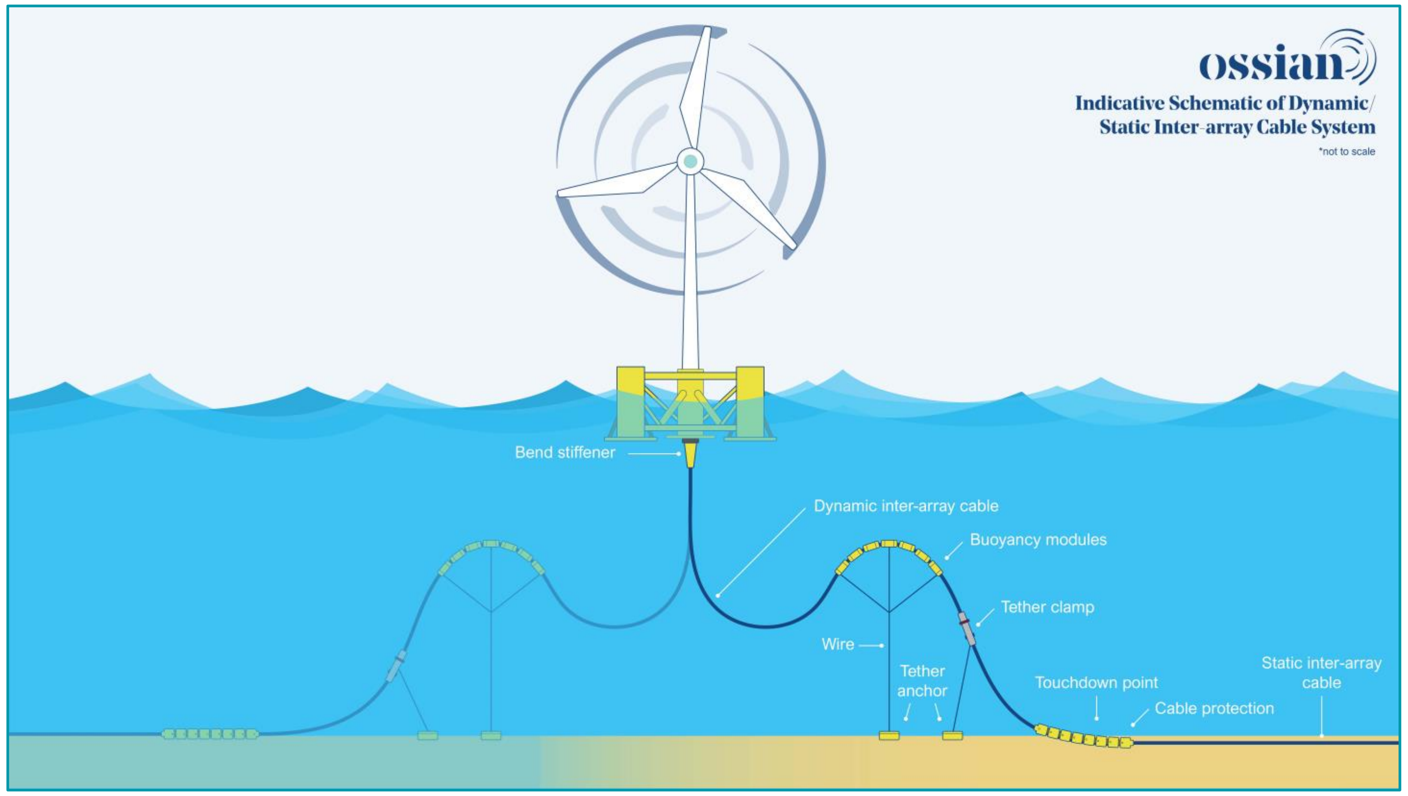

Figure 4.12: Typical Indicative Schematic of the Dynamic/Static Inter-array Cable System (Subject to Detailed Design Configuration)

104. Different approaches and techniques are available for burial of the inter-array cables laid on the seabed. The final choice of burial or external cable protection methods will be subject to a review of the seabed conditions and the CBRA. Equipment which will be used to achieve cable burial is described in paragraph 154.

105. External cable protection methods will be required in areas where cable burial is unachievable, for example, where there are pre-existing cables or pipelines, or areas of exposed bedrock. A hard protective layer, such as rock or concrete mattresses, may be used to protect exposed cables. The need for this additional external protection will be subject to whether minimum target cable burial depths recommended for protection from the external threats can be achieved. Factors such as seabed conditions and sedimentology, naturally occurring physical processes and any potential interactions with human activities such as vessel anchoring and bottom-trawl fishing gear, will influence the requirement for additional protection. Site preparation activities may be required to provide relatively flat seabed surface for installation of cables and enable burial of inter-array cables to target burial depths.

106. The cable burial methodology and potential external cable protection will be identified at the final design stage (post-consent). The maximum design envelope for the inter-array cables is presented in Table 4.18. Figure 4.13 presents a schematic of the dimensional characteristics set out in Table 4.18.

Table 4.18: Maximum Design Envelope: Inter-Array Cables

Parameter	Maximum Design Envelope
Maximum voltage (kV)	132
Maximum total cable length (km)	1,261
Maximum external cable diameter (mm)	300
Minimum external cable diameter (mm)	100
Maximum length of cable on the seabed (km)	1,222
Maximum length of cable in the water column (km)	116
Cable burial methodology	• Cable plough • Jet trencher • Mass flow excavator • Mechanical cutter
Minimum target burial depth (m)	0.4 (subject to CBRA)
Maximum width of cable trench (m)	2
Maximum width of seabed affected from installation tool per cable (m)	20

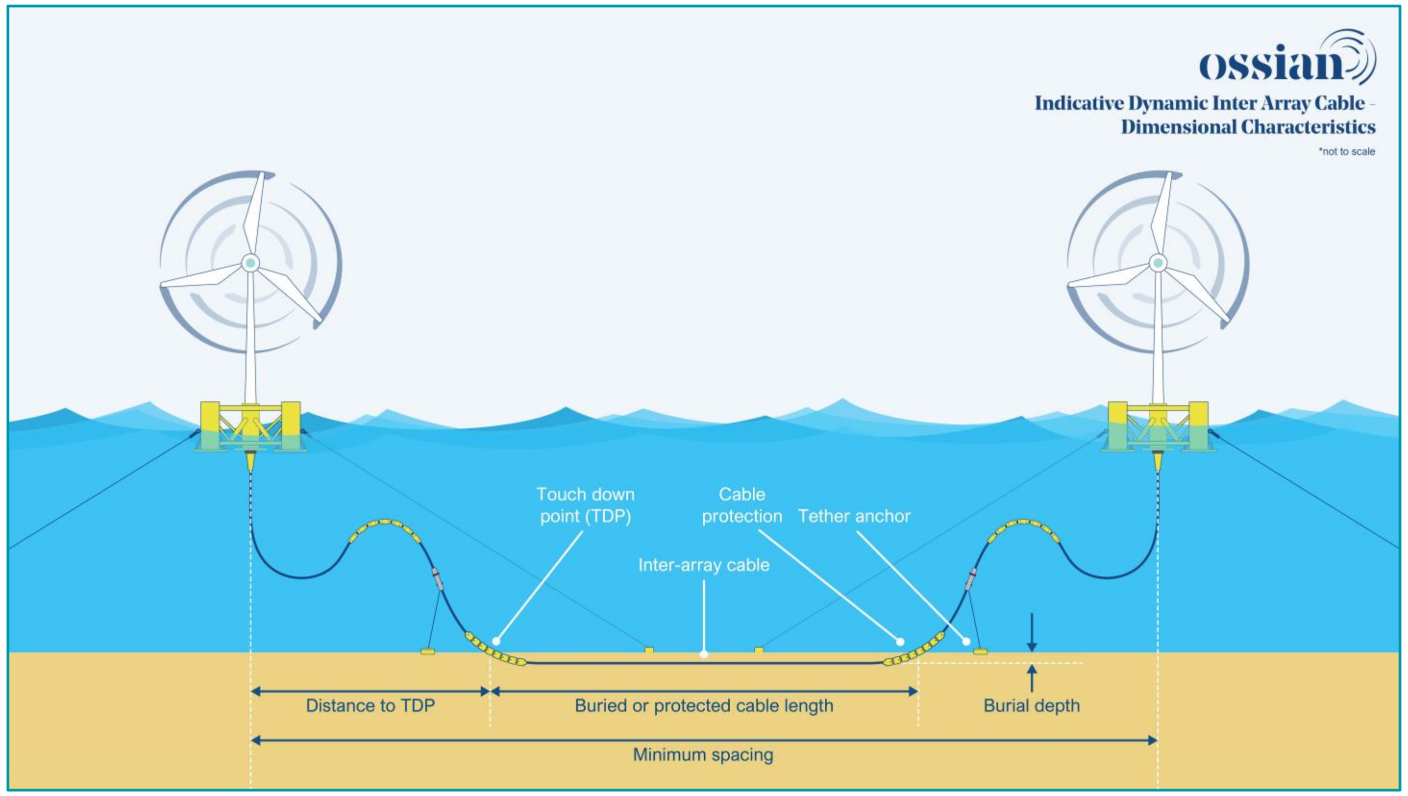

Figure 4.13: Indicative Inter-Array Cable Dimensional Characteristics

Subsea junction boxes

107. Subsea junction boxes may be installed on the seabed which serve as a single connection point for inter-array cables from several wind turbines. There are several configurations which may be used to connect inter-array cables into the subsea junction boxes as depicted in Figure 4.14. These comprise the following:

- Daisy-chain – two inter-array cables are required per wind turbine, which connect wind turbines together in sequence. The wind turbines located at either end of the grouping are connected to a single subsea junction box via the second inter-array cable exiting each of the two wind turbines. Once reaching the subsea junction box, a single static inter-array cable exits, to connect into the OSP.
- Fishbone – each wind turbine is connected to a single subsea junction box via one inter-array cable. Lengths of static inter-array cable connect the subsea junction boxes together in sequence and then a single static inter-array cable exits the final subsea junction box in the sequence to connect into the OSP.
- Star – several wind turbines are connected to a single subsea junction box via one inter-array cable per wind turbine. A single static inter-array cable exits the subsea junction box, to connect into the OSP.
- Fishbone and star hybrid – several wind turbines are connected to a single subsea junction box via one inter-array cable per wind turbine. Lengths of static inter-array cable then connect multiple subsea junction boxes together in sequence. A single static inter-array cable exits the final subsea junction box in the sequence to connect into the OSP.

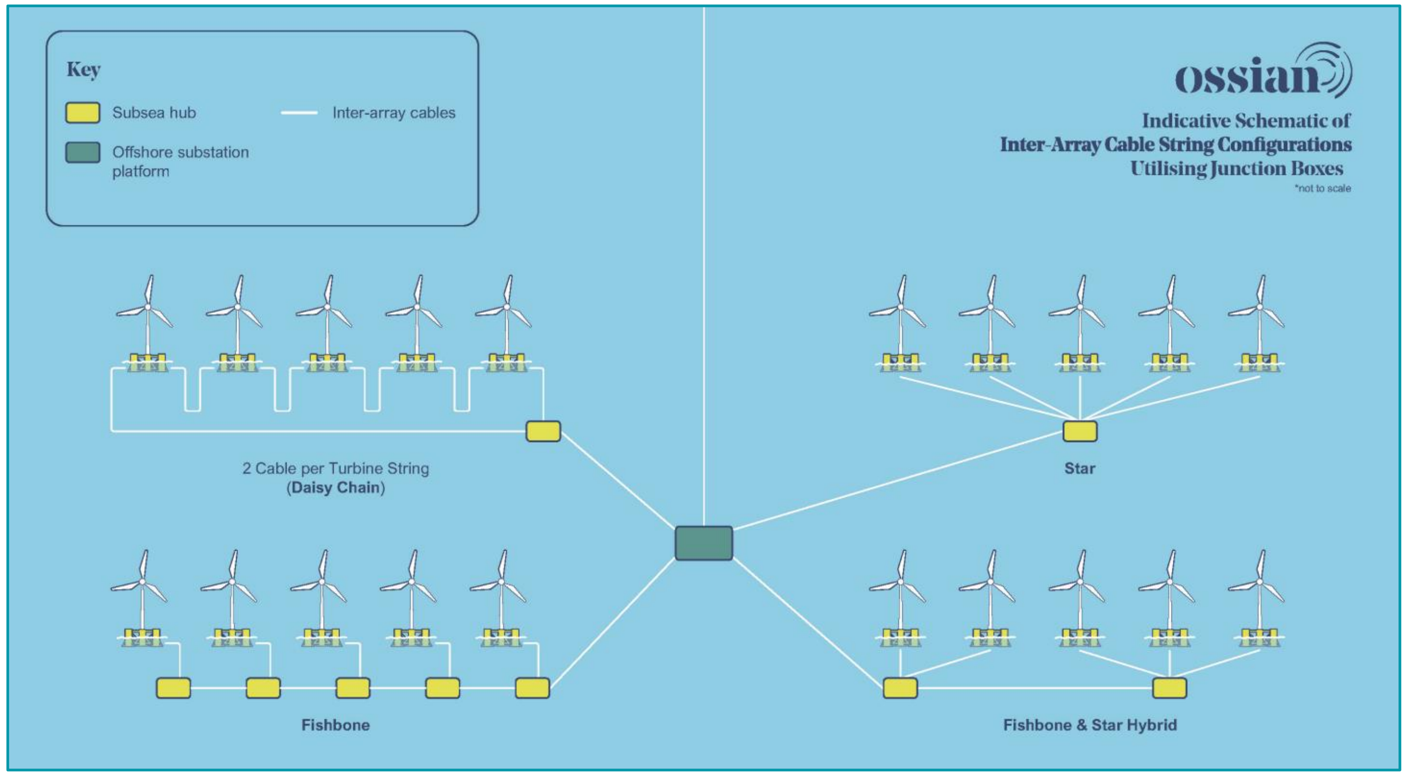

Figure 4.14: Schematic of Indicative Inter-Array Cable String Configurations utilising Junction boxes (Subject to Detailed Design Configuration)

108. The maximum design envelope for inter-array cables, presented in Table 4.18, takes into account these potential configurations and, therefore, allows flexibility in design should any of these configurations be employed alongside the subsea junction boxes.

109. The maximum design envelope for the subsea junction boxes is presented in Table 4.19. At this stage, the design of the subsea junction boxes is conceptual, therefore, some parameters included are estimated; this is indicated in Table 4.19 as appropriate. In addition, the parameters presented in Table 4.19 take into account the junction boxes associated with the various inter-array cable configurations, therefore, the parameters represent a conservative estimate which is considered to be the maximum design scenario. The parameters included within the maximum design envelope for the subsea junction boxes account for ongoing development of this technology and allows flexibility in the future.

Table 4.19: **Maximum Design Envelope: Subsea Junction Boxes**

Parameter	Maximum Design Envelope
Maximum number of subsea junction boxes	228
Maximum average cable length from floating foundation to subsea junction boxes (m)	3,000
Maximum length of subsea junction boxes on seabed (m)	18
Maximum width of subsea junction boxes on seabed (m)	10
Maximum height of subsea junction boxes (m)	6
Material type	Steel (assumed)
Scour protection	
Maximum area of scour protection per subsea junction box (m^2)	884
Maximum height of scour protection per subsea junction box (m)	1.5
Maximum volume of scour protection per subsea junction box (m^3)	1,326
Maximum area of seabed preparation per subsea junction box (m^2)	884
Anchoring	
Anchoring method	Ballasting where the design and weight of the junction box base stabilises the structure on the seabed. Suction anchors (using similar technology as described in Table 4.5)

Interconnector cables

110. Interconnector cables connect OSPs to one another and provide redundancy should there be any failures within the electrical transmission system. It is expected that these cables will be a combination of HVAC and HVDC. The maximum design envelope is presented in Table 4.20

111. Up to 236 km of interconnector cables will be installed within the Array. It is anticipated that cables will be protected via burial methods and will be buried at a minimum target depth of 0.4 m (subject to CBRA). External cable protection will be used in areas where minimum target burial depth cannot be achieved. Site preparation activities may also be required to provide relatively flat seabed surface for installation of cables and enable burial of interconnector cables to target depths.

Table 4.20: **Maximum Design Envelope: Interconnector Cables**

Parameter	Maximum Design Envelope
Maximum total cable length (km)	236
Maximum external cable diameter (mm)	300
Cable burial methodology	Cable plough Jet trencher Mass flow excavator Mechanical cutter
Minimum target burial depth (m)	0.4 (subject to CBRA)
Maximum width of cable trench (m)	2
Maximum width of seabed affected from installation tool per cable (m)	20

External cable protection

112. Where minimum target cable burial depth cannot be achieved, external cable protection methods will be employed to restrict movement and prevent exposure over the lifetime of the Array. This will protect cables from activities such as fishing, anchor placement or dropped objects, and limit effect of heat and/or electromagnetic fields. External cable protection systems include concrete mattresses, rock placement, cast iron shells or polyurethane/polyethylene sleeving. The final solution(s) chosen at final design stage (post-consent) will be dependent upon seabed conditions and any potential interactions with human activities which may occur within the Array. Table 4.21 presents the maximum design envelope for external cable protection for inter-array cables and interconnector cables.

Table 4.21: **Maximum Design Envelope: External Cable Protection Parameters**

Parameter	Maximum Design Envelope	
	Inter-Array Cables	**Interconnector Cables**
Type	Concrete mattresses, rock, cast iron shells and polyurethane/polyethylene sleeving	Concrete mattresses, rock, cast iron shells and polyurethane/polyethylene sleeving
Maximum cable protection height (m)	3	3
Maximum cable protection width (m)	20	20
Maximum percentage of cables which may require cable protection (%)	20	30
Maximum length of cables which may require cable protection (m)	244,480	47,200
Maximum total cable protection footprint area for Array (m^2)	4,889,600	944,000
Maximum total cable protection volume for Array (m^3)	14,668,800	2,832,000

<u>Concrete mattressing</u>

113. Concrete mattresses comprising high strength concrete blocks and Ultraviolet (UV) stabilised polypropylene rope may be used as a means of external cable protection for inter-array and interconnector cables and at cable crossings. The standard size of units is 6 m x 3 m x 0.3 m with standard density, however, size, density, and shape of units may be modified (within the parameters presented in Table 4.21) for example, by tapering edges of units for use in high current environments, or using denser concrete, so that they are engineered for and bespoke to the locality in which they are installed.

114. 69. Concrete mattresses are installed above the cables using a Dynamic Positioning (DP[1]) vessel and free swimming installation frame. The mattresses are lowered to the seabed and the installation frame is released in a controlled manner once in the correct position to deploy the mattress on the seabed. This installation process is repeated for each mattress along the length of cable that requires external protection. Dependant on expected scour, mattresses may be gradually layered in a stepped formation on top of each other.

<u>Rock placement</u>

115. Rock placement may also be utilised as a form of external cable protection for inter-array and interconnector cables and at cable crossings. Rock is placed on top of cables either by creating a berm or using rock bags (Figure 4.15).

116. Installation of rock placement in the form of berm creation will utilise a vessel with equipment such as a ‘fall pipe’ so that rock can be placed close to the seabed. Rock may be placed to a maximum height of 3 m

and 20 m width (see Table 4.21). The berm created via rock placement will be designed to provide protection from anchor strike and anchor dragging, and to reduce risk of snagging by towed fishing gear as far as practicable in line with best practice guidance. Depending on expected scour, the cross-section of the berm may vary, and the length of the berm will be dependent on the length of the cable which requires protection.

117. Alternatively, pre-filled rock bags may be used which will be placed above the inter-array and interconnector cables or cable crossings using installation beams. Rock bags consist of various sized rocks contained within a rope or wire net which are lowered to the seabed and deployed on to the seabed once in the correct position. Rock bags have typical dimensions of 0.7 m in height and 3 m diameter; the number of rock bags which may be required will be dependent on the length of cable which requires protection.

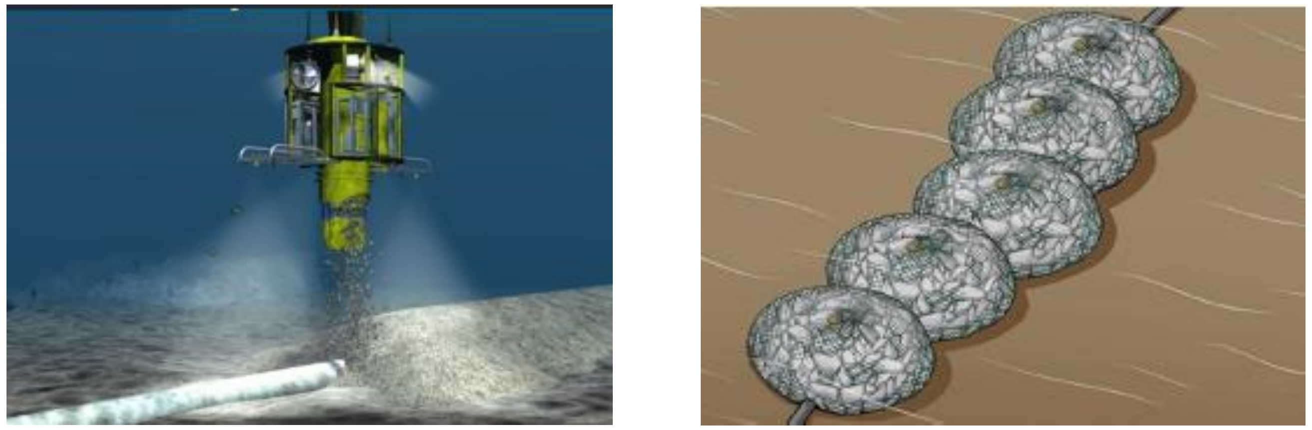

Figure 4.15: Rock Cable Protection Methods (Left: Rock Placement; Right: Rock Bags)

Cable crossings

118. Up to 12 inter-array cable crossings and up to 12 interconnector cable crossings may be installed across the Array. Cable crossings may comprise several different methods as demonstrated in Table 4.22, and additional cable protection will be installed at cable crossings. Table 4.22 presents the maximum design envelope for cable crossings, and accounts for additional protection required.

Table 4.22: Maximum Design Envelope: Cable Crossing Parameters

Parameter	Maximum Design Envelope	
	Inter-Array Cables	Interconnector Cables
Maximum number of crossings	12	12
Crossing material/method	Concrete mattresses, rock bags, rock, cast iron shells and polyurethane/polyethylene sleeving	Concrete mattresses, rock bags, rock, cast iron shells and polyurethane/polyethylene sleeving
Maximum height of crossing (m)	4	4
Maximum width of crossing (m)	20	20
Maximum length of each crossing (m)	50	50
Maximum length of crossings across the Array (m)	600	600
Maximum total area of crossings (m^2)	12,000	12,000
Maximum volume of protection material (per crossing) (m^3)	4,000	4,000
Maximum total volume of crossing protection across the Array (m^3)	48,000	48,000

4.4. SITE PREPARATION ACTIVITES

119. Prior to the construction phase of the Array, a number of site preparation activities will be required to be undertaken. It is assumed that site preparation works will continue throughout the construction phase as required, therefore, these works may be undertaken at any point within the construction programme. A summary of site preparation activities is provided in this section.

4.4.1. PRE-CONSTRUCTION SURVEYS

120. Pre-construction surveys, including geophysical and geotechnical surveys, may be carried out to provide further information of:

- seabed conditions and morphology;
- soil conditions and properties;
- presence or absence of any potential obstructions or hazards; and
- to inform detailed design for the Array.

121. Geophysical surveys will be undertaken within the Array to provide further information of Unexploded Ordnance (UXO), bedforms and mapping of boulders, bathymetry, topography and sub-surface layers. Geophysical survey techniques to be employed include Multibeam Echosounder (MBES), magnetometer, Side-Scan Sonar (SSS), Sub-Bottom Profiler (SBP) and Ultra-High Resolution Seismic (UHRS).

122. Geotechnical surveys will be carried out at specific locations within the Array and will employ techniques such as Cone Penetration Tests (CPTs), vibrocores, box cores, piston cores and boreholes.

4.4.2. CLEARANCE OF UNEXPLODED ORDNANCE

123. The possibility exists for UXO originating from World War I or World War II to be present within the Array. Due to the health and safety risks posed by UXO and potential interactions with planned locations of installed infrastructure and vessel activities, it is necessary for UXO to be surveyed and managed carefully before the construction phase and installation of offshore infrastructure commences.

124. A desk-based study of the Array (Ordtek, 2022) reviewed the relevant military history in the vicinity of the Array and the likelihood of encountering UXO. Based on known military activity the desk-based study concluded that there was a low background risk of UXO within the Array, and the likelihood of encountering different types of UXO within the Array was considered to be unlikely, meaning that it would be unusual for UXOs to be encountered within the Array. However, due to existing evidence of use in the wider area, potential for unrecorded activities such as munitions dumping, and potential for burial and migration of UXO due to natural seabed processes, the potential presence of UXOs cannot be discounted (Ordtek, 2022).

125. Methodologies considered within the PDE to avoid/clear UXOs are as follows:

- avoid and leave *in situ;*
- micrositing of offshore infrastructure to avoid UXO;
- relocation of UXO to avoid detonation;
- low order technique (e.g. deflagration); and
- high order detonation (with associated mitigation measures).

126. Due to the health and safety risks that UXOs pose, the Applicant would seek to either avoid UXOs entirely, avoid UXOs via micrositing, or relocate UXO where practicable. If methods cannot be employed to avoid UXOs, a specialist contractor will clear UXOs in advance of further site preparation and construction works taking place. The preferred clearance method for UXO is use of a low order technique with a single donor charge of 0.25 kg Net Explosive Quantity (NEQ) for each clearance event. Up to 0.5 kg NEQ clearance shot will be required for neutralisation of residual explosive material at each location. Detailed design work would be required to confirm planned locations of infrastructure, prior to conducting any UXO surveys. The Applicant have assumed that up to 15 UXOs may require clearance based upon the desk-based study (Ordtek, 2022) and experience from other offshore wind farms in the region such as the Seagreen 1 Offshore Wind Farm. As a risk remains that unintended high order detonation may occur, 10% of clearance events have been assumed to have the potential to result in high order detonation.

127. Table 4.23 presents the maximum design envelope for UXO clearance.

Table 4.23: Maximum Design Envelope: Unexploded Ordnance Parameters

Parameter	Maximum Design Envelope
Theoretical maximum weight anticipated to be encountered (kg)[8]	698
Maximum realistic charge weight (kg)[9]	227
Maximum estimated number of UXOs anticipated to be identified	15
Maximum estimated number of UXOs anticipated to be cleared	15
Maximum number of detonation activities occurring within 24 hours	2
Maximum total duration of UXO clearance activities (days)	8

4.4.3. SAND WAVE CLEARANCE

128. Existing sand waves may need to be cleared in some areas of the Array prior to the installation and burial of inter-array and interconnector cables. There are two main reasons for undertaking sand wave clearance:

- To provide a relatively flat seabed surface for cable installation and so that cable burial tools can work effectively: if cables are installed up or down a slope over a certain angle, or where the cable burial tool is working on a camber, the ability to meet target burial depths may be impacted.
- In order for cables to be buried at the target burial depth and remain buried for the operational lifetime of the Array (35 years): as sand waves are generally mobile in nature, the cable must be buried beneath the level where natural sand wave movement could uncover it. Therefore, for this to be achieved, mobile sediments may need to be removed before cables are installed and buried.

129. No large bed forms were observed as being prevalent across the site. It is expected based on geophysical data that if sand wave clearance is required it will be undertaken in specific discrete areas of the Array (e.g. along inter-array and interconnector cables) and could occur throughout the construction phase.

130. Sand wave clearance techniques could include pre-installation ploughing which flattens sand waves and pushes sediment from wave crests into adjacent troughs to level the seabed may be employed. It is not anticipated that large scale dredging would be required within the site boundary.

131. Table 4.24 presents the maximum design envelope for sand wave clearance. A geophysical survey campaign will be completed prior to construction which will allow the final parameters for sand wave clearance to be defined.

Table 4.24: Maximum Design Envelope: Sand Wave Clearance Parameters

Parameter	Maximum Design Envelope
Inter-Array Cables/Interconnector Cables	
Maximum width of sand wave clearance along inter-array/interconnector cables (m)	24
Maximum percentage of total length of inter-array/interconnector cable requiring sand wave clearance (%)	20
Maximum area of sand wave clearance along inter-array cables (m^2)	5,867,520
Maximum area of sand wave clearance along interconnector cables (m^2)	1,132.8
Maximum volume of sand wave clearance along inter-array cables (m^3)	5,867,520
Maximum volume of sand wave clearance along interconnector cables (m^3)	1,132.8
OSP	
Maximum area of sand wave clearance per large OSP for scour protection (m^2)	16,388
Maximum area of sand wave clearance per small OSP for scour protection (m^2)	4,594.39
Maximum area of sand wave clearance for OSP Option 1 (6 x large OSPs) for scour protection (m^2)	98,325
Maximum area of sand wave clearance for OSP Option 2 (3 x large OSPs, and 12 x small OSPs) for scour protection (m^2)	104,295
Maximum volume of sand wave clearance per large OSP for scour protection (m^3)	16,388
Maximum volume of sand wave clearance per small OSP for scour protection (m^3)	4,595
Maximum volume of sand wave clearance for OSP Option 1 (6 x large OSPs) for scour protection (m^3)	98,325
Maximum volume of sand wave clearance for OSP Option 2 (3 x large OSPs, and 12 x small OSPs) for scour protection (m^3)	104,295

4.4.4. BOULDER CLEARANCE

132. Boulder clearance may be required in some areas of the Array prior to installation of offshore infrastructure, in particular, along inter-array cables and interconnector cables. A boulder is defined as being over 256 mm (Wentworth Scale) in diameter and/or length. A DP[1] vessel is likely to be used to undertake the boulder clearance campaign.

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[8] Based upon findings of the Ordtek (2022) desk-based study. This value is based upon German World War II ground mines; these have not been recorded as having been present within the vicinity of the Array, however, there is a background risk from unrecorded mine lays. The likelihood of encountering a UXO of this type and charge weight is considered very unlikely as these types of mines typically targeted ports and shallower waters than are recorded within the Array (Ordtek, 2022).

[9] Based upon findings of the Ordtek (2022) desk-based study. This value is based upon British World War II mines; a total of nine British World War II minefields are recorded as having been present within the vicinity of the Array, the closest of which was recorded as being located 23 km north of the Array. Although mine sweeping operations were undertaken within the vicinity, there is potential for migration and subsequent burial of UXO from their original lay position, therefore, there is potential that these may be encountered within the Array although this is considered unlikely (Ordtek, 2022).

133. Boulder clearance is required to aid cable installation and increase the success rate for achieving minimum target burial depth during cable burial, therefore, reducing the risk of further cables burial works and/or the need for cable protection. Boulder clearance also reduces the risk of cable damage during installation and subsequent burial. It may also be required in the vicinity of the OSP jacket foundation locations (including within the jack-up vessel zone around the OSP foundation locations), to avoid disruption to installation activities and to ensure stability for the jack-up vessel. The maximum design envelope for boulder clearance in the Array is presented in Table 4.25.

134. Boulders may be cleared using a plough or boulder grab, however, the geophysical and pre-construction surveys, and the parameters of any boulders present (e.g. size, density and location of boulders), will inform the methodology to be used. It is possible that more than one method of boulder clearance may be deployed across the Array. Cleared boulders will be relocated to an appropriate location within the site boundary.

Table 4.25: Maximum Design Envelope: Boulder Clearance Parameters

Parameter	Maximum Design Envelope
Maximum width of boulder clearance along inter-array/interconnector cables (m)	24
Maximum area of boulder clearance along inter-array cables (m^2)	7,334,400
Maximum area of boulder clearance along interconnector cables (m^2)	1,416,000

4.4.5. VESSELS FOR SITE PREPARATION ACTIVITIES

135. The maximum design envelope for vessels to be used during site preparation activities is presented in Table 4.26.

Table 4.26: Maximum Design Envelope: Vessels for Site Preparation Activities

Parameter	Maximum Design Envelope	
	Maximum Total Number of Vessels on Site at any One Time	Total Movements (Return Trips Across Site Preparation Activities)
Survey vessel	2	10
Boulder clearance vessel	3	42
Geophysical/geotechnical survey vessel	2	10
Sand wave clearance vessel	1	2
UXO clearance vessel	2	4
Total	**10**	**68**

4.5. CONSTRUCTION PHASE

Methodology

136. Construction of the Array is expected to occur over a period of eight years cumulatively aligning with the following indicative construction series:

- step 1 – anchoring and mooring installation;
- step 2 – OSP topsides and fixed jacket foundations installation/commissioning;
- step 3 – inter-array and interconnector cables installation, including cable burial and/or protection, where required; and
- step 4 – floating wind turbine and floating foundation installation/commissioning.

137. The following subsections summarise these steps.

Step 1 – Anchoring and mooring installation

138. Moorings and anchoring systems will be transported to the Array by vessel and pre-laid at the installation locations (exact locations to be confirmed at final design stage (post-consent)), prior to installation of all other infrastructure. It should be noted that some components, such as anchors, mooring chains and clump weights may be wet stored within the Array and close to the final installation locations to optimise delivery schedules. These will not be wet stored for an extended period, but they may be queued whilst installation of mooring and anchoring systems and other construction works are ongoing.

139. There are several anchoring options being considered, however, these will comprise either driven piles or DEAs alone, or a combination of driven piles and DEAs/suction anchors, depending on seabed conditions. Driven piles will be installed in the seabed using a vibro/hydraulic hammer until any hard ground is encountered. Drilling techniques may be used to install the remaining length of pile, if required.

140. Anchoring systems will be transported to site using an installation vessel(s) (e.g. heavy lift vessels) and installed in the seabed using a crane and other equipment as appropriate. The mooring lines will then be connected to the anchoring system using LTM connectors, or similar. Once mooring and anchoring systems are installed, mooring lines will be left lying on the seabed until they are hooked up to the floating foundations. Ancillaries such as clump weights may be used to temporarily anchor portions of the mooring lines to the seabed to restrict movement prior to hook up.

141. If DEAs are selected as an anchoring method for floating foundations (see Anchoring Option 2 and 3; Table 4.7 and Table 4.8), it is assumed that these will be lifted from the installation vessel using a crane and positioned on the seabed. The DEAs will then be pulled using a anchor handling tug or similar, in order to embed the anchor in the seabed. The anchor will likely be pulled 30 m to 60 m during the installation process and subject to further ground investigations and anchor design. This process will be undertaken in a controlled manner to ensure that DEAs are installed at the correct position and to appropriate depth.

142. If suction anchors are selected as an anchoring method for floating foundations (see Anchoring Option 4; Table 4.9), it is assumed that a crane will be used to lift the jacket foundation from the installation vessel towards the seabed. Once the steel caisson reaches the seabed, water is sucked out of each bucket via a pipe which runs through the stem above each caisson. The resulting suction force allows the buckets to penetrate into the seabed. Once the bucket has penetrated the seabed to the desired depth, the pump is turned off. A thin layer of grout is then injected under the bucket to fill the air gap and ensure contact between the soil within the bucket, and the top of the bucket itself.

143. Table 4.27 presents the piling characteristics required for the installation of the anchoring and mooring systems, if driven piles are selected as an anchoring method (see Anchoring Option 1, 3, 4 and 5; Table 4.6, and Table 4.8 to Table 4.10). It is assumed that a crane will be used to lower the pile to the seabed and will be kept in position using a pile gripper. To enable pile placement, a pile installation frame may be temporarily placed on the seabed, which will be moved to the next location once the piles are installed. A hydraulic hammer will be positioned onto the pile, driving it to target depth. A hammer energy of 3,000 kJ has been considered as the MDS for the purposes of assessment.

144. Piling will commence with a lower hammer energy of approximately 450 kJ and will slowly ramp up energy up to a maximum 3,000 kJ, if required, over a period of 20 minutes. Detailed geotechnical data of the Array will be reviewed to inform a driveability assessment which will in turn inform maximum realistic hammer energy required for piling. The findings of this study will allow the final hammer energies used to be optimised so that piling progress can be maintained whilst reducing required hammer energy. It is anticipated that the maximum hammer energy stated in Table 4.27 will only be required at some piling

locations. Up to two piling events occurring simultaneously at wind turbines (or wind turbine and OSP locations) are considered within the PDE. No concurrent piling of OSP foundations is proposed. The maximum design envelope for the driven piles associated with the wind turbine anchoring is presented in Table 4.27.

145. If scour protection is required, this will be installed at a later stage following installation of the anchoring systems.

Table 4.27: Maximum Design Envelope: Wind Turbine Anchoring – Piling Characteristics

Parameter	Maximum Design Envelope
Maximum number of piles requiring piling	1,590[10]
Maximum hammer energy (kJ)	3,000
Soft start energy (% of maximum hammer energy)	15%
Duration	
Maximum soft start duration (minutes)	20
Maximum duration of piling per pile (hours)	8
Maximum number of piles installed over 24 hours	8
Estimated average number of piles installed over 24 hours	4
Maximum duration of piling per day over construction phase (hours)	24
Average duration of piling per day over construction phase (hours)	18
Maximum total number of days when piling may occur over construction phase	795
Concurrent piling	
Maximum number of concurrent piling events	2
Minimum distance between concurrent piling events (m)	950
Maximum distance between concurrent piling events (km)	41

146. If hard ground is encountered which makes pile driving unsuitable, drilling may be required. In this case, a sacrificial caisson may be installed to support surficial soils during the drilling activities; this would be driven into the seabed and left in place. The pile would then be lowered into the drilled bore and grouted in place, with the voids (annuli) between the pile and the rock, and between the pile and the caisson, filled with inert grout. The grout would be pumped from a vessel into the bottom of the drilled hole. The process would be subject to control measures and monitoring to ensure minimal spillage to the marine environment. Drilling characteristics are presented in Table 4.28.

147. Seabed material (drill arisings) will be released as a result of drilling activities. This material will be deposited adjacent to each drilled foundation location within the Array.

Table 4.28: Maximum Design Envelope: Wind Turbine Anchoring – Drilling Characteristics

Parameter	Maximum Design Envelope
Maximum number of piles requiring drilling over the Array	159
Maximum (%) of all piles requiring drilling over the Array	10
Minimum drilling rate (m/hour)	0.2
Maximum drilling rate (m/hour)	1.0
Maximum drilling depth (m)	40
Maximum drilling duration (per pile) (hours)[11]	200
Maximum drilling duration for Array (days)[12]	442
Maximum volume of drill arisings per pile (m^3)[13]	1,178
Maximum volume of drill arisings for the Array (m^3)[14]	131,123
Maximum number of concurrent drilling events	1

Step 2 – OSP topsides and fixed jacket foundation installation/commissioning

148. The OSP jackets will be fixed to the seabed using driven piles. Driven piles will be transported to the Array by vessel from the fabrication site or port facility and installed in the seabed at the installation locations (exact locations to be confirmed at final design stage (post-consent)). Should drilling techniques be required, this will follow the same methodology as described in paragraphs 146 and 147.

149. Piling will commence with a lower hammer energy of 660 kJ and will slowly ramp up energy up to a maximum 4,400 kJ over a period of 20 minutes. No concurrent piling is proposed across multiple OSPs. Concurrent piling may occur between an OSP and a turbine location.

150. Once the driven piles have been installed, the OSP jackets will be delivered to site by barge or delivery vessel, lowered to the seabed using a crane, and installed over the pre-installed driven piles. Once in place the jackets would be grouted onto the piles.

151. The maximum design envelope for the driven piles associated with the OSPs foundations is presented in Table 4.29. Drilling characteristics are presented in Table 4.30.

Table 4.29: Maximum Design Envelope: OSP Options – Piling Characteristics

Parameter	Maximum Design Envelope	
	OSP Option 1	**OSP Option 2**
Maximum number of piles requiring piling	144	216
Maximum hammer energy (kJ)	4,400	4,400
Soft start energy (% of maximum hammer energy)	15%	15%
Duration		
Maximum soft start duration (minutes)	20	20
Maximum duration of piling per pile (hours)	8	8
Maximum number of piles installed over 24 hours	8	8
Maximum average number of piles installed over 24 hours	4	4
Maximum duration of piling per day over construction phase (hours)	20	20
Average duration of piling per day over construction phase (hours)	16	16
Maximum total number of days when piling may occur over construction phase	48	72
Concurrent piling		
Maximum number of concurrent piling events	1	1
Minimum distance between concurrent piling events (m)	N/A	N/A

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[10] Based upon Anchoring Option 1 (driven piles only) for 265 foundations.

[11] Based upon Anchoring Option 1 (driven piles only) for 265 foundations with minimum drilling rate of 0.2 m per hour.

[12] Based upon Anchoring Option 1 (driven piles only) for 265 foundations.

[13] Based upon Anchoring Option 5 (Driven piles only, shared anchoring between floating foundations) for 265 foundations.

[14] Based upon Anchoring Option 5 (Driven piles only, shared anchoring between floating foundations) for 265 foundations.

Parameter	Maximum Design Envelope	
	OSP Option 1	OSP Option 2
Maximum distance between concurrent piling events (km)	N/A	N/A

Table 4.30: Maximum Design Envelope: OSP Options – Drilling Characteristics

Parameter	Maximum Design Envelope	
	OSP Option 1	OSP Option 2
Maximum number of piles requiring drilling per foundation	24	36
Maximum (%) of all piles requiring drilling over the wind farm	100	100
Minimum drilling rate (m/hour)	0.2	0.2
Maximum drilling rate (m/hour)	1.0	1.0
Maximum drilling depth (m)	85	85
Maximum drilling duration (per pile) (hours)[15]	425	425
Maximum drilling duration for Array (days)	2,550	3,825
Maximum average drilling duration for Array (days)	850	1,275
Maximum volume of drill arisings per pile (m^3)	300	300 for large OSPs and 200 for small OSPs
Maximum volume of drill arisings for Array (m^3)	43,260	50,470
Maximum number of concurrent drilling events	1	1 for large OSPs and up to 2 for small OSPs

152. Once the jacket foundations are installed, the OSP topsides will be transported to the Array via vessel either from the fabrication yard or the port facility. It is likely this will be transported by the installation vessel or on a barge towed by a tug. Once on site, the OSP topside will be rigged up, sea fastening cut, lifted and installed onto the foundation. The topside and foundation will then be welded or bolted together. Rigging, welding and bolting equipment will be available on board the installation vessel.

153. It is expected that commissioning works will be carried out using a jack-up or DP[1] vessel. Assisting support and supply vessels will be used as required and Crew Transfer Vessels (CTVs) will be used for transfer of personnel to and from the installation vessel.

Step 3 – Inter-array and interconnector cable installation

154. A cable lay vessel will be used for installation (lay) of inter-array cables and interconnector cables (Figure 4.16) using various equipment such as a carousel or reels, tensioners and cable lay spread. Inter-array cables and interconnector cables are typically surface laid prior to cable burial or installation of external cable protection post lay. Cable lay and cable burial can also be performed simultaneously.

155. There are several options which may be used to bury cables to the minimum target burial depth. Equipment that may be used to bury the static portion of the inter-array and interconnector cables include:

- Jet trenchers or mass flow excavators which inject water at high pressure into the sediment surrounding the cable. Jet trenching tools use water jets to fluidise the seabed which allows the cable to sink into the seabed under its own weight.
- Mechanical trenchers, usually mounted on tracked vehicles, which use chain cutters or wheeled arms with teeth or chisels to cut a trench across the seabed.

156. Cable ploughs are usually towed either from a vessel or vehicle on the seabed. There are two types of plough:

- a displacement plough which creates a V shaped trench into which the cable can be laid; or
- a non-displacement plough which simultaneously lift a share of seabed whilst depressing the cable into the bottom of the trench. As the plough progresses, the share of the seabed is replaced on top of the cable.

157. Paragraph 118 describes cable crossings potentially required for the inter-array and interconnector cables.

158. Junction boxes will be installed from a Construction Support Vessel (CSV) with adequate craneage and laid on the seabed. The junction boxes will then be secured by the structure's design (e.g. gravity anchors which are buried in the sediment with burial depth dependent upon various factors such as weight, geometry and soil characteristics) or through suction anchors, depending on ground conditions. Once in position the inter-array cables will be pulled into the junction boxes and secured by ROV.

159. The inter-array cables will run from the floating foundation to the junction box as described in paragraph 107.

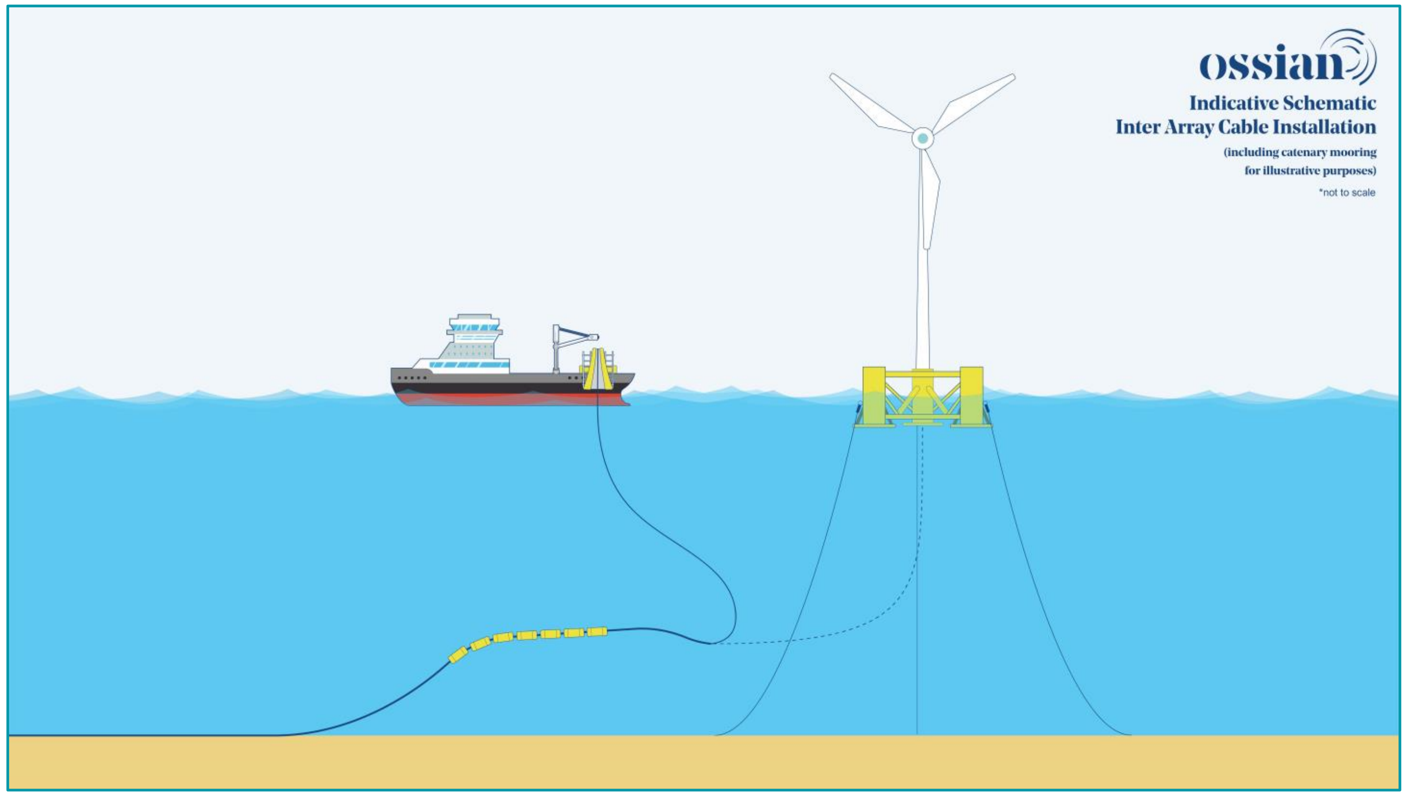

Figure 4.16: Indicative Schematic of Inter-Array Cable Installation from Vessel

Step 4 – Floating wind turbine and floating foundation installation/commissioning

160. Floating foundations will be fabricated and assembled at a fabrication yard. The floating foundations will be wet stored within harbour limits of the fabrication yard / integration port. A supply of floating foundations

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[15] Based upon the minimum drilling rate of 0.2 m per hour.

will be assembled in advance of turbine delivery to optimise the integration programme. The floating foundations will then be towed or dry transported on a barge or delivery vessel to the final wind turbine assembly yard using anchor handling tugs (Figure 4.17, step 1). The wind turbines (comprising nacelle, rotor blades, hub and towers) will be assembled and integrated onto the floating foundations at the final wind turbine assembly yard (Figure 4.17, step 2). The schedule for integration of wind turbines with floating foundations will be optimised so that there is limited requirement for wet storage at this stage. It is not anticipated that integrated floating wind turbines will be queued at the wet storage area awaiting tow to the Array, instead, they will be towed to the installation location within the Array as soon as they are pre-commissioned, by up to two anchor handling tugs, or similar, (exact locations to be confirmed at final design stage (post-consent)) (Figure 4.17, step 3). Most floating substructures will employ a ballasting system to control their draft and level of submergence when transported or in operation. The ballasting methodology shall be dependent on the final substructure design and water depth of the final integration port. Some concepts allow the control of the ballast inside different compartments in the structure to modify the response of the floating wind turbine during operation, effectively applying an active control on the volume and mass of the ballast distribution. Active ballast will require special equipment hosted on board (e.g. pumps, pipes, valves). The ballasting material may vary across concepts but generally consists of sea water for the part of the ballast that will be changed for transportation or operation. Permanent ballast (i.e. ballast that won't be modified during the design life of the foundation) is usually made of solid material (gravel, sand, iron ore etc.) and would be placed and sealed prior to load-out. At the installation location, the integrated floating wind turbines will be installed and hooked up to the pre-installed mooring system (Figure 4.17, step 4). Depending on the foundation concept, the final placement and positioning of the floating wind turbines prior to commissioning may require the adjustment of the ballast configuration.

161. Following hookup of the pre-existing mooring system to the integrated floating wind turbines, dynamic inter-array cables are 'pulled-in' to the integrated floating wind turbines using a cable laying vessel and connected to the wind turbine. Buoyancy modules, and tether clamps with clump weights, will be installed as required in order to maintain the dynamic inter-array cable configuration. Following connection to the necessary cabling, a process of testing and commissioning will be undertaken.

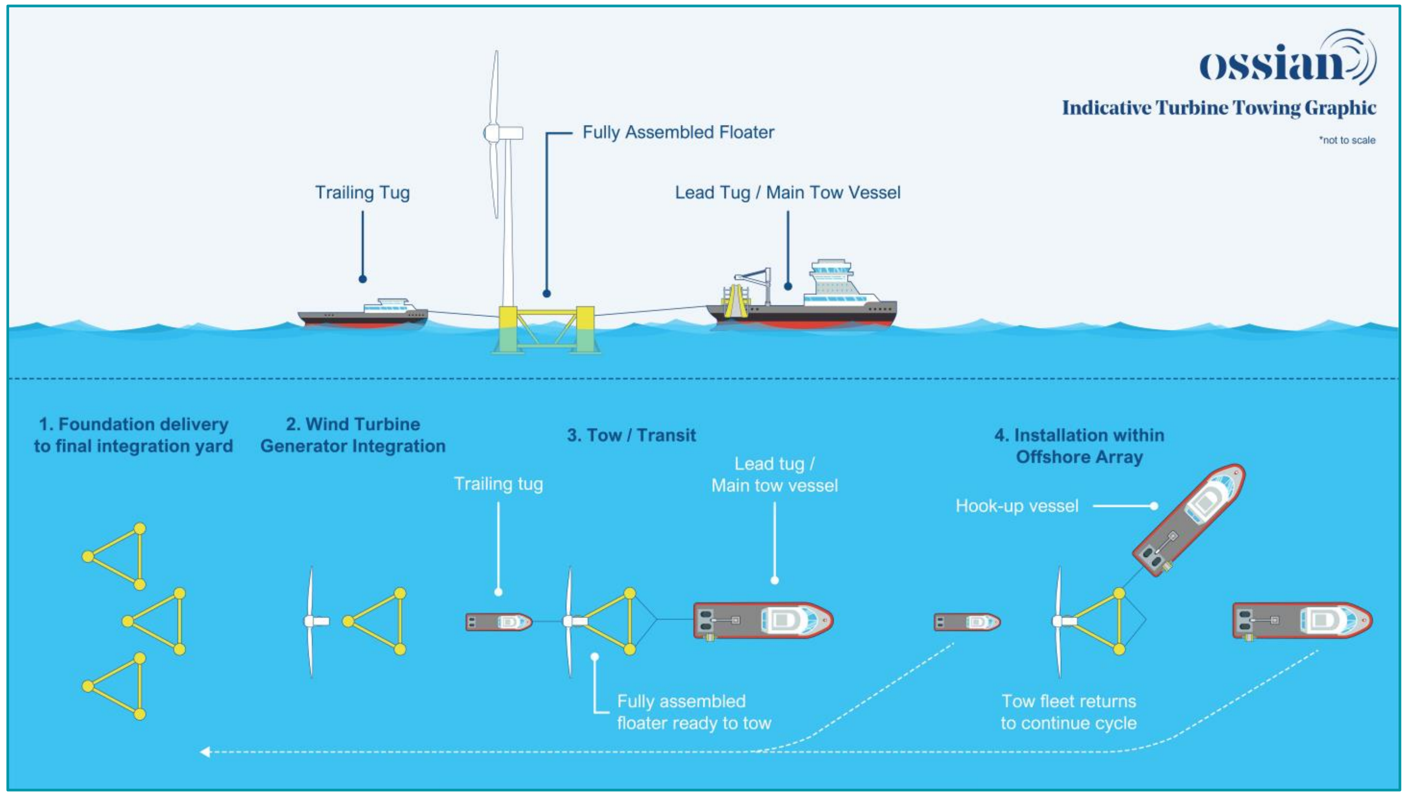

Figure 4.17: Indicative Schematic of Floating Wind Turbine and Floating Foundation Installation and Towing Operations During the Construction Phase

4.5.2. INSTALLATION VESSELS AND HELICOPTERS

162. A number of installation vessels will be used during the construction phase including main installation vessels (e.g. DP[1] vessels with heavy lifting equipment), support vessels (including Service Operation Vessels (SOVs)), tugs and anchor handlers, cable installation vessels, guard vessels, survey vessels, CTVs and scour/cable protection installation vessels. Helicopters may also be used for crew transfers.

163. Table 4.31 presents the maximum design envelope for vessels and helicopters used for the construction phase. The number of vessels/helicopters on site at any one time and the total vessel/helicopter movements (return trips) during the entire construction phase are presented in this table. The vessel numbers presented in Table 4.31 are an estimated maximum design scenario for the purposes of the assessment, and it is anticipated that vessel and helicopter numbers will be less than those presented in reality. The maximum number of vessels is 89 on site at any one time with up to 7,834 return trips.

Table 4.31: Maximum Design Envelope: Infrastructure Installation – Vessels and Helicopters

Parameter	Maximum Design Envelope	
	Maximum Total Number of Vessels on Site at any One Time	**Total Movements (Return Trips Across Site Preparation Activities)**
Main installation vessels (jack-up -/DP vessel)	6	220
Cargo barge/Heavy Transport Vessels (HTVs) (self-propelled)	9	421
Support vessels (including SOVs)	10	1,269

Parameter	Maximum Design Envelope	
	Maximum Total Number of Vessels on Site at any One Time	**Total Movements (Return Trips Across Site Preparation Activities)**
Tug/anchor handlers	27	2,059
CSVs	6	1,353
Cable installation vessels	3	236
Guard vessels	6	1,026
Survey vessels	3	70
CTVs	6	770
Trenching support vessels	3	189
Geophysical/geotechnical survey vessels	2	40
Sand wave clearance vessels	1	40
Pre-Lay Grapnel Run (PLGR) vessels	2	64
Rock dumping vessels	2	40
Dive Support Vessels (DSVs)	1	36
Helicopters	7	3,942
Total	**94**	**11,776**
Total (excluding helicopters)	**87**	**7,834**

164. Jack-up vessels or barges touch down on the seabed when their jack-up spud cans (base structure of each leg) are lowered into place. Jack-up vessel parameters are presented in Table 4.32.

Table 4.32: Maximum Design Envelope: Jack-up Vessels

Parameter	Maximum Design Envelope
Maximum number of legs per vessel	4
Maximum individual leg diameter (m)	22
Maximum area of spud cans (m^2)	360
Maximum seabed footprint (m^2)	1,440
Maximum number of jack-up positions per small/large OSP	2

4.5.3. CONSTRUCTION PORTS

165. Fabrication of components for the Array infrastructure is likely to occur at a number of manufacturing sites including those located within Scotland, the UK, Europe, the Middle East and the Far East. It is likely that components will be transported to final assembly yards on the east coast of Scotland for final fabrication or integration before being towed to the Array.

166. It is anticipated that all components will be transported to the Array for installation via sea transport using vessels and associated equipment. It is not anticipated that large components (e.g. wind turbine blades) will be transported via road.

167. At time of writing this Array RIAA, the Applicant is yet to determine which construction port(s) will be used for the storage, fabrication, pre-assembly and delivery of the Array infrastructure. The Applicant will determine suitable ports based on the facilities available to handle and process components for the Array. Port selection will take into account logistics to reduce towing distance of foundations and integrated turbines as far as practicable. The Applicant anticipates that established port licences and operational controls will cover all activities associated with the Array which are carried out within port. In order to assess a MDS, the assessments within this Array RIAA consider a maximum number of vessels and vessel movements to/from site, where relevant from the east coast of Scotland or England.

168. Construction personnel will transit to the Array location on the installation vessels or other vessels listed in Table 4.31. CTVs, SOVs, or helicopters operating from a licenced airfield may be used to transfer crew between the port facility and the Array location during construction, operation and decommissioning.

169.

4.5.4. CONSTRUCTION PROGRAMME

170. The indicative construction programme for the Array is provided below. This indicative construction programme, including the estimated commencement and completion dates, and estimated durations of activities, has been used within the technical chapter assessments of construction impacts.

171. As described at paragraph 161, there is no intention to wet store integrated turbines within the limits of the final integration and marshalling port. The location of the final integration and marshalling port is currently unknown. The Applicant are currently developing a fabrication, delivery and integration strategy and engaging with a number of port and harbour operators to identify an optimised approach. In the absence of an integration and marshalling yard it is not possible, at this stage, to consider the potential site-specific impacts on relevant receptors. The Ossian construction programme will be managed to reduce the requirement for storage of integrated pre-commissioned turbines within port. A stock of floating foundations will be accumulated, and mooring lines and cables would be installed within the array in advance of turbine integration. The Applicant aims to minimise any wet storage requirements by towing integrated turbines to their final location within the array as soon as they are ready, subject to suitable weather conditions for transfer. Enabling works, including integration, and marshalling activities, required within the final integration port to cover turbine pre-commissioning, testing and storage (if required) will be covered by the consenting requirements applying to them (including any requirements for environmental assessment) and will be managed by the port or harbour authority with support where appropriate from the Applicant.

172. The Array will be built out over a period of up to eight years including site preparation works. Separate campaigns will be undertaken for the relevant assets and are likely to occur concurrently across the eight year construction period. It should be noted that the activities listed below will not occur continuously throughout the eight year period, rather, the programme indicates the period within which these activities could occur. Increased construction activity is anticipated within the spring to autumn months, with limited works undertaken at site during the winter period.

173. The indicative construction programme is as follows:

- Commencement of offshore construction phase (site preparation activities) expected Q2 2031;
- Completion of construction expected Q4 2038;
- Key construction activity and estimated durations:
    - Site preparation activities – estimated seven year duration between Q2 2031 and Q4 2037. These works will not be continuous;
    - Floating turbine mooring and anchoring installation – estimated seven year duration between Q2 2031 and Q4 2037. These works will not be continuous;
    - OSP topsides and fixed jacket foundations installation/commissioning – will occur for the duration of the construction period but will not be continuous;
    - inter-array and interconnector cables installation – will occur for the duration of the construction period but will not be continuous; and
    - floating wind turbine and floating foundation installation/commissioning – estimated seven year duration between Q2 2032 and Q4 2038. These works will not be continuous.

4.5.5. RECOMMENDED SAFE PASSING DISTANCES AND AIDS TO NAVIGATION

Safety zones, recommended safe passing distances and Notice to Mariners

174. The Applicant will communicate with other mariners of safe clearance distances around construction, installation, maintenance and decommissioning activities during the construction and operation of the Array as per standard practice and guidance.

Statutory safety zones

175. Volume 1, chapter 2 of the Array EIA Report describes the legislation for establishment of statutory safety zones. The Applicant intends to apply for the following safety zones for the Array:

- temporary (or rolling) 500 m safety zones surrounding the location of all surface piercing structures where construction work is being undertaken by a construction vessel;
- 50 m safety zones around all partially completed or completed surface piercing structures which are not yet fully commissioned during the construction phase; and
- 500 m around any structure where major maintenance is ongoing (major maintenance works are defined within the Electricity (Offshore Generating Stations) (Safety Zones) (Application Procedures and Control of Access) Regulations 2007.

176. The Applicant will apply for statutory decommissioning safety zones during the decommissioning phase (as appropriate) which are not anticipated to exceed the standard 500 m safety zone.

Recommended safe passing distances

177. The Applicant may use recommended safe passing distances during the construction, operation and maintenance and decommissioning phases for the safety of third party vessels. Notice to Mariners (NtMs) will be used to communicate these to sea users during all phases of the Array.

Aids to navigation

178. The floating wind turbines and OSPs will be lit and marked to aid navigation. The Lighting and Marking Plan (LMP) for the Array will be defined post consent in consultation with the Northern Lighthouse Board (NLB), Maritime and Coastguard Agency (MCA), the Civil Aviation Authority (CAA) and the Ministry of Defence (MOD).

179. Marine aids to navigation will be provided throughout the lifetime of the Array in accordance with the requirements of the NLB, MCA and MOD, and in adherence to Civil Aviation Publication 393 Article 223 (CAA (2016) (as amended)), unless otherwise agreed. Monitoring and maintenance of all navigational aids associated with the Array will be undertaken so that the relevant CAA availability targets are met.

4.6. OPERATION AND MAINTENANCE

4.6.1. METHODOLOGY

180. The overall operation and maintenance strategy will be finalised once the operation and maintenance base location and technical specification of the Array are known, including wind turbine type, electrical export option and final project layout. Therefore, this section provides an overview of the potential scheduled and unscheduled operation and maintenance activities within the Array which are reasonably foreseeable.

181. Routine operation and maintenance works will be conducted using SOVs, CTVs, and/or Remotely Operated Vehicles (ROVs). Divers and Dive Support Vessels (DSVs) may be utilised if required, although it is anticipated that diverless operations will be utilised as far as practicable. For infrequent major operation and maintenance works, including major component replacements, wind turbines will be decoupled from their mooring and anchoring systems and towed to a suitable port facility. Jack-up vessels will be used for infrequent major maintenance campaigns associated with the OSPs. ROVs will be used to inspect foundations, mooring and anchoring systems, and cabling. A summary of the reasonably foreseeable operation and maintenance activities is provided in the following sections.

182. Offshore operation and maintenance will comprise of both preventative and corrective activities.

Floating foundations (including mooring and anchoring systems)

183. The following operation and maintenance activities are expected to occur in relation to the floating foundations:

- routine inspections;
- geophysical surveys;
- repairs or replacements of navigational equipment and other ancillary equipment including condition monitoring equipment;
- removal of marine growth;
- repairs or replacements of corrosion protection anodes;
- removal of fishing debris;
- painting;
- replacement of access ladders and boat landings;
- modifications to/replacement of ancillary structures;
- repairs or replacement of any buoyancy aids and/or clump weights; and
- replacement of scour protection.

184. It is assumed that the majority of these activities will be carried out using Uncrewed Surface Vessels (USVs), SOVs, CTVs, ROVs, CSVs, DP2 vessels, survey vessels, and tug vessels, with appropriate equipment for the activity to be undertaken. Divers and DSV may be required if necessary. Although it is assumed that the majority of these operation and maintenance activities will be routinely scheduled throughout the lifetime of the Array, repairs and replacements of navigational equipment, corrosion protection anodes and access ladders and boat landings, removal of marine growth and fishing debris, and painting are expected to be unscheduled. The frequency of these unscheduled activities will be dependent on the findings of routine inspections and will be carried out during other works as and when required.

Floating wind turbines

185. The following operation and maintenance activities are expected to occur in relation to the floating wind turbines:

- replacement of consumables;
- routine inspections;
- blade coatings/repairs;
- minor repairs and replacements within the wind turbines;
- major component replacement;
- painting or other coatings; and
- statutory inspections.

186. It is assumed that the majority of these activities will be carried out using SOVs and CTVs. ROVs, CSVs, tow vessels, cable vessels and anchor handler vessels may be used in the case of major component replacement which is anticipated to occur on an unscheduled basis (i.e. as and when required).

187. It is currently anticipated that any large operation and maintenance activities, including major component replacements will take place at a local operation and maintenance port or harbour facility. The process

would follow a reverse of the installation approach. It is anticipated that the following indicative steps will be followed to undertake any major operation and maintenance works:

- Disconnect and unhook the inter-array cables, and wet store on the seabed.
- Deballast the floating foundation, if required.
- Disconnect the mooring lines from the floating foundation and wet store on the seabed.
- Tow the turbine to a suitable operation and maintenance facility using up to two anchor handling tugs, or similar. It is expected that a quay side mounted crane, or a suitable alternative, will be used to undertake any major component replacements. Ballasting and de-ballasting at the quayside may also be required.

188. Following completion of operation and maintenance works, the wind turbine will be towed back to the turbine location within the Array. Mooring lines would be reconnected, the turbine foundation would be reballasted (as required) and the inter-array cable will be pulled into the turbine and reconnected.

189. Other operation and maintenance strategies would be considered including novel solutions which do not require towing to port. Temporary floating structures may also be used to and connected to mooring lines and dynamic cables to reduce the need for lowering to and recovery from the seabed.

OSP jacket foundations

190. The following operation and maintenance activities are expected to occur in relation to the OSP jacket foundations:

- routine inspections;
- geophysical surveys;
- repairs and replacements of navigational equipment and other ancillary equipment including condition monitoring equipment;
- removal of marine growth;
- replacement of corrosion protection anodes;
- painting;
- replacement of access ladders and boat landings;
- modifications to/replacement of J/I-tubes; and
- replacement of scour protection.

191. It is assumed that the majority of these activities will be carried out using USVs, SOVs, CTVs, ROVs, CSVs, and DP2 vessels, with appropriate equipment for the activity to be undertaken. Unscheduled maintenance activities as the same as described in paragraph 184 (with the exception of fishing debris removal which is not anticipated to be required for OSP jacket foundations), the frequency of which will be dependent on the findings of routine inspections and carried out during other works as and when required.

OSP topsides

192. The following operation and maintenance activities are expected to occur in relation to the OSP topsides:

- routine inspections;
- removal of marine growth;
- replacement of consumables and minor components;
- major component replacement; and
- painting or other coatings.

193. It is assumed that the majority of these activities will be carried out using SOVs and CTVs. Jack-up barges and/or heavy lift vessels may be required in the case of major component replacement. Although it is anticipated that the majority of these operation and maintenance activities will be routinely scheduled throughout the lifetime of the Array, replacement of consumables and minor components is an unscheduled activity which will occur as required, dependent upon the findings of routine inspections.

Inter-array and interconnector cables

194. The following operation and maintenance activities are expected to occur in relation to both the inter-array cables and interconnector cables:

- routine inspections;
- geophysical surveys;
- inter-array cable/interconnector cable repair;
- inter-array cable ancillary equipment repair;
- inter-array and interconnector cables reburial or installation of cable protection (if required);;
- removal of marine growth and/or fishing debris;
- modifications to/replacement of J/I tubes;
- replacement of scour protection; and
- repairs or replacement of buoyancy modules and/or clump weights

195. It is assumed that the majority of these activities will be carried out using USVs, SOVs, CTVs, ROVs, CSVs, DP2 vessels, survey vessels, and cable vessels, with appropriate equipment for the activity to be undertaken (including burial equipment). Divers and DSV may be required if necessary. It is anticipated that the majority of these operation and maintenance activities will be routinely scheduled throughout the lifetime of the Array.

4.6.2. OPERATION AND MAINTENANCE VESSELS

196. Table 4.33 presents the maximum design envelope for vessels involved in operation and maintenance activities for the Array.

Table 4.33: Maximum Design Envelope: Vessels Required During the Operation and Maintenance Phase

Parameter	Maximum Design Envelope	
	Maximum Total Number of Vessels on Site at any One Time	**Maximum Total Movements (Return Trips Across Operation and Maintenance Phase)**
CTV/SOV/workboats	9	117
Tug (anchor handlers) vessels	6	200
Jack-up vessels	2	5
Cable repair vessels (including burial solution)	2	40
CSV	5	60
DSV	1	26
Other vessels	6	60
Helicopters	3	216
Total	**34**	**724**
Total (excluding helicopters)	**31**	**508**

4.7. HEALTH AND SAFETY

197. Risk assessments for all elements of the Array will be undertaken as per the relevant government guidance and the Applicant's good practice procedures. The risk assessments will form the basis of the methods and safety mitigations put in place across the lifetime of the Array.

4.8. WASTE MANAGEMENT

198. The construction and decommissioning phases of the Array in particular will generate waste. A Site Waste Management Plan (SWMP) will be prepared and will describe the procedures for handling waste materials, the quantities of waste types generated as a result of the Array activities, and how these will be managed (e.g. disposal, reuse, recycle or recovery). Information on the management arrangements for the identified waste types and management facilities in the vicinity of the Array will also be provided within the SWMP.

199. The SWMP will be provided prior to construction when further detailed design information is available.

4.9. DECOMMISSIOING PHASE

200. In line with the requirements under Section 105 of the Energy Act 2004 (as amended), (described fully in volume 1, chapter 2 of the Array EIA Report), the Applicant will prepare a Decommissioning Programme for approval by the Scottish Ministers which will include anticipated costs and financial securities, and consider good industry practice, guidance and legislation relating to decommissioning at the time.

201. At the end of the Array's operational lifetime, it is expected that all structures above the seabed (with the exception of driven piles and DEAs (depending upon anchor system used), scour protection and cable protection) will be fully removed where feasible. Driven piles and/or DEAs installed as part of the wind turbine anchoring system, static portions of inter-array cables, interconnector cables, scour protection and cable protection are either expected to remain in situ or method of decommissioning is yet to be determined. Legislation, guidance and good practice will be kept under review throughout the lifetime of the Array and will be followed at the time of decommissioning. Environmental conditions and sensitivities will also be considered since removal of structures may result in greater environmental impacts in comparison to leaving *in situ.*

202. The sequence of decommissioning is likely to be the reverse of the construction sequence, and similar types and numbers of vessels and equipment are expected to be involved. The Option for Lease agreement for the Array awarded by the CES requires the Array to be decommissioned at the end of its lifetime.

4.9.1. OFFSHORE DECOMMISSIONING

Floating wind turbine components

203. The integrated floating wind turbines (i.e. floating wind turbine and floating foundation) will be removed from site by reversing the methods used to install them.

Wind turbine floating foundations – mooring and anchoring systems

204. Mooring lines will be fully removed from site where this be feasible and practicable. It may not be feasible to fully remove anchors where they are embedded in the seabed (e.g. DEAs or driven piles). These are expected to be left in situ and will follow good practice and consideration of environmental conditions and sensitivities. This will be reviewed throughout the lifetime of the Array and the most up to date and good practice guidance at time of decommissioning will be followed.

OSP topsides

205. OSP topsides will be fully removed from site by reversing the methods used to install them.

OSP fixed jacket foundations

206. Driven piles will be cut at seabed level and left *in situ*, depending on seabed mobility, to reduce further disruption of the seabed. This will be reviewed throughout the lifetime of the Array and the most up to date and good practice guidance at time of decommissioning will be followed. Jackets will be fully removed from site.

Scour protection

207. It is currently proposed that scour protection will be left *in situ* subject to the final material used. Good practice guidance at time of decommissioning will be followed.

Inter-array cables and interconnector cables

208. The dynamic portion of the inter-array cables within the water column will be fully removed. The approach for decommissioning the static portion of the inter-array cables and the interconnector cables on the seabed is yet to be determined, however, this will be reviewed throughout the lifetime of the Array and good practice guidance at time of decommissioning will be followed. Where cables remain buried these may be cut and left *in situ* taking account of environmental sensitivity at the time of decommissioning.

Cable protection

209. The approach for decommissioning the cable protection systems is yet to be determined, however, this will be reviewed throughout the lifetime of the Array and good practice guidance at time of decommissioning will be followed.

4.10. REPOWERING

210. Although it is standard procedure for sectors where a non-renewable resource is being exploited, such as oil and gas, for removal of all structures on the seabed as part of offshore decommissioning, the alternative option of repowering may be considered for offshore renewables – especially as, at the time of decommissioning, the need for the power generated will likely still exist.

211. The operational life of the Array is expected to be 35 years, during which there will be a requirement for upkeep and maintenance of the Array, as described in section 4.6.

212. 'Repowering' of the Array at or near the end of its design life may be considered suitable, for example, where new technology becomes available. In this example, wind turbines and/or foundations may be reconstructed and replaced with those of a different specification or design. If the specifications and designs of the new wind turbines and/or foundations fell outside of the MDS or if the impacts associated with the construction, operation and maintenance, and/or decommissioning the wind turbines and/or foundations were to fall outside those considered by this RIAA, further consent(s) (and potentially an EIA Report) would be required for repowering. Therefore, this is outside of the scope of this RIAA.

4.11. DESIGNED IN MEASURES

213. A number of designed in measures have been considered as part of the PDE which the Applicant commits to deliver as part of the development of the Array. Table 4.34 presents the designed in measures of relevance to the RIAA. As these measures have been incorporated into the description of the Array, they have also been considered within Part 2 and Part 3 of this RIAA, where relevant.

Table 4.34: Designed In Measures for the Array which are Relevant to the RIAA

Designed In Measures	Justification
Annex II Diadromous Fish	
The development of, and adherence to a Piling Strategy (PS) (or equivalent) which will set out the following measures: Implementation of initiation stage and soft start during piling. This will involve the use of a low hammer energy with a low number of strikes used initially, followed by lower hammer energies at a higher strike rate at the beginning of the piling sequence before energy input is 'ramped up' (increased) over time to required higher levels.	These measures will reduce the likelihood of injury from elevated underwater noise to marine life in the immediate vicinity of piling operations as far as practicable, allowing individuals to move away from the area before sound levels reach a level at which injury may occur.
UXO clearance using low order disposal techniques where technically feasible.	Low order techniques will be adopted wherever practicable (e.g. deflagration and clearance shots) as mitigation to reduce noise levels and thereby injury and disturbance to sound-sensitive receptors during UXO clearance. There is a small risk that low order disposal could unintentionally result in a high order detonation and therefore this scenario has also been considered in the assessment of LSE[1].
Development of, and adherence to an EMP (volume 4, appendix 21 of the Array EIA Report).	To ensure adequate environmental controls are in place across the project to manage and mitigate any potential risk to the environment. Measures will cover all aspects of environmental management including environmental awareness training, auditing, environmental reporting and waste management. It is anticipated that the MPCP and INNSMP will be appendices to the overarching EMP.
Development of, and adherence to a Marine Pollution Contingency Plan (MPCP) (volume 4, appendix 21, annex A of the Array EIA Report).	To reduce the potential for release of pollutants from construction, operation and maintenance and decommissioning plant is reduced so far as reasonably practicable. These will likely include designated areas for refuelling where spillages can be easily contained, storage of chemicals in secure designated areas in line with appropriate regulations and guidelines, double skinning of pipes containing hazardous substances, and storage of these substances in impenetrable bunds. All vessels associated with the Array will be required to comply with the standards set out by MARPOL.
Development of, and adherence to an Invasive Non-Native Species Management Plan (INNSMP) (volume 4, appendix 21, annex B of the Array EIA Report).	To reduce the risk of introduction and spread of INNS during all phase of the Array as far as reasonably possible.
Development of, and adherence to a CBRA	The CBRA will determine the risks arising from cable burial, such as scour, erosion, and dropped objects, and any measures to address them, in order to limit disturbance to the seabed as far as reasonably practicable.
Development of, and adherence to a Decommissioning Programme (DP[2])	The aim of this plan is to adhere to the existing UK and international legislation and guidance, with decommissioning industry practice applied. Overall, this will reduce the amount of long term disturbance to the environment as far as reasonably practicable.
Annex II Marine Mammals	
Development of, and adherence to an EMP (volume 4, appendix 21 of the Array EIA Report).	To ensure adequate environmental controls are in place across the project to manage and mitigate any potential risk to the environment. Measures will cover all aspects of environmental management including environmental awareness training, auditing, environmental reporting and waste management. It is anticipated that the MPCP and INNSMP will be appendices to the overarching EMP.
Development of, and adherence to a MPCP (volume 4, appendix 21, annex A of the Array EIA Report).	To reduce the potential for release of pollutants from construction, operation and maintenance and decommissioning plant is reduced so far as reasonably practicable. These will likely include designated areas for refuelling where spillages can be easily contained, storage of chemicals in secure designated areas in line with appropriate regulations and guidelines, double skinning of pipes containing hazardous substances, and storage of these substances in impenetrable bunds. All vessels associated with the Array will be required to comply with the standards set out by MARPOL.
Development of, and adherence to an INNSMP (volume 4, appendix 21, annex B of the Array EIA Report).	To reduce the risk of introduction and spread of INNS during all phase of the Array as far as reasonably possible.
The development of, and adherence to, a Navigational Safety and Vessel Management Plan (NSVMP) (volume 4, appendix 24 of the Array EIA Report)	The NSVMP will include measures to reduce disturbance to Annex II marine mammals from transiting vessels, requiring them to: • not deliberately approach marine mammals as a minimum; and • avoid abrupt changes in course or speed should marine mammals approach the vessel to bow-ride. The NSVMP will be implemented as far as practicable and where it does not compromise the safety of vessels..
The development of and adherence to a PS (or equivalent): Implementation of initiation stage and soft start during piling. This will involve the use of a low hammer energy with a low number of strikes used initially, followed by lower hammer energies at a higher strike rate at the beginning of the piling sequence before energy input is 'ramped up' (increased) over time to required higher levels.	The Piling Strategy (or equivalent) will be submitted post-consent in collaboration with stakeholders, including but not limited to, MD-LOT, Marine Directorate – Science, Evidence, Data and Digital (MD-SEDD), and NatureScot, following collation of additional data and final design parameters (e.g. piling locations, hammer energies). Noise modelling will be reviewed with the additional information and inform the final PS, which will be submitted to MD-LOT, following consultation with stakeholders. These measures will reduce the likelihood of injury from elevated underwater noise to marine mammals in the immediate vicinity of piling/UXO clearance operations as far as practicable, allowing individuals to move away from the area before sound levels reach a level at which injury may occur. This is in line with the most up to date guidance for piling/UXO clearance operations (Joint Nature Conservation Committee) (JNCC, 2010a, JNCC, 2010b)) and, in most cases, compliance with this guidance reduce the likelihood of injury to marine mammal receptors to negligible levels.
UXO clearance using low order disposal techniques where technically feasible.	Low order techniques will be adopted wherever practicable (e.g. deflagration and clearance shots) as mitigation to reduce noise levels and thereby injury and disturbance to sound-sensitive receptors during UXO clearance. There is a small risk that low order disposal could unintentionally arise in a high order detonation and therefore this scenario has also been considered in the assessment of likely significant effects.

Designed In Measures	Justification
Implementation of soft start measures for UXO clearance using a sequence of small explosive charges detonated over set time intervals.	These measures will reduce the likelihood of injury from elevated underwater noise to marine mammals in the immediate vicinity of piling/UXO clearance operations as far as practicable, allowing individuals to move away from the area before sound levels reach a level at which injury may occur. This is in line with the most up to date guidance for piling/UXO clearance operations (JNCC, 2010a; JNCC, 2010b) and, in most cases, compliance with this guidance reduce the likelihood of injury to marine mammal receptors to negligible levels.
The development of and adherence to a Marine Mammal Mitigation Plan (MMMP), which will present appropriate mitigation for activities that could potentially lead to injurious effects on marine mammals (e.g. piling, UXO clearance and geophysical surveys)	The MMMP will: • mitigate for the risk of permanent auditory injury to marine mammals within a pre-defined ‘mitigation zone’ for each activity. The mitigation zone is determined considering the largest injury zone across all species for each relevant activity; • reduce the potential injury to, marine mammals and other marine megafauna (e.g. basking shark and sea turtles) as far as practicable; and detail the visual and acoustic monitoring required as a minimum over the defined mitigation zones so that animals are clear before the activity commences. Additional measures to deter animals from injury risk zones may be applied in some instances (e.g. Acoustic Deterrent Devices (ADDs) or soft start charges). An outline MMMP has been developed on the basis of the most recent published statutory guidance (JNCC, 2010a, JNCC, 2010c, JNCC, 2017).
Routine inspections of the inter-array cables and mooring lines.	Mooring lines and dynamic inter-array cables in the water column will undergo regular inspections during the operation and maintenance phase with inspection frequency more frequent initially for the first two years and then decreasing to an annual schedule. The removal of marine debris from mooring lines and inter-array cables will be undertaken as necessary following monitoring and further relevant action taken if required, based on findings from the inspections. The removal of debris from mooring lines and cables further reduces the likelihood of secondary entanglement.
Development of, and adherence to a DP[2].	The aim of this plan is to adhere to the existing UK and international legislation and guidance (at the time of writing) during the decommissioning phase. This will reduce the amount of long term disturbance to the environment as far as reasonably practicable.
Offshore Ornithology	
UXO clearance using low order disposal techniques where technically feasible.	Low order techniques will be adopted wherever practicable (e.g. deflagration and clearance shots) as mitigation to reduce noise levels and thereby injury and disturbance to sound-sensitive receptors during UXO clearance. There is a small risk that low order disposal could unintentionally arise in a high order detonation and therefore this scenario has also been considered in the assessment of likely significant effects.
Implementation of soft start measures for UXO clearance using a sequence of small explosive charges detonated over set time intervals.	These measures will reduce the likelihood of injury from elevated underwater noise to marine mammals in the immediate vicinity of piling/UXO clearance operations as far as practicable, allowing individuals to move away from the area before sound levels reach a level at which injury may occur. This is in line with the most up to date guidance for piling/UXO clearance operations (JNCC, 2010a; JNCC, 2010b) and, in most cases, compliance with this guidance reduce the likelihood of injury to marine mammal receptors to negligible levels.
Development of, and adherence to a NSVMP.	The NSVMP will include measures to reduce disturbance to marine mammal receptors from transiting vessels, requiring them to: • not deliberately approach marine mammals as a minimum; and • avoid abrupt changes in course or speed should marine mammals approach the vessel to bow-ride. The NSVMP will be implemented as far as practicable and where it does not compromise the safety of vessels.
Routine inspections of the inter-array cables and mooring lines	Mooring lines and dynamic inter-array cables in the water column will undergo regular inspections during the operation and maintenance phase with inspection frequency more frequent initially for the first two years and then decreasing to an annual schedule. The removal of marine debris from mooring lines and inter-array cables will be undertaken as necessary following monitoring and further relevant action taken if required, based on findings from the inspections. The removal of debris from mooring lines and cables further reduces the likelihood of secondary entanglement.

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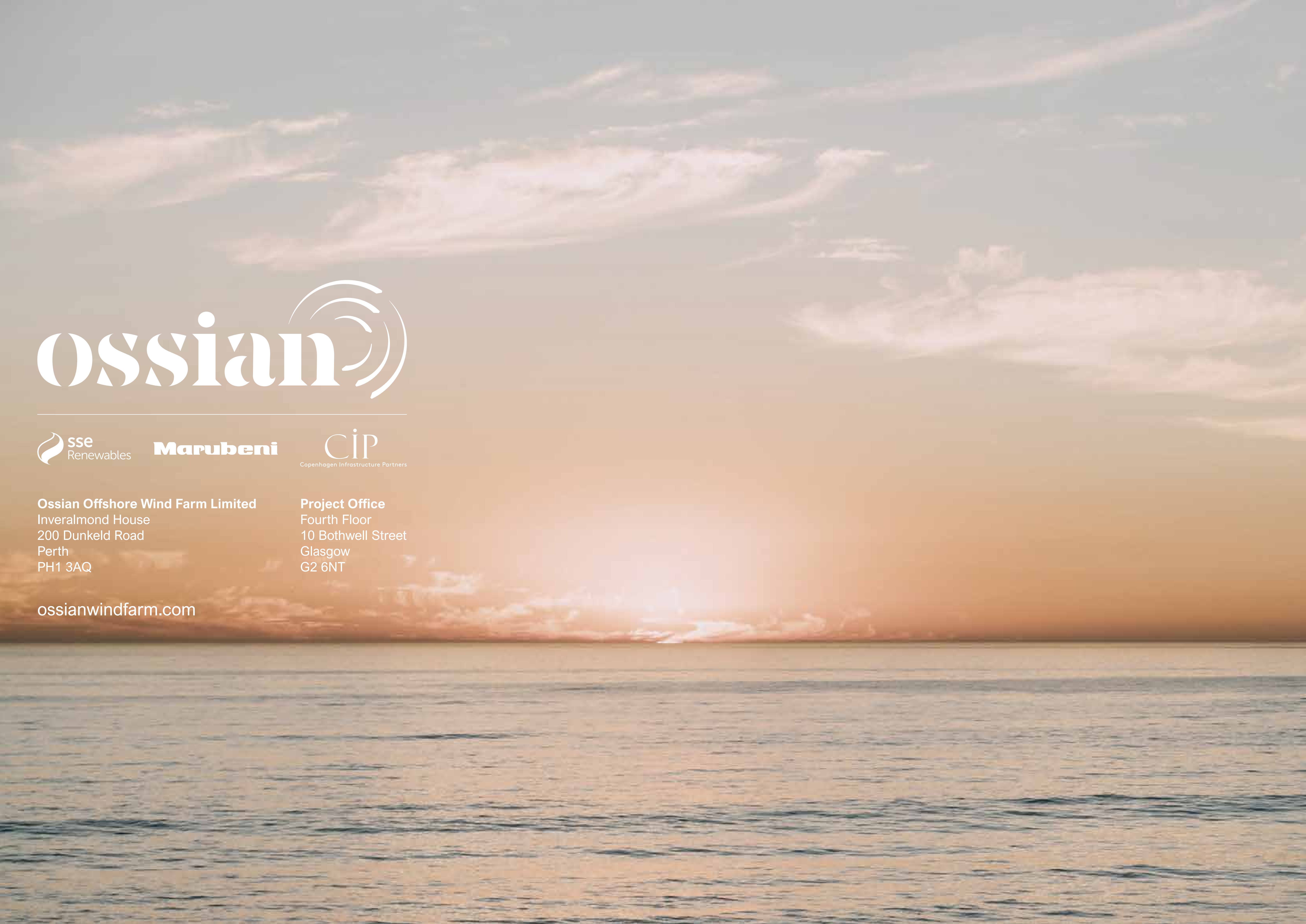
APPENDIX 1A: ARRAY HRA STAGE ONE LSE[2] SCREENING REPORT

214. Please find appendix 1A attached to this document separately.



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