Foreshore Licence Application for Site Investigation Work – NISA Cable Assessment Area

Schedule of Works

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Guidelines of use of report:

This report is produced in support of an application for a site investigation licence under Section 3 of the Foreshore Act, as amended, and should not be used for any other purpose apart from that expressly stated in this document.

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1 Introduction

North Irish Sea Array Windfarm Limited, which is a wholly owned subsidiary of Statkraft Ireland Ltd. (Statkraft), has prepared this report in support of an application for Licence under Section 3 of the Foreshore Act 1933, as amended, to carry out site investigation works to determine the suitability of the application area as a cable corridor area for the North Irish Sea Array (NISA) offshore wind farm.

Statkraft is currently investigating the feasibility of developing the NISA wind farm located off the coast of Co. Dublin, Meath and Louth and previously submitted a foreshore licence application (FS007031) for the site investigations on the array site (shown in red outline in Figure 1-1). Statkraft intends to undertake further site investigations activities at the proposed Foreshore Licence Application Area (shown in red outline in Figure 1-1) in order to inform the location and design of the export cable route between the array site and the landfall. Statkraft will investigate three landfalls and cable routes options but not all routes will be used for the wind farm cabling. The purpose of this site investigation is to investigate the feasibility of the different routes to allow Statkraft to determine the most preferred option. The site investigation activities will include geophysical, geotechnical, ecological and archaeological surveys. A foreshore licence is required for the proposed site investigation activities. This document forms part of the Foreshore Licence Application to the Foreshore Section of the Department of Housing, Local Government and Heritage.

1.1 Foreshore License Application Area

Statkraft have already applied for a Foreshore Licence for the array site (FS007031), and this application is for the cable corridor to facilitate the export cable between the array site and the landfall. The Foreshore License area is situated off the coast of County Dublin and Meath (Figure 1-1). The Foreshore Licence cable assessment area has a total area of 106.2km^2.

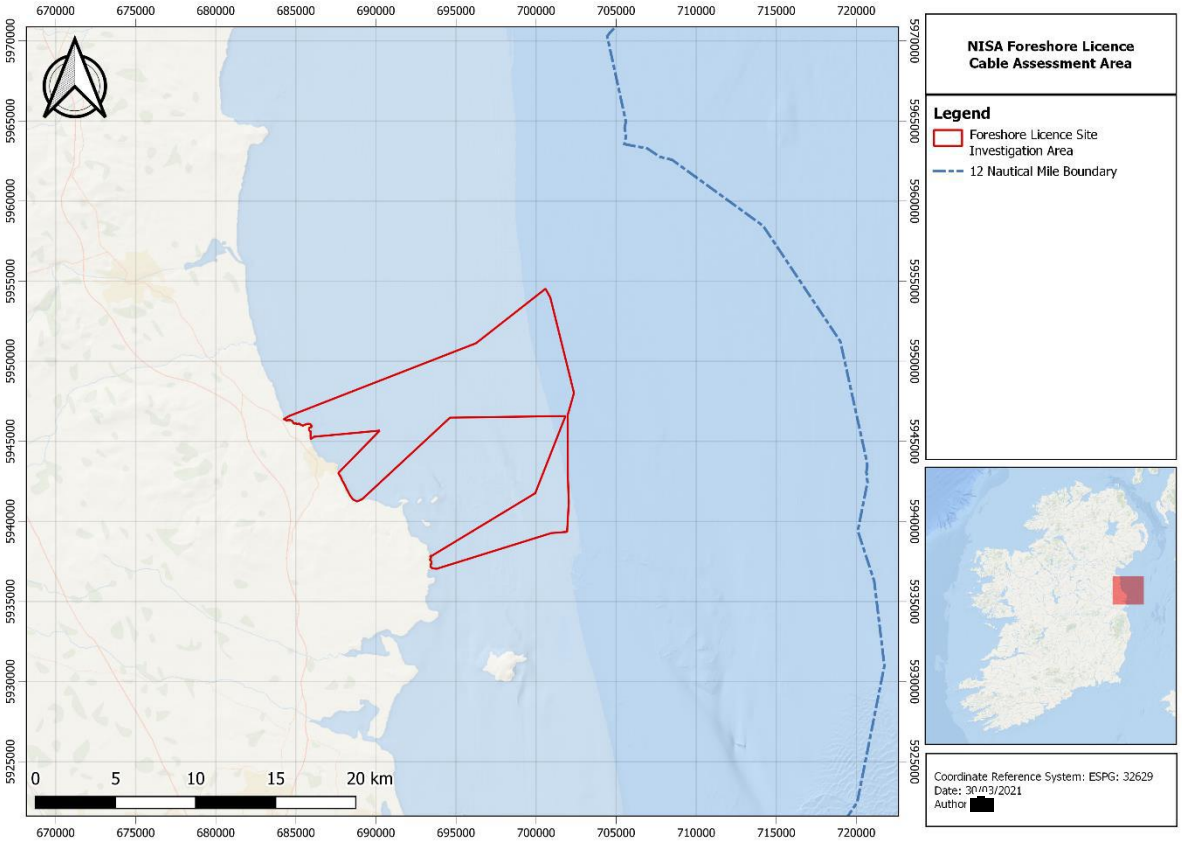

Figure 1-1: Foreshore Licence Site Investigation Area presenting three landfall and cable route options which will be narrowed down following the site investigations.

2 Marine Site Investigation Activities: Schedule of Works and Proposed Methodology for Data Acquisition

Subject to the award of a Foreshore licence as well as favourable weather conditions Statkraft propose a site investigation activities schedule of works that will be commenced and completed as soon as possible following execution of the licence.

As a "Relevant Project" NISA aims to apply for a Conditional Marine Area Consent (CMAC) before the end of 2021 once the process opens for relevant projects following enactment of MAP. To feed into the CMAC process and the subsequent planning application which NISA intends to submit in 2022 NISA intends to undertake site investigations as soon as possible following execution of the licence.

All effort will be made to follow survey recommendations outlined in the Guidance on Marine Baseline Ecological Assessments & Monitoring Activities for Offshore Renewable Energy Projects Part 1 and 2 (April 2018), where the specific timeframes are indicated for the survey provision.

This report should not be considered as a replacement for a Survey Strategy and as such the contents herein should be considered indicative.

The following sections outline the proposed suite of surveys to be undertaken within the cable assessment area and the proposed programme of marine surveys to be undertaken within the cable assessment area is summarised in Table 2-1.

Table 2-1: Summary of Site Investigation Activities Methodologies

Survey	Methods /Techniques	Purpose
Hydrographical and Geophysical	Multibeam Echosounder (MBES)	MBES is a system for collecting detailed topographical data of the seabed. The R2Sonic 2024 may be taken as an indicative example of a MBES system to be used in the completion of these works. For these surveys the equipment will operate at a typical central frequency of 400kHz (700kHz optional) with sound pressure levels in the range of 200-228dB re1µPa @1m.
	Side Scan Sonar (SSS)	SSS surveys are used to determine sediment characteristics and seabed features. The Edgetech 4200 may be taken as an indicate example of an SSS device and for these surveys will have a potential operating frequency range of approximately 300 to 900 kHz with sound pressure levels of 228dB re1µPa @1m.
	Magnetometer	A magnetometer is used to identify magnetic anomalies and hazard mapping for metal obstructions, shipwrecks and unexploded ordnance on the surface and in the shallow sub-surface. The Geometrics G-882 can be taken as an indicative equipment example, it is a passive device (i.e. it does not emit any sound waves into the marine environment).
	Sub-bottom Profiling (SBP)	SBP is used to develop an image of the subsurface, identifying different strata encountered in the shallow sediments. The Innomar SES-2000 Medium is an indicative example of a parametric system with a primary and secondary frequency range of 85-115kHz

		and 2-22kHz, respectively, and sound pressure levels of up to 247 dB (typically operated at <200dB) re1µPa @ 1m. The Seatronics Edgetech 3300 is an indicative example of a hull-mounted pinger system with an operating frequency range of approximately 2-16 kHz with sound pressure levels of 200dB re1µPa @1m. The Applied Acoustics AA301 is an indicative example of a boomer, with sound pressure levels in the range of 208-215dB re1µPa @ 1m. The Geo-Source 200 lightweight or the Applied Acoustics Squid 500 are indicative examples of sparker systems used in sub-bottom profiling, with sound pressures in the range of 204-216dB re1µPa @1m.
	Higher Energy Sub-surface Acoustic Sources (for example: Sparker systems, eSource)	Sub-surface acoustic surveys are used to image the subsurface and categorise sediment strata. These surveys can create 2D or 3D images of the subsurface. The intensity of the source varies depending on the requirements of the survey. Higher energy sub-surface sources used in multi-channel surveys will only be used if sufficient depth data is not achieved with the use of the Sub-bottom profiling methods.
Geotechnical	Downhole Sampling	A total of 6 sampling boreholes to 40m at each landfall for cable landfall assessment. Both bedrock and gravel tills may occur at depths from mudline to >40mbsf, both materials, particular gravel tills can be problematic for HDD. A variety of sampling methods including large diameter Geobor S coring to be utilised. Samples and cores to be retained for onshore laboratory testing. Water depths for nearshore restrict SI to be conducted from jack-up units. Each sampling borehole shall be paired with a CPT borehole. There may be recommendations for sampling boreholes along export cable route in locations where bedrock outcrops at shallow depths and CPT or seabed sampling penetration is limited. These may replace some vibrocore locations. The final number and location of SI points may be informed by the geophysical survey results or existing information.
	Cone Penetration Tests (CPTs)	CPTs are a method for testing in situ soil parameters. CPT can be performed as either Seabed CPTs or downhole in boreholes. A total of 6 CPT boreholes with target depth of 40m at each landfall, co-located with each sampling borehole. Up to 70 CPT seabed CPT locations to a depth of 6 to 10m bsf (approx. 1 every 500m co-located with seabed sampling points along the export cable route until water depths become prohibitive). The spacing interval will be determined by the variability and level of understanding of the shallow geology.

		The final number and location of SI points will be informed by the geophysical survey results.
	Seabed Sampling	Up to 70 vibrocore samples with a target depth of 6m bsf (approx. 1 every 500m co-located with seabed CPT points along the export cable route until water depths become prohibitive). Up to 70 grab samples shall be completed through the export cable route areas as part of benthic studies and for ground truthing.
Ecological	Bird Survey	Identify bird species distribution and behaviour within the Foreshore Licence Site Investigation Area. This does not require a licence under the Foreshore Act 1933, as amended and is included for information only.
	Fisheries Survey	Identify fish species distribution within the Foreshore Licence Site Investigation Area. Exact details of monitoring required will be determined through engagement with the relevant authorities such as SFPA, the Marine Institute and through local knowledge where appropriate.
	Subtidal benthic survey, intertidal habitat walkover survey and sampling	This survey is designed to identify the benthic communities and habitats within the Foreshore Licence Site Investigation Area. This may consist of an intertidal walkover survey of the proposed landfall locations with identification of the main habitats present (in the form of biotope mapping). Features of conservation importance will be identified by means of intertidal habitat mapping with core/quadrat sampling and hard substrate quadrat sampling where appropriate. Subtidal sample locations may be subject to drop down video or ROV inspection in advance of sampling. Up to 70 no. subtidal and 20 intertidal locations (at each landfall) will be sampled. Multiple samples will be taken at each location.
	Marine Mammal Survey	Identify marine mammal species distribution within the Foreshore Licence Site Investigation Area. This does not require a licence under the Foreshore Act 1933, as amended and is included for information only. The marine mammal observational studies will be run concurrently with bird surveys.
	Marine Mammal Acoustic Monitoring	Marine mammal acoustic monitoring using CPODs deployed on the seabed. SoundTrap hydrophones may be deployed alongside the CPODs for periods throughout the monitoring campaign. Either 2 permanent sites will be selected, or the 2 sites will be relocated every 3 months during battery change. The CPOD locations are subject to archaeological survey results.
Archaeological	Underwater Archaeology	Identification and assessment of metallic and other targets recorded if required during the marine geophysical surveys.

3 Geophysical Survey

The proposed geophysical survey programme involves a multi-disciplinary approach that is designed to acquire a full suite of data which includes a multibeam echosounder, side scan sonar, magnetometer, sub-bottom profiler and a seismic survey using a higher energy source (only if sufficient depth data cannot be obtained using the sub-bottom profiler). The collected data will be used to better understand the water depths, topography and relief structure of the seabed and the subsurface structure, in particular the sub-surface stratigraphy, determining sediment strata and the elevation of competent bedrock. To inform the suitability of a cable corridor area, understanding the top ~5m is crucial. The process is non-intrusive and at no point will the equipment used make contact with the seafloor. The exact equipment to be used will be confirmed following a tender process to procure the site investigation contractor however the operating frequencies outlined in Table 2-1 represent the operating frequencies employed in site investigations for offshore wind.

The objectives of the geophysical survey shall be:

- To obtain up to date high-resolution water depth measurements across the site;
- To obtain information on the seabed surface (type, texture, variability, etc.) and in particular, to identify any seabed features that may be of interest to the overall project;
- Identify any shallow geohazards and man-made hazards (including but not limited to outcropping, boulders, shallow gas, wrecks, debris etc.);
- Determine the stratigraphy across the site and quantify the variability in the lateral and vertical extents to depths of up to approximately 50m below seabed, if necessary;
- Identify the presence of bedrock should it exist within the top 50m;
- Identify any magnetic anomalies;
- Identify marine habitat areas as the basis for benthic survey to be carried out;
- Identify sensitive marine habitats which will need to be avoided during geotechnical and environmental sampling.

3.1 Multibeam Echosounder (MBES)

A Multibeam Echosounder (MBES) system will be used to provide detailed bathymetric mapping throughout the survey area.

MBES system will be hull mounted. The exact equipment used will be confirmed following the appointment of a survey contractor. The R2 Sonic 2024 or the Kongsberg EM2040 may be taken as a typical example (Figure 3-1). Typical operating frequencies for offshore wind are in the regions of 400kHz and can be up to 700kHz.

MBES is non-intrusive therefore does not interact with the seabed. MBES may be undertaken across the site to a suitable percentage coverage.

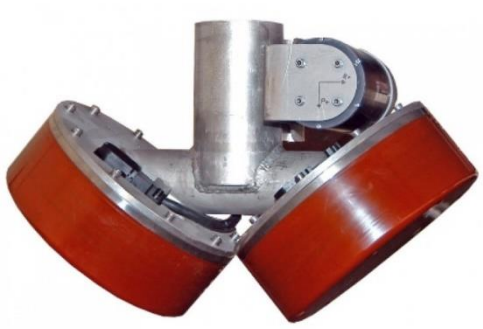

Figure 3-1: Multibeam Echosounder (EM2040)

3.2 Side Scan Sonar (SSS)

Side Scan Sonar (SSS) is a towed sensor which is typically towed behind the vessel on an armoured tow cable, although some models can be pole mounted on the side of the vessel. SSS will be a dual frequency hydrographic sonar used to produce seabed imagery. A Side Scan Sonar (SSS) system will be used to provide detailed imagery of the seabed throughout the survey area which will aid with seafloor sediment/bedrock and geomorphology mapping as well as for identifying any shallow geohazards.

Side scan systems are available from a number of manufacturers. These units vary in size, working and technical characteristics and acquisition configuration (towed or vessel mounted). Presently, dual frequency digital systems are available in the market which allows more survey flexibility; some systems can acquire and record both frequencies swaths independently and simultaneously. Using these systems, operator may use a higher frequency to produce sharper images and narrow swath or use the lower frequencies to obtain wider seabed coverage at lower resolutions. The exact equipment used will be confirmed following the appointment of a survey contractor. The typical operating frequency range for offshore wind purposes is between 300 to 900 kHz.

The system will be adequate to the depth range of the study area and the seabed discrimination level required. The design of transects will consider the geographic and depth extent of the study area, seabed coverage ratio, overlap coverage desired, priority areas to survey, prevailing winds and currents, etc. Often, the complete coverage of the seabed is the ultimate goal of an acoustic survey design, to enable the creation of full mosaics. In these cases, theoretically, parallel transects should be run to produce swath overlapping of, at least, 50%. When complete coverage is not necessary to define seabed boundaries, consecutive swaths overlapping 20 to 30% can be adequate. However, in some cases, transect spacing of at least 75% of the swath width can provide reasonable overlapping to compensate any loss of resolution at the outer range limits. This is very dependable on weather conditions and the survey will be planned accordingly by an experienced sonar operator.

SSS is non-intrusive therefore does not interact with the seabed. SSS may be undertaken across the site to a suitable percentage coverage.

Figure 3-2: Example of a Towable Side Scan Sonar Data Device (EdgeTech)

3.3 Magnetometer

A magnetometer is a passive device that is towed behind a survey vessel. It is used to detect ferrous objects on the surface or in the subsurface. Magnetometer surveys are widely used prior to intrusive works to highlight any obstruction or potential risk such as existing infrastructure, shipwrecks and unexploded ordnance.

The vessel will tow a submerged pod (Magnetometer). The exact equipment used will be confirmed following the appointment of a survey contractor. The marine magnetometer will be of the Caesium Vapour type and capable of recording variations in magnetic field strength during survey to an accuracy of ±0.5nT.

A Magnetometer is non-intrusive therefore does not interact with the seabed. It may be undertaken across the site to a suitable percentage coverage and the parameters of the survey may be determined by the requirements of the Underwater Archaeology Unit of the National Monuments Service. Their requirements are set out in Table 3-1.

Table 3-1: Underwater Archaeology Unit Requirements for Magnetometer Survey

Survey Type	Requirements for Archaeological Purposes
Side Scan Sonar	• Operational frequency of 410/500kHz. • 50m survey line spacing • 100% site coverage (overlap of areas may be required)
Magnetometer	• Proton or caesium magnetometer • 50m side spacing

Figure 3-3: Magnetometer Example (Geometrics)

3.4 Sub-Bottom Profiling (SBP)

Shallow Sub-Bottom Profiling aims to create a 2-D image of the subsurface up to potential depths of approximately 10-50 m below seabed, depending on the geological conditions encountered and the choice of system used. Different types of SBP are available including chirp, pinger, boomer, sparker and parametric chirp systems. The most appropriate system will be decided depending on the seabed, anticipated geological environment and the objectives of the survey.

A Sub-Bottom Profiling (SBP) system may be used to determine the stratigraphy across the site and quantify the variability in the lateral and vertical extents to a depth of at least 50m below seabed.

The Seatronics Edgetech 3300 may be taken as an indicative example of a hull-mounted pinger system and would have an expected operating frequency range of approximately 2-16 kHz with sound pressure levels of 200dB re1µPa at 1 metre range. The Applied Acoustics may be taken as an indicative example of a boomer source and would have an expected operating frequency of approximately 2.5 kHz with sound pressure levels in the range of 208-215dB re1µPa at 1 metre range. The Geo-Source 200 or the Applied Acoustics Squid 500 may be taken as an indicative example of a towed sparker system, with sound pressure levels in the range of 204-216dB.

This survey is non-intrusive therefore does not interact with the seabed. It may be undertaken across the site to a suitable percentage coverage.

Figure 3-4: Example of Boomer Sub-Bottom Profiler

Figure 3-5: Example of Pinger Sub-Bottom Profiler

Figure 3-6 Example of Sparker sub-bottom profiler

3.5 Higher Energy Sub-surface Acoustic Source

Higher energy sub-surface acoustic sources may be used to determine the stratigraphy across the site and quantify the variability in the lateral and vertical extents to a depth of at least 50m below seabed.

Multi-channel sub-surface acoustic surveys using higher energy acoustic sources are used to image the subsurface and categorise sediment strata. These surveys can create ultra-high resolution 2D or 3D images of the subsurface whilst achieving greater depths than sub-bottom profiling systems. The intensity of the source can vary depending on the requirements of the survey. These surveys will only be used if sufficient depth data is not achieved with the use of the Sub-bottom profiling method.

This survey is non-intrusive therefore does not interact with the seabed. This is considered low power in comparison to the oil and gas equivalent. It may be undertaken across the site to a suitable percentage coverage.

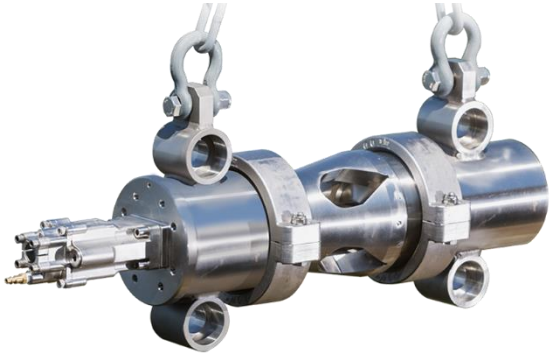

Figure 3-7: Example of Sub-surface Acoustic Energy Source eSource (TeledyneMarine)

4 Geotechnical Survey

The purpose of the geotechnical survey is to yield in situ soil properties and recover soil samples or rock cores to allow for derivation of geotechnical properties related to the installation of the export cable from offshore to the landfall transition.

The geotechnical survey shall have two main objectives:

- Provide data and samples over the depth of interest for the export cable installation at landfall;
- Provide data and samples over the depth of interest to determine cable installation methods and risk assessments along the proposed export cable route.

The location, quantity, target depths and type of scheduled geotechnical survey will be finalised following the interpretation of the geophysical survey results but indicatively may comprise of:

- 6 sampling boreholes and 6 CPT boreholes with target depth of 40m bsf at each landfall;
- 70 seabed CPTs with target depths of 10m;
- 70 seabed samples with target depths of 6m;
- 70 geotechnical grab samples locations

The sampling and CPT boreholes shall be co-located (i.e. completed in pairs). The seabed testing sampling shall be co-located and completed at approximately 500m intervals along the export cable routes within the cable assessment area.

Indicative geotechnical locations for the proposed investigative locations are shown in Figure 4-1. The positioning of individual geotechnical site investigation locations also needs to take into consideration environmental constraints such as the position of sensitive habitats or archaeological features.

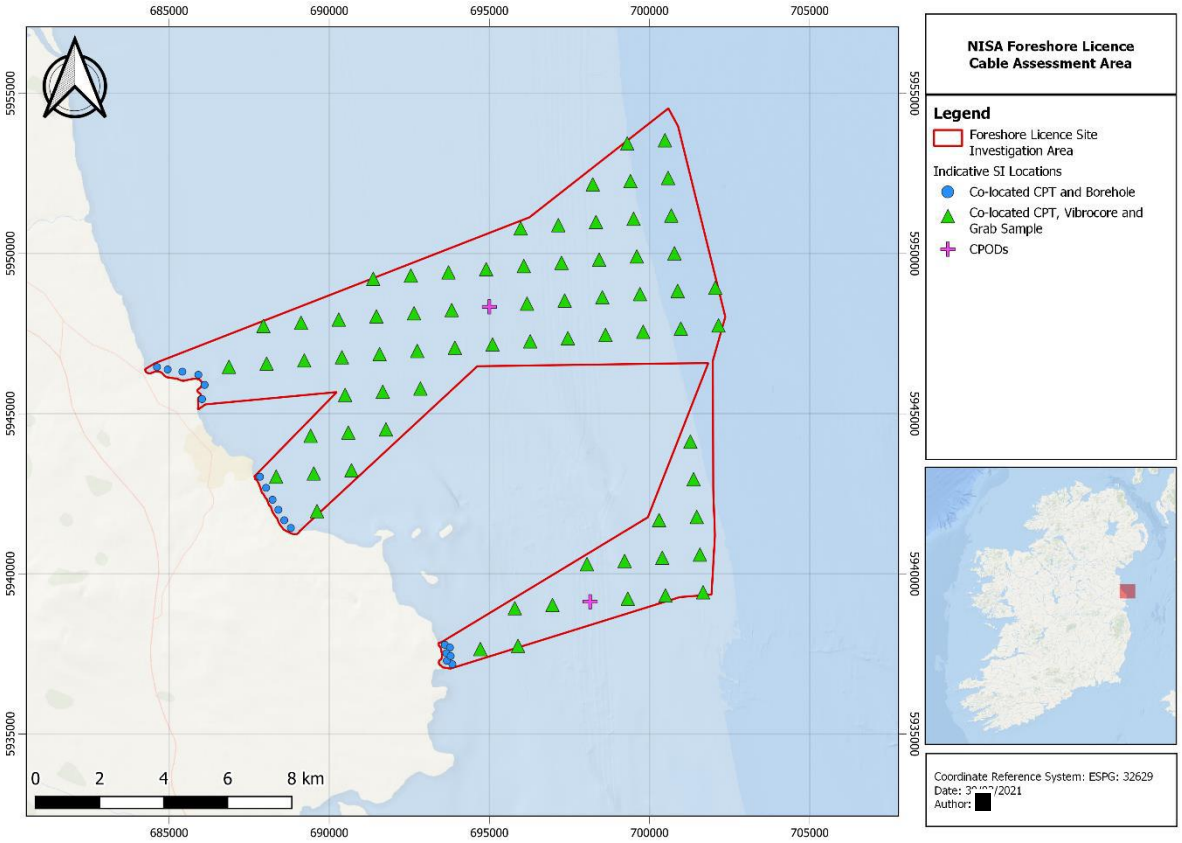

Figure 4-1: Indicative Site Investigation locations presenting three landfall and cable route options which will be narrowed down following the site investigations.

4.1 Downhole Sampling

The geotechnical survey at landfall will be located in shallow water depths and will be performed by a geotechnical drilling rig mobilised on board a jack-up barge. This scope of work shall comprise of pairs of co-located sampling borehole and CPT boreholes. This shall provide in situ soil properties and recover soil samples or rock cores for the full depth range of interest.

It is envisaged that seabed sampling and CPT may have limited penetration along some sections of the export cable route due to shallow outcropping of till or bedrock. In such a situation it may be recommended that a limited number of locations along the export cable route are completed by geotechnical drilling vessel.

For the landfall boreholes, a jack-up barge shall be fully equipped with a rotary drilling rig capable of deploying various sampling and coring methods. An example of which is presented in Figure 4-2. Coring through rock will require a large diameter system such as the Geobor S. The jack-up will also be able to deploy downhole CPT equipment in a borehole adjacent to the sampling borehole. All equipment shall be deployed downhole and all thrust shall be top loaded.

Generally, all jack-ups shall be maintained and operated in accordance with SNAME TR5-5A/. Sampling methodologies shall be in accordance with BS EN ISO 22475 and CPT testing in accordance with ISO 22476.

During drilling, borehole wall integrity will be maintained using drilling mud mixed with sea water. This drilling fluid is comprised of biodegradable miscible guar gum. This drilling mud and any drill risings will disperse into the water column.

During fieldworks, the retrieved samples and cores shall be logged, and the CPT data processed and interpreted, to produce borehole and CPT logs that includes interpreted stratigraphy and all in situ and offshore laboratory data results. An example of the combined borehole logs is presented in Figure 4-3.

Figure 4-2: Example of a drill rig mobilised on a jack-up (Comacchio MC1200)

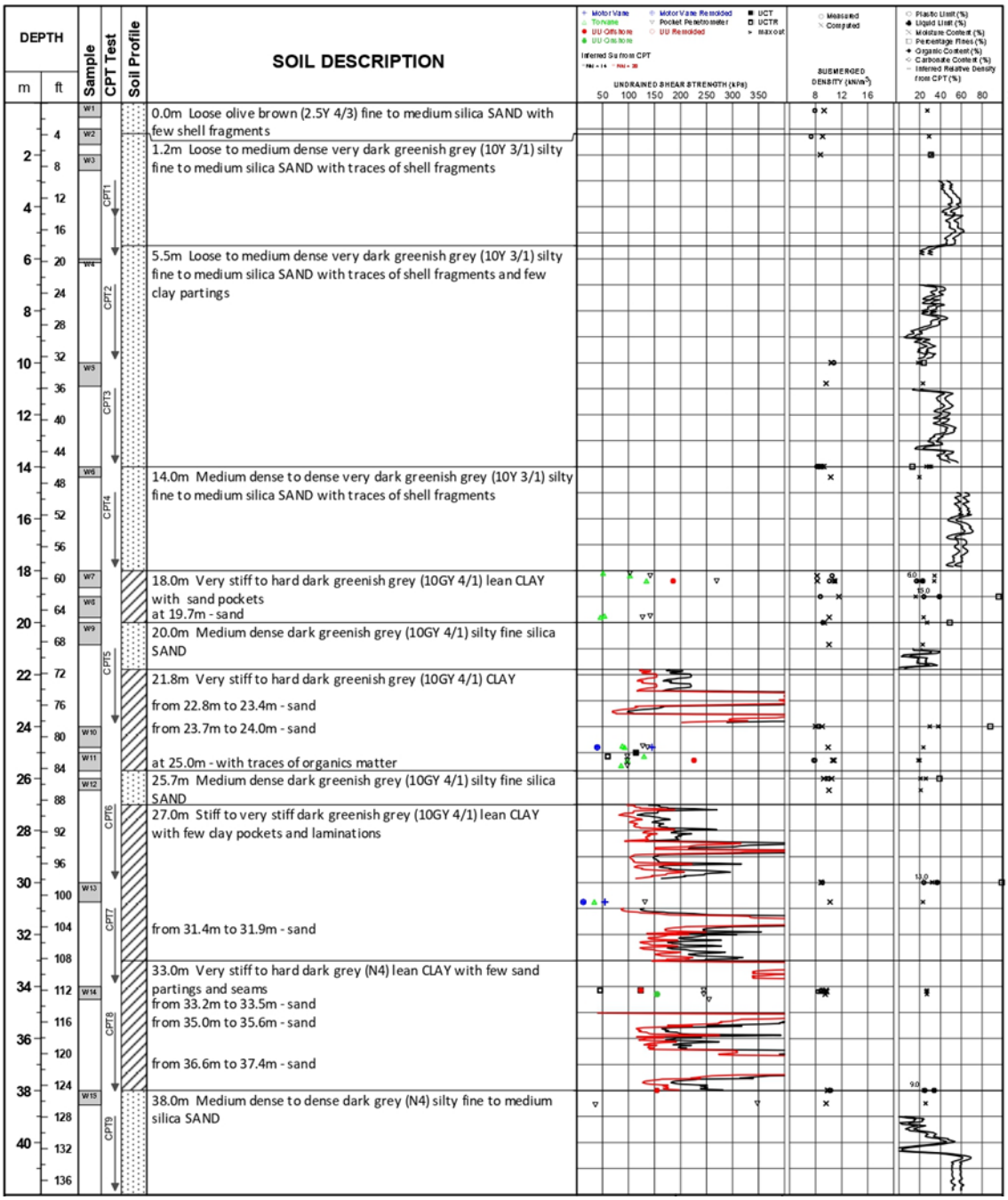

Figure 4-3: Typical Borehole Log

4.2 Cone Penetrometer Tests (CPTs)

The Cone Penetration Test (CPT) is a geotechnical test used to measure in situ properties of soil. The CPT is one of the most commonly employed site investigation techniques for offshore projects worldwide.

CPT is performed by pushing an instrumented and calibrated steel cone into the ground at a constant rate. During testing, the resistance on the cone tip and sleeve are measured, as well as pore water pressure. These results can be used to derive soil parameters and interpret soil behaviour, and may be used to provide soil parameters.

There are two broad categories of CPT testing methods as discussed below:

Downhole CPT: Downhole CPTs may be deployed using traditional offshore rotary heave compensated drilling rig or drilling rigs mobilised on to jack-up barges. The CPT test start depth may be at seabed or any depth below. The CPT tool is deployed by wireline through the drill string, which then in turn latches within the drill bit. The CPT test starts, and the cone advances out through the drill bit and into virgin soil. The test stroke length is typically 3m. The CPT tool is recovered to deck, and the borehole is advanced by drilling to the depth corresponding to the end of test depth. A drill string is then used to drill out the hole at the CPT location. Downhole CPT test only experiences friction along the CPT sounds rod length. By contrast, the seabed CPT experiences friction along the entire length of the CPT rod, which may be up to 40m in length, which may cause refusal. The downhole CPT test is quick, but the cumulative time associated with deploying and recovering the tool, drilling and adding pipe, means that a comparative target depth takes longer compared to seabed CPT. However, downhole CPT may provide CPT data to greater depths, primarily limited by the length of pipe available.

Seabed CPTs: Seabed CPTs involve mobilizing a self-contained and automated CPT test unit housed within a seabed frame. This frame is typically kept on the deck of a dynamically positioned vessel and may be deployed using a dedicated Launch and Recovery System (LARS) – such as an A-frame – or in the case of larger CPT unit, through a moonpool (as illustrated in Figure 4-4). The vessel will hold station over the target position and deploy the CPT unit. The CPT is connected to the vessel via an umbilical, which acts as a lift wire and data transfer umbilical. Depending on the CPT unit, the CPT rods may need to be built up overboard prior to deployment through the water column. Once on seafloor, the cone is pushed into the seabed until it reaches refusal. Refusal is defined as the point where one of the following criteria are met: target penetration depth is reached, maximum system thrust is reached, excessive load on the tip or the sleeve, or excessive cone inclination occurs, or a combination of these.

The objective of the survey will typically define the size and configuration of the CPT unit. A lightweight CPT unit with maximum penetration depth of 10m, may weigh about 5 tonnes and are frequently used for the export cable route survey. For deep seabed CPT testing, with target penetration depths of 20 to 40m, the seabed unit will weight in the order of 20 to 25 tonnes. The test typically takes 2 to 5 minutes, depending on the target penetration depth, however total time taken to be deployed and recovered may be in order of one to two hours. If at each location the technical requirements of the project are met, the CPT unit is lifted back on to the vessel and the vessel moves on to the next location. If target depth is not achieved, then the CPT unit may “bump-over” – which is where the unit is lifted a small distance of seafloor and moves horizontally so another test can be completed.

Figure 4-4: Example of a Block Push Seabed CPT System (Fugro Seacalf)

4.3 Sampling and Coring

Sampling or coring equipment provide a means to recover samples to deck to allow for logging and testing offshore, and onward testing at onshore laboratories.

As for CPT testing, sampling may be conducted via dedicated seabed units or downhole. Coring is generally only achieved downhole. Downhole samplers include the push and piston samplers for soils, and coring equipment for rock.

> Downhole sampling and coring: The wireline push or piston sampler is lowered into the drill string where it latches into the Bottom Hole Assembly (BHA). The attached sample tube is then pushed into the ground ahead of the drill bit to sample the soil. Before the push commences, the piston is located at the bottom of the sample tube preventing any ingress of drill cuttings and travels up the tube as it penetrates the ground minimising sample disturbance and maximising recovery. When the piston is not fitted the push sampler head has a hole which allows water to escape whilst penetrating the ground. After the test has completed the hole is then covered by a ball and held in place using a spring this is to prevent losing the sample when recovering the tool. Sample tubes (or Shelby tubes) are typically 1m in length with various wall thicknesses and internal diameters. Generally, the thinner walled tubes are used for soft cohesive material, and thicker walls for granular material. Depending on various factors, high quality, undisturbed samples may be recovered.
>
> Rock core samples are recovered by either using the main drill string or using piggy-back drill rig. For the former, a double tube barrel is dropped into and latched into the BHA. This set up comprises two concentric steel tubes joined in such way to permit the rotation of the out tuber without causing rotation of the inner tube. Within the inner tube is a liner that can be recovered without the need to recover the entire BHA and drill string. Piggy-back coring is achieved when a separate rig with smaller diameter drill string it deployed through the main drill string. In both cases, the drill bit is advanced, and a core of rock is recovered within the

liner. When the core is recovered to deck it is logged, tested and prepared for onward testing at an onshore laboratory. Typical core diameters can range from 70mm up to 100mm, though larger is possible.

Seabed Samplers: Vibrocoring is a method for retrieving samples of up 6m in length from mudline. Penetration into the soil is afforded by the reciprocal motion of the motor at the top of the barrel. High frequency, low amplitude vibration that is transferred from the vibrocore head down through the attached barrel. This vibration energy allows the core barrel to penetrate the sediments under self-weight. The core barrel is fitted with a plastic liner, core catcher and cutting shoe. The vibrocore rig is similar to that seen in Figure 4-5. Once coring is started, the core barrel will penetrate to the target depth or refusal. Samples will be recovered in the plastic liner, split into 1m lengths, processed, sealed appropriately for onward freight to an onshore laboratory. Vibrocore is best suited to non-cohesive soils (e.g. gravel or sand) as samples recovered are considered disturbed. Vibrocore samples are typically 50 – 100mm and a have a maximum diameter of 110mm.

Gravity or piston core (self-weight penetration sampler) is performed where cohesive soil is expected. The sampler is comprised of an outer barrel with PVC inner barrel, and a cutting show. The sampler may be fitted with a piston which effectively reduces the resistance to the soil entering the liner and may result in a superior quality sample. The sampler penetrates the seabed under its own weight. Upon refusal or at target depth, the sampler is recovered on deck where the sample is split, typically into 1m lengths, logged and tested in the offshore laboratory. The typical diameter of the liner is in the region of 60mm with a typical maximum diameter of 120mm.

The exact equipment to be used will be confirmed following a tender process to procure the site investigation contractor. Indicative locations are shown in Figure 4-1 however final individual site investigation locations will depend on the geophysical survey locations. Some locations may need to be avoided due to environmental reasons including sensitive archaeological features or unsuitable substrate types.

Figure 4-5: Example of a Crane-Deployed Vibrocore System

4.4 Grab Samplers

Grab samplers recover samples from approximately the top 0.2 - 0.5m of seafloor. These samples may be used to classify the seabed, or for chemical and biological analyses. These samples are generally deployed overboard using a crane from a vessel.

There are various grab sampler types to include but not limited to Van Veen, Hamon and Day Grab samplers. Generally, some variants may come either as single or double, and in a variety of different sizes.

Geotechnical Grab sampling: A grab sampler with dimensions of a 0.5x0.5x0.5m is recommended, though multiple attempts with smaller samples is possible. The aim of this sampling is to recover sufficient seabed material for onshore classification testing for ground truthing of the seafloor seismic interpretation. The grab sample locations may be co-located with other seabed sampling.

Grab samplers generally comprises of steel buckets that are deployed open and which trigger shut when the sampler is in contact with the seafloor. As the buckets close, sediment and biological material are retained inside the sampler. The grab sampler is then recovered to deck and place on a trestle or table. The retained material is then visually inspected for acceptance and then transferred to adequate container or on to a designated mat for further offshore processing and logging.

There are various grab sampler types to include but not limited to:

> Single Van Veen Grab: It is ideal for the collection of sediment samples for biological and environmental sampling. In a range of sizes (0.025m^2, 0.1m^2, 0.2m^2, 0.3m^2) each model has a

marine grade stainless steel bucket with hinged access flaps on the top allowing sub sampling of the collected sediment before it is emptied from the grab. The bucket is operated with a pair of stainless-steel lever arms that increase the tension to secure the sample securely in the grab as it is retrieved to the surface. Additional lead weights can be added to the back of the bucket to improve stability in strong currents and to the lever arms to increase the equipment's ability to perform in harder conditions. More information on the technical specifications can be found at https://www.cms-geotech.co.uk/single-van-veen-grabs

Figure 4-6: Single Van Veen Grab (OSIL)

Double Van Veen Grab: The Double Day Grab allows collection of two 0.1m2 samples at the same. This equipment is frequently used to carry out comparable sampling, for example where biological and chemical samples are required on the same sampling location. The connection of two samplers into one is also time and cost-effective solution for the surveys where large number of sampling locations are planned with repetition of sediment sampling on the same location or when larger depths are considered. More information on the technical specifications can be found at https://www.cms-geotech.co.uk/double-van-veen-grab-.

Figure 4-7: Double Van Veen Grab Sampler (OSIL)

Mini and Standard Hamon Grabs (0.1m^2 and 0.2 m^2 respectively): These grabs are particularly used for the collection of samples generally from coarse (sand and gravel) sediment substrates and used for benthic macrofauna and particle size measurement. The grab is relatively simple to operate in almost any water depth.

A 0.1m² sample area is a standard practice used in many benthic sampling applications. The Hamon Grab is a box shaped sampling scoop mounted in a triangular frame. Upon contact with the seabed, tensioned wires are released, which causes the sampling bucket to pivot through 90º pushing seabed sediment into the bucket. On completion of its travel the open end of the bucket comes against a rubber sealed steel plate which stops the sediment escaping during recovery. 0.1m² Hamon Grab refers to 0.1m² area of seabed sampled. The depth of scoop penetration is up to 20cm. On recovery the grab is landed onto a rectangular base from where access can be gained to the inside of the bucket via an inspection window. Whilst in the stand the grab sample can then be easily emptied into a sampling container located under the bucket. More information on the technical specifications can be found at https://www.cms-geotech.co.uk/standard-hamon-grabs-

Figure 4-8: Hamon Grab (CMS – Geotech Ltd)

Day Grabs (single and double): The Single Day Grab is built from two stainless steel bucket sections combined within a stainless-steel frame that level to the seabed when it is deployed. When frame is in contact with the seabed, the latch plates on the buckets unlock and they are released. A typical 0.1 m^2 operational Day Grab weights between 60-165 kg (sediment sample weight not included), where additional weights can be added to the frame as required. Insufficient weight can lead to the frame being pushed upwards as the buckets are drawn into the sediment, reducing the effective bite depth. The sampler has sturdy design, simple mechanism and ability to access the undisturbed surface of the sample. It not designed for work on hard, coarse, substrata. More information on the technical specifications can be found at https://www.cms-geotech.co.uk/siingle-day-grab and https://www.kc-denmark.dk/products/sediment-samplers/day-grab-/day-grab-1000-cm%C2%B2.aspx)

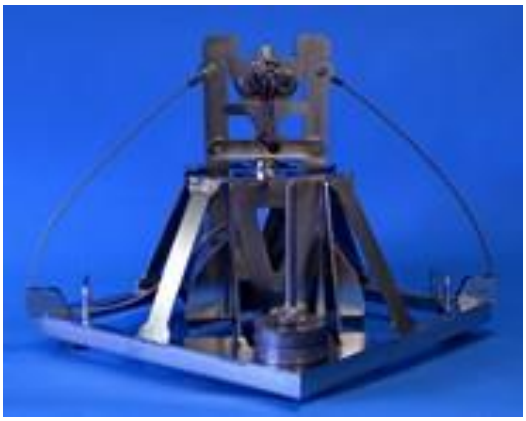

Figure 4-9: Day Grab (KC Denmark A/S)

Generally, any grab sampling will be carried out by deploying sampling gear from the vessel, as per standard operation procedure for deck works involving this kind of equipment taking into account the technical specification of the grab in use. Various grabs will be available for the benthic survey provision to ensure adequate sampling equipment for various sediment types.

5 Ecological Site Investigations

The purpose of the ecological site investigation activities is to collect baseline data that will primarily be used to inform the Environmental Impact Assessment Report (EIAR), by describing the environmental conditions within the Foreshore Licence Site Investigation Area, and subsequently developing appropriate mitigation measures for any potential environmental impacts. The ecological scope of work proposed for the Foreshore Licence Site Investigation Area includes the following:

- Fisheries surveys (Does not require an FLA);
- Benthic surveys (Does require an FLA);
- Marine mammal survey including static acoustic monitoring which will be achieved by utilising C-Pods deployed on the seabed (Does require an FLA);

5.1 Fisheries Survey

Areas delineated for offshore wind development often coincide with complex bottom habitats, productive marine communities, and protected species. They also often overlap with economically valuable and culturally rich fishing grounds. Wind farms may affect marine species through a variety of means that act over varying spatial scales. The spatial overlap between the advancing offshore wind industry and natural resources with inherent biological, economic, and cultural value suggests an urgent need to understand how wind farms affect the distribution and abundance of fisheries resources.

A fisheries survey will be carried out to determine the species and their distribution within the cable investigation area. The Sea Fisheries Protection Authority will be consulted regarding the exact nature of the survey, survey design and survey methods to be applied. In addition, consultation with the local fishing industry will be undertaken in advance of any survey effort and survey design will take into consideration fish spawning and fishing seasons. The aim of the survey is to maximise the accuracy and value of the information to the ongoing design of the project and to feed into engagement with fishing communities. The information will also feed into the EIAR. Engagement with the relevant stakeholders will commence in the coming months on this matter.

5.2 Subtidal Benthic Survey Including Video Inspection

The aim of the proposed benthic survey is to map the distribution and extent of marine benthic biological communities and habitats in the Foreshore Licence Site Investigation Area. This will comprise a video and still photographs or remote operated vehicle (ROV) inspection followed by a benthic sampling programme (using various grab samplers as described in the Section 4.4). The sampling locations will be selected to sample different habitats. The resulting ground-truthing information (from grab sample and seabed imagery) will be then overlaid on available geophysical data to accurately map biotopes and delineate protected habitats (e.g. biogenic and rocky reefs).

This information is usually then combined to conduct Annex I habitat assessments of any biogenic and rocky reefs present within the Foreshore Licence Site Investigation Area. In any case where benthic sampling is not possible, sufficient video and stills will be taken from the sample location to identify existing habitats (to include Annex I habitats) and the habitat boundaries.

Van Veen/Day Grab/ Double van Veen will be used for soft sediments for quantitative benthic infauna analysis and for physio–chemical analysis. Colonial and epifaunal species will be recorded qualitatively. Sediment samples for physio–chemical analysis will be acquired for later laboratory analysis. Physio–chemical analysis would include the following standard parameters unless specified differently by the client or regulator:

- Particle size analysis
- Sediment organic matter and carbon analysis
- Major trace element analysis
- Hydrocarbon analysis

If the quantitative grab sampler cannot gather a sufficient sample of minimum 5 cm due to nature of sediment (coarser sediments), then a Hamon grab will be used for qualitative benthic fauna collection and particle size analysis (PSA). In this case the minimum sample retention should be 7 cm.

Three grab samples will be retrieved for benthic fauna analysis. An additional grab sample will be collected for physio–chemical analysis. This will ensure sufficient data for quantitative analysis of benthic fauna and physio–chemical analysis.

To minimise repetition of benthic sampling approaches, it is proposed to use double van Veen grab/double Day grab, where suitable. This will provide two samples for each grab therefore minimising the number of deployments needed to obtain the required four samples.

All retrieved and accepted samples will be processed on deck. Benthic fauna samples will be ideally sieved through a 1mm mesh sieve or a 0.5mm mesh sieve if required. Photographic records will be taken (following retrieval of the grab sampler and of the sieve residue following processing through the mesh sieve). The faunal residue will be transferred to properly labelled sealable wide neck containers (tube) and preserved in buffered 10% w/v formaldehyde solution (or 96% ethanol if possible) for subsequent transport and analysis at a specialist benthic fauna analysis laboratory. The laboratory will ideally have NMBAQC applied protocols in place. The containers with the biological samples will be kept in a well-ventilated area at all times due to the high toxicity of the preserving medium used (very important for formaldehyde in particular).

5.2.1 Underwater Video Camera Systems

Various underwater camera systems may be used for underwater video inspections to provide the best quality of gathered data. An underwater drop camera system or similar will be used for the provision of benthic survey video inspection.

The SeaSpyder Telemetry system is a typical underwater camera system and is designed for operation in water depths up to 1000m utilising standard coaxial sonar umbilicals. This system is one of the most commonly used camera systems for underwater video inspections. The system as standard offers simultaneous uninterrupted recording of low latency live video footage along with high resolution stills photography, along with interfacing to a wide range of sensors and dataloggers. The stills camera is fitted with a high quality 18 mega pixel digital SLR Camera offering full control of all photographic parameters including manual focus, shutter speed and aperture. The stills camera is housed within a robust 1000m rated aluminium enclosure along with an internal IP video camera. All data is

transferred directly to the surface unit for live interpretation, this includes video, stills photos, serial sensor data and ethernet data such as an imaging sonar.

5.3 Ecological Intertidal Survey

An intertidal survey (walkover survey) will be carried out at the landfall for the windfarm export cable once locations suitable for cable landing have been identified. A series of locations will be also sampled in areas of both soft sediment and hard substrates to allow a detailed biotope mapping at these landing locations. The area surveyed could be up to 500m wide.

The intertidal surveys will be undertaken during spring tides in line with guidance in the Marine Monitoring Handbook (Davies et al., 2001). During the walkover survey, biotopes will be identified according to the European Nature Information System (EUNIS) classification. Where possible, boundaries of biotopes will be tracked using a handheld GPS device and recorded using a suitable software package.

Various locations will be sampled by quadrat with dimensions of a 0.04 m^2 (0.2 m x 0.2 m), to identify the Benthic macrofauna at the landfall location.

5.4 Marine Mammal Acoustic Monitoring

It is proposed that the survey will involve the use of Continuous Porpoise Detectors (CPOD) which will be installed for the purpose of acoustic monitoring of marine mammal activity within the survey area. It is proposed that the survey will involve the use of Continuous Porpoise Detectors (CPOD) which will be installed for the purpose of acoustic monitoring of marine mammal activity within the survey area. Up to 2 CPODs will be deployed at any 1 time across the site.

A sound trap may be deployed alongside one of the CPODs for various durations throughout the monitoring campaign to obtain background noise measurements. The CPODs will be recovered every 3 months to download data and change batteries. Upon each 3-month recovery they will be relocated based on a 4x4km survey grid across the site so that over the 18 to 24 month monitoring period, CPODs will be deployed at a total of 32 locations across the site Location. The exact locations of the CPODs has not yet been determined. The strong currents in parts of the site may make some areas unsuitable for deployment. Figure 4-1 in Section 4 shows the 2 indicative CPOD locations.

6 Archaeological Survey

The proposed archaeological survey will comprise of identification and assessment of metallic and other targets recorded during geophysical survey where magnetometer data will be acquired for further archaeological assessment.

This will follow the baseline assessment that includes documentary and cartographic searches using a number of sources in order to locate all known cultural heritage assets within the Foreshore Licence Site Investigation Area, and to identify the archaeological potential of the area. The baseline assessment will be carried out in line with industry best practice and any relevant offshore renewables and underwater archaeological guidance.

Survey specifications will need to consider archaeological data acquisition to enable professional archaeological interpretation and analysis of data. The data collected will be used to support the archaeological assessment.

All archaeological work will be carried out by a suitably qualified archaeologist to determine the location of all known archaeological features in advance of the intrusive geotechnical and environmental survey.

7 Underwater Video Inspections and ROV Operations

Remotely Operated Vehicles (ROVs) are unoccupied, highly manoeuvrable vehicles controlled by qualified personnel onboard of the ship or platform from which it was deployed. ROVs are to assist in a variety of industries including Search and Rescue, Military, Recreation and Discovery, Aquaculture, Marine Biology, Oil, Gas, Offshore Energy, Shipping and Submerged Infrastructure. There are several classes of ROV as described in in Table 7-1.

Table 7-1: Examples of the of Remote Operated Vehicles (ROV)

Classification of ROV	Description
Light Work Class ROV	They are as well unmanned vehicles. A Light Work Class ROV is used in activities such as cleaning, drilling; various survey works. It can be also used during inspections for reparation works. Additionally, they can be equipped in for example laser scanners or specialized inspection devices and sensors. They can operate at depths of 3,000m (Cappoci, R. at al, 2017).
Surveyor Interceptor ROV (SROV)	The Surveyor Interceptor ROV (SROV) is new generation survey support ROV developed by Reach Subsea AS and MMT. It was designed for pipeline inspection and seabed surveys to provide improved, accurate data at higher speed as being towed by the ship in speeds up to 6 knots. This result in substantially better inspection quality with production of high quality and density data at a lower cost per km. The SROV is very stable and equipped with state-of-the-art sensors with respect to geophysical instrumentation as well as sounding equipment, such as dual swath and ping Multi Beam Echo Sounder in order to keep density at higher speeds. The data is obtained live and can be quality controlled with respect to quality and coverage in real time. The SROV was initially designed for pipeline inspections however has also proven its excellence in geophysical surveys and ecological visual inspections. More information on the technical specifications can be found at https://www.mmt.se/innovations/srov/

8 Survey Vessels

Several different marine vessels will be required for efficient deployment, execution, and recovery of the various site investigation activities methodologies. It is envisaged that different vessels will be required for the geotechnical, geophysical, ecological and metocean stages of the survey.

Geotechnical survey vessels are typically 55-90m in length and have an endurance of up to 28 days. Their port of mobilisation will depend on previous work but may be Irish, UK, or another European location.

Geophysical survey vessels are typically between 15m and 60m in length and have an endurance of up to 14 days. These vessels are likely to use a local port for mobilisation and replenishment. The exact vessels to be used, will be confirmed following a tender process to procure the survey contractor. All vessels will be fit for purpose, certified, and capable of safely undertaking all required survey work. The vessels will conform to the following minimum requirements as appropriate:

- Station-keeping and sea keeping capabilities required by the specified work at the proposed time of year; the appointed contractor may provide supplemental tug assistance if such assistance benefits the operation;
- Endurance (e.g. fuel, water, stores, etc.) to undertake the required survey works;
- Staffing to allow all planned work to be carried out as a continuous operation (on a 24 hour per day basis for the offshore activities and on a 12 hour per day basis for the inshore activities);
- Equipment and spares with necessary tools for all specified works;
- Appropriate accommodation and messing facilities on board;
- Adequate soil laboratory testing facility.

The survey contractor and vessels will comply with international and national statute as appropriate. A non-exhaustive list of examples includes:

- Sea Pollution Act 1991 which transposes into Irish statute the requirements of the International Convention for the Prevention of Marine Pollution from Ships (MARPOL 73/78)
- Sea Pollution (Amendment) Act, 1999 - which gives effect to the International Convention on Oil Pollution Preparedness, Response and Co-operation, 1990 (OPRC).
- S.I. No. 372/2012 - Sea Pollution (Prevention of Pollution by Garbage from Ships) Regulations 2012.
- S.I. No. 492/2012 - Sea Pollution (Prevention of Pollution by Sewage from Ships) (Amendment) Regulations 2012
- S.I. No. 507/2012 - Merchant Shipping (Collision Regulations) (Ships and Water-Craft on the Water) Order 2012.

8.1 Noise Sources From Survey Works

The ranges of noise frequency and sound pressure associated with all the surveys outlined in previous sections is summarised in Table 8-1 below. It should be noted that while equipment may have the ability to operate at lower frequencies (below 200kHz) the frequencies required to return the data necessary for offshore wind development generally operate at the higher end of the frequency range. For example, equipment for multi-beam echo sounder may be capable of operating at 200kHz however the typical frequency for offshore wind purposes is 450kHz.

In addition, while the exact equipment will not be known until after the procurement process there is some equipment and frequencies that would not be used for offshore wind data acquisition such as the EM122 which may be used for Multi-Beam Echo Sounder which can operate at 12 kHz. This would never be used as it does not serve the needs to offshore wind development.

Table 8-1: Survey Sound Pressure Levels

Noise Source	Frequency (kHz)	Sound Pressure Level (dB re 1µPa @ 1m)
Shipping Noise	50-300 Hz	160 – 175
Multi-beam echo sounder	400 – 700	200 – 228
Side scan sonar	300 – 900	228
Pinger or Chirp/Sparker system	2 – 16	200
Boomer system	2.5	208 - 211
Geotechnical drilling (Rotary)	2Hz – 50kHz	190

9 Timeline for Site Investigations

The intention is to begin survey activities as soon as feasible following license award, with a staged programme of investigations, capitalising on suitable weather windows over this time period. This phased approach will progress the overall development towards detailed design stage. The exact mobilisation dates will not be known until the process of procuring a contractor is complete.

Typical deployment periods for the different site investigations as well as maximum time at any one location is described in Table 9-1.

Table 9-1: Typical Time Required for Individual Site Investigation Activities

Activity	Typical Time Period Required for Activity
Geophysical	2-6 weeks (weather dependent)
Borehole	Up to 24 - 36 hours in any one location
CPT	30 minutes to 3 hours in any one location
Benthic Grab Sampling	Up to 3 hours in any one location
CPODs	4 weeks to 12 months in any one location
Gravity Corer	45 minutes to 2 hours at any one location

10 Comparative Analysis of Offshore Wind Surveys with Oil and Gas Surveys

The activities required for oil and gas exploration are very different in magnitude to those required for offshore wind. While both industries may use similar geophysical survey methods, they would use far different equipment. Equipment used for oil and gas is many times greater in magnitude than equipment used for offshore wind data gathering and visually one is not likely to be mistaken for the other.

The vessels for offshore wind geophysical surveys are typically up to 21m for inshore work in shallower waters and between 15m and 60m for work outside shallow waters. Vessels for Oil and Gas (O&G) exploration are typically at least 90m in length and can be in the region of 70m wide. In addition, there are other differences between the vessels used in the two industries. O&G vessels will have the ability to tow a much greater number of pieces of equipment behind them. They will also tow them for over much greater distances. The length of the tow for offshore wind is measured in meters, for O&G it is measured in kilometres.

Examples of O&G geophysical vessels are shown in Figure 10-1 and Figure 10-2. The first vessel (Figure 10-1) is Dolphin Geophysical's Polar Marquis used in O&G exploration. This vessel is 121m long. The second is the PGS vessel, Ramform Atlas which was used to survey 7900km^2 in seas off New Guinea. It has a 70m wide back deck and surveyed in water depts of up to 4500m. The length of the tow was over 8000m (8km) with a distance of 150m between each tow line (Offshore Energy Today, 2019).

Figure 10-1: Dolphin Geophysical's Polar Marquis (GCaptain.com, 2014)

Figure 10-2: The Ramform Atlas Vessel (PGS)

Examples of offshore wind surveying vessels can be seen in Figure 10-3 and Figure 10-4. The first is MMT's M/V Franklin. This vessel is 54m in length and is suitable undertake geophysical surveys at offshore windfarms (MMT, 2021). The second is the Fugro Seeker which is suitable for undertaking geophysical surveys in water as shallow as 2m. It is 12m in length (Fugro, 2021).

Figure 10-3: MMT's M/V Franklin (MMT, 2021)

Figure 10-4: Fugro Seeker (Shipspotting, 2018)

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