Energy for generations

Tonn Nua

Site Investigation – Schedule of Works

Submission to: MARA

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Table of Contents

Table of Figures

Table of Tables

1 INTRODUCTION

This document has been prepared to accompany an application by Helvick Head Offshore Wind Designated Activity Company (Helvick Head OSW DAC) for a Marine Usage Licence (MUL) to the Maritime Area Regulatory Authority (MARA) for the area referred to as the Tonn Nua project. The document provides an overview of the survey works proposed to be undertaken within the proposed MUL boundary as illustrated in the Proposed MUL Map accompanying this MUL application.

1.1 Programme of Works

It is proposed to commence surveys on a phased approach, commencing in Q2/Q3 2026 (subject to grant of this MUL) with surveys proceeding over a 5-year licence period. The exact dates for the surveys are to be determined pending grant of an MUL and the appointment of survey contractors but based on the forecasted scope of works the estimated duration of each project scope is as per Table 1.

Table 1: Estimated Project Schedule

Scope of Work	Estimated Duration	Estimated Survey Commencement date
Geophysical Campaigns (see Section 2.1)	2 to 5 months	Q2/Q3 2026 or 2027
Geotechnical Campaign (see Section 2.2)	2 to 5 months	Q2/Q3 2026 or 2027
Environmental/Ecological & Archaeological Surveys (see Section 2.4)	Periodically across a 12 to 24 month duration	2026 or 2027
Metocean Survey (see Section 2.3)	Fixed 12 to 36 month period including the need for site access for data collection and maintenance as needed	2026, 2027 or 2028

The above estimated durations are subject to change based on variables such as weather conditions onsite, unforeseen seabed conditions, unforeseen obstructions etc.

The applicant will consult with MARA and other relevant stakeholders where appropriate prior to the commencement of the surveys outlined within this application.

1.2 Method Statements

The subsequent section of this document entitled Schedule of Works provides a succinct overview of the likely method in which the surveys will be undertaken, the specific and detailed method statements relating to each of the specific surveys will be confirmed upon appointment of the preferred survey contractor(s).

2 SCHEDULE OF WORKS

2.1 Geophysical Surveys

The geophysical survey scope is intended to provide significant seabed and sub-seabed information to assist in the consenting, design and installation phases of the project. It is therefore foreseen to gather, as a minimum, detailed information on:

- Water depths, reduced to LAT, throughout the defined survey area;
- The nature of any seabed features, obstructions, sediments and shallow geological conditions throughout the defined survey areas;
- The nature of the sub-seabed conditions and horizons;
- Any man-made, geological or shallow gas hazards that could impair the satisfactory installation of the turbines, inter-array cables and geotechnical drilling operations;
- Seabed conditions/ hazards to any project equipment which may need to be located on the seabed at any stage of the Offshore Wind Farm (OWF) project;
- Seabed habitats to inform further benthic surveys and preparation of environmental impact assessment reports (EIAR's);
- Archaeological features within the OWF project footprint.

The foreseen Geophysical scope of works will consist of primarily non-intrusive survey methods, in that they will not physically interact with the seabed, such as Multi Beam Echosounder (MBES), sub-bottom profiler (SBP), Ultra High Resolution Seismic (UHRS), Side Scan Sonar (SSS) and Magnetometer surveys but may also incorporate visual surveys (e.g. drop down video, ROV, ROTV etc.) pending the development of the project's ground model and assessment of potential hazards such as UXO.

Typical vessels for geophysical surveys will be circa 15 – 100 m in length. See Figure 1 for an example of a geophysical survey vessel.

Figure 1: Offshore Geophysical Survey Vessel - Fugro Discovery IMO 9152882

Some aspects of the geophysical / hydrographic surveying may be undertaken using unmanned surface vehicles (USVs) and / or autonomous surface vehicles (ASVs). Depending on programme requirements at the time of survey, more than one USV may be deployed and operate in parallel to undertake the survey.

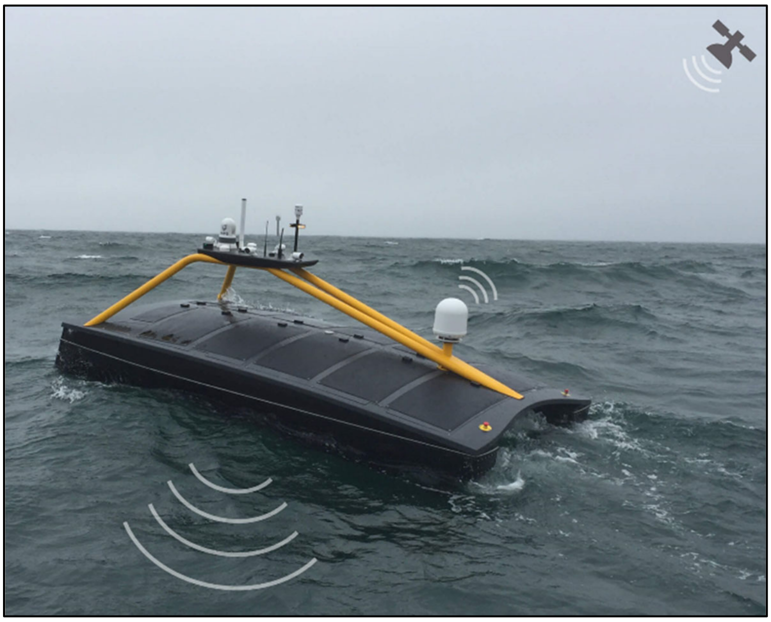

Figure 2: Typical USV (XOCEAN)

A brief description of the geophysical survey methods has been provided in the subsequent sections (2.1.1 to 2.1.46).

2.1.1 Multibeam Echosounder (MBES)

Method: A remote sensing acoustic device which will be either attached to the vessels hull at the bow or mounted on a side pole.

Indicative Equipment:

- GeoAcoustics GeoSwath Plus interferometric echo sounder,
- Teledyne Reson SeaBat T50-R,
- R2Sonic 2024 – see Figure 3,
- Norbit Winghead B51s
- Kongsberg EM2040 KMII
- or similar.

Swath width: Swath width will be optimised to provide 100% seafloor coverage with typical swath widths of 3 to 6 times water depth depending on arrangement of equipment hardware.

Location: MBES survey may be performed throughout the proposed licence area.

Figure 3: MBES R2Sonic 2024 typical configuration and equipment

2.1.2 Side Scan Sonar (SSS)

Method: A submerged acoustic device (SONAR – SOund NAvigation & Ranging) for imaging areas of the seafloor will be either hull mounted or towed (see Figure 4).

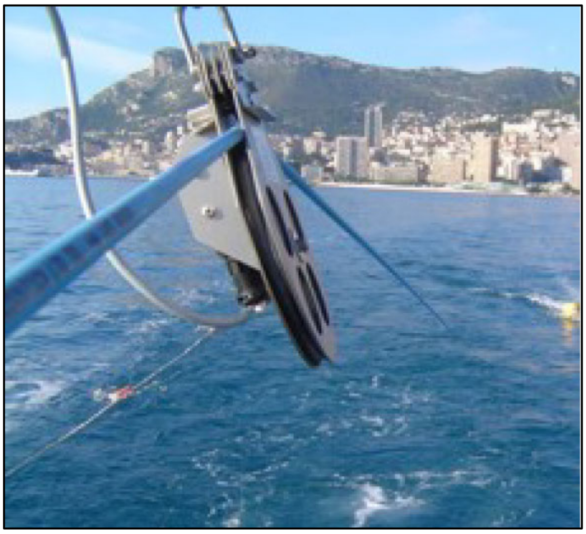

Figure 4: counting pulley for winch-towed C-Max CM2 SSS

Indicative Equipment:

- GeoAcoustics 160 system,
- Edgetech 4200,
- C-Max CM2 system (see Figure 4),
- Klein Hydro Scan,
- Klein 4k-SVY
- SAS & MAS systems
- or similar.

Range: Depending on resolution and coverage requirements. Line spacing from 30 – 100 meters are often seen. 75 meters line spacing is most frequently used. **Location:** SSS survey may be performed throughout the proposed licence area.

2.1.3 Sub-Bottom Profiling (SBP) / Ultra High Resolution Seismic (UHRS)

Method: SBP / UHRS are acoustic devices for imaging sections of the seabed. The images produced are used to produce profiles beneath the seafloor, enabling delimitation of major sedimentary interfaces. They are either mounted on the vessel / pole or towed behind the vessel.

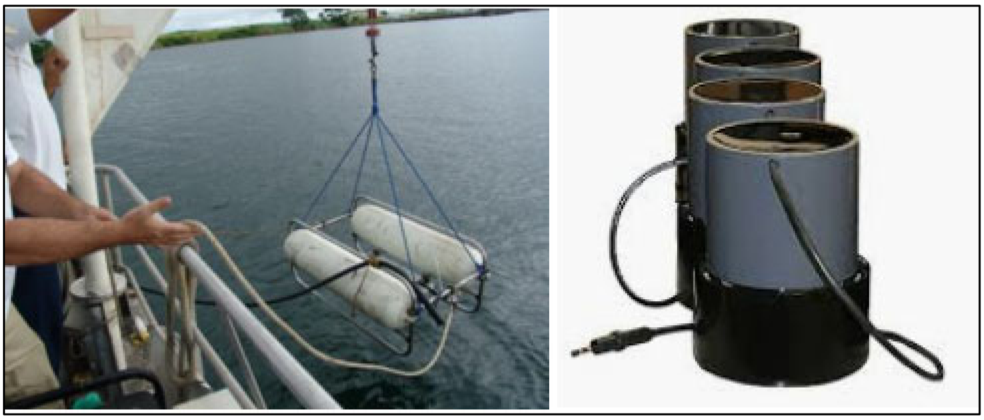

Figure 5: Left - Applied Acoustics AA300 being deployed & Right - Typical Hull Mounted SBP - Seatronics Edgetech 3300

Indicative Equipment:

Sub-bottom profiler:

- GeoAcoustics 5430A profiling system,
- Edgetech 3100 or similar 'pinger' system – see Figure 5.
- Innomar SES 2000 medium 100 or similar
- Ultra High Resolution Seismic (UHRS) (sparker/boomer):
- Applied acoustics boomer plate AA251/AA301 or similar – see Figure 5,
- Seismic Energy Source Applied acoustics CSP-L or similar.
- Geosource 200-400
- Geosource 400
- or similar

Line spacing: Line spacing for this survey equipment will be dependent on geology and the level of detail required for investigation.

Location: SBP and UHRS surveys may be performed throughout the proposed licence area.

Note: Surveys may employ 2D or 3D UHRS methods, with slight differences in vessel requirements. A sample 3D UHRS configuration is shown below.

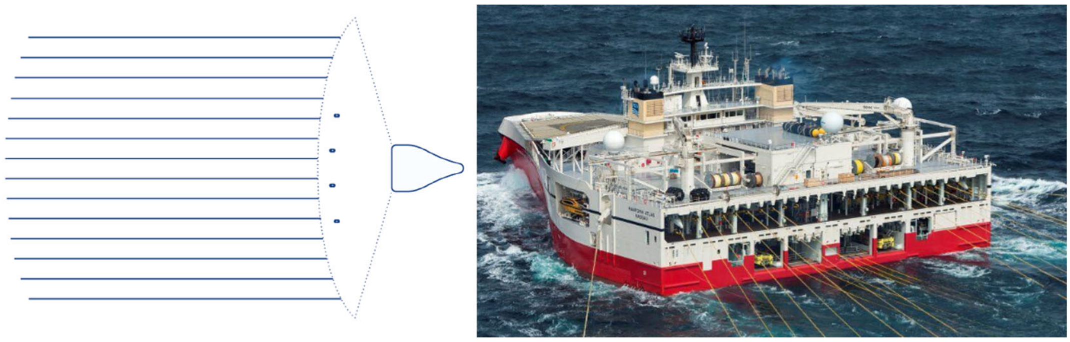

Figure 6: 3D UHRS Sample Streamer Configuration and Vessel Type

2.1.4 Magnetometer Survey

Method: Magnetometers provide information on embedded magnetic/ferrous objects such as cable crossings, debris and potentially UXO's. They are towed from the vessel.

Indicative Equipment:

- Geometrics G-882 caesium vapour magnetometer – see Figure 7,
- Marine Magnetics SeaSPY,
- G-Tec Magwing System,
- or similar.

Survey spacing: Dependent on physical size of body targeted by the investigation. For detailed and local UXO investigation spacing of individual magnetometer fish can be down to 1 meter. For reconnaissance surveys, a magnetometer is towed behind the side scan sonar.

Location: Magnetometer surveys may be performed throughout the proposed licence area.

Figure 7: Geometrics G-882

2.1.5 Subsurface navigation systems

Subsurface navigation (USBL) is used for positioning of towed equipment when precise and correct navigation of towed equipment is required. Transmitter is located on towed equipment, receiver mounted on vessel.

Indicative Equipment

- iXblue GAPS
- Sonardyne GyroUSBL 5000
- Sonardyne Mini-Ranger
- Kongsberg HiPAP 351/352

Location: Subsurface navigation may be performed throughout the proposed licence area.

2.2 Geotechnical Surveys

The aim of the offshore geotechnical surveys is to provide sufficient geotechnical data to allow the characterisation of the sub-seabed strata in order to refine a 3D soil model of the offshore windfarm site. These details will be used to initiate the design of the WTG foundations and inter-array cables, and to carry out analyses of the installation of all of these. The output from the survey will directly support the subsequent Front-End Engineering Design (FEED) activities for the OWF site.

The works may include some or all of the following within the proposed licence area;

1. Seabed Cone Penetration Testing at a pre-defined number of locations within seabed sediments, either to refusal or the depth of interest for WTG foundation design and installation.
2. Sampling/coring boreholes at a pre-defined number of locations within the depth of interest for WTG foundation design and installation.
3. Vibrocoring (or piston coring) at a pre-defined number of locations within the depth of interest for inter-array cable design and installation.
4. In situ Thermal Conductivity Testing at a pre-defined number of locations within the depth of interest for inter-array cable design and installation.
5. Down the hole Cone Penetration and/or Pressuremeter Testing (i.e. inside the boreholes) within the depth of interest for inter-array cables design and installation.
6. Offshore & Onshore Laboratory testing of recovered samples.

The execution of 1, 3, and 4 may be undertaken as a standalone campaign, likely Q3 2026, or in conjunction with a deep borehole campaign (likely 2027).

The geotechnical surveys are intrusive investigations typically carried out over 2 separate campaigns, a preliminary geotechnical campaign to inform the project design envelope for consenting and early-stage design studies, with a subsequent detailed geotechnical investigation survey to inform the OWF's detailed design prior to fabrication and construction.

The indicative quantities given below relate to the requirements for the preliminary geotechnical campaign, the final quantity, location and specification of equipment will be determined following interpretation of the geophysical survey data and considering environmental constraints (i.e. proximity to sensitive receptors).

The geotechnical survey will be undertaken from a dedicated geotechnical vessel (length 50-90m, see Figure 8).

Figure 8: Typical Offshore Geotechnical Survey Vessel – Fugro Synergy IMO 9452488

2.2.1 Boreholes

Indicative Quantity: 5 – 15. **Method:** A drill head is lowered to the seabed from the vessel via a drill string and stabilised using a seabed frame. The drill head penetrates the seabed via rotation of the drill string and the application of a downward pressure. Drilling mud may also be used. Soil samples and rock cores are then retrieved for laboratory testing via the drill string. Sampling and coring may be combined with in-situ testing such as cone penetration testing (see section 2.2.2) or down the hole testing (see 2.2.4) at some investigative locations.

Sample Diameter: up to 102mm.

Depth: Up to 70m below the seabed. **Indicative Equipment:** Drilling equipment used will follow the ISO and API technical specifications for drilling equipment. Indicative equipment to be used would be traditional API drill string or a triple core barrel system (e.g. Geobor 'S') or similar (see Figure 9).

Location: Indicative locations are shown on Figure 34 as provided in Appendix A accompanying this licence application; however, change can be expected prior to mobilisation of this campaign as understanding of the site develops.

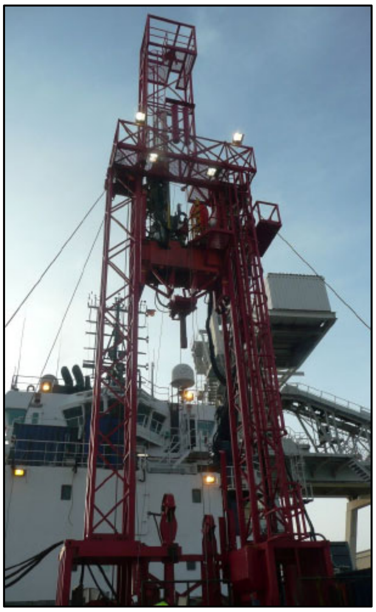

Figure 9: Typical Marine Drill (Fugro)

2.2.2 Cone Penetration Testing (CPT)

Indicative Quantity: 10 – 40.

Diameter: Cone diameter: up to 44mm (Up to $15cm^2$); Borehole diameter (down the hole mode only): up to 102mm.

Method: In situ Cone Penetration Test on seabed frame, see Figure 10, and/or deck-push CPT from the vessel via a moonpool. In situ thermal tests may be performed using a built-in sensor within the Cone Penetration Test equipment.

Depth: Up to 70m or refusal within the WTG array area. **Indicative Equipment:** Fugro Seacalf, G-Tec GT25 or similar are examples of Cone Penetration Test units. Fugro Heat Flow Module is an example of CPT-based in situ thermal test equipment.

Location: Indicative locations are shown on Figure 34 as provided in Appendix A ; however, change can be expected as understanding of the site develops.

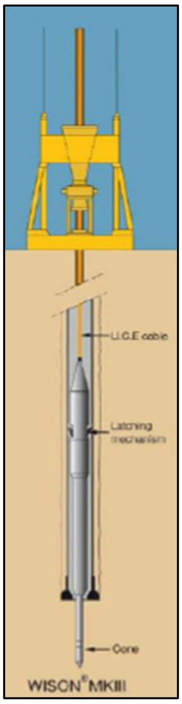

Figure 10: Typical Seabed Frame CPT (Fugro)

2.2.3 Vibrocore (VC)

Indicative Quantity: 30 - 60

Method: Vibrocore (see Figure 11), piston core, or similar. These devices are typically deployed from a crane on the vessel. In situ thermal tests may be performed using a sensor string attached to a Vibrocorer.

Diameter: Vibrocore sample: up to 106mm; In situ thermal test sensor string: up to 50mm.

Depth: Vibrocore up to 6m depth

Indicative Equipment: Fugro HPC (high performance corer) & OSIL Vibro-Corer are typical examples of vibrocoring systems. Fielax VibroHeat is an example of VC-based in situ thermal conductivity equipment.

Location: Indicative locations are shown on Figure 34 as provided in Appendix A ; however, change can be expected as understanding of the site develops.

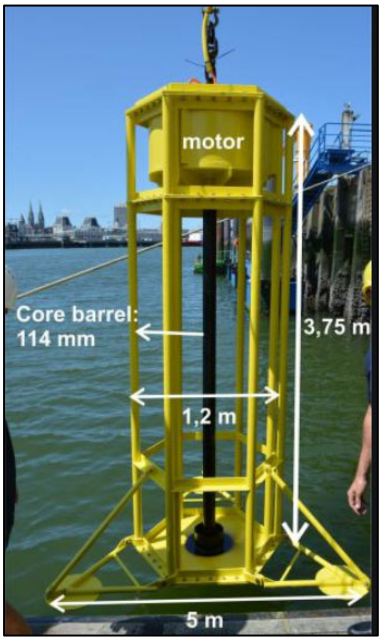

Figure 11: Typical Vibrocore System (OSIL)

2.2.4 Down the Hole testing

Diameter: Up to 102mm.

Depth: Up to 70m.

Method: These tests would be conducted within the open boreholes during sampling/coring or down the hole Cone Penetration Testing. Testing methodology involves the installation of a probe within the open borehole. Options for down the hole testing include;

- Seismic Wave Velocity Measurements
- High Pressure Dilatometer Testing
- Televiewer

Indicative Equipment:

- Robertson Geo PS Logger Probe
- Cambridge Insitu HPD95 High Pressure Dilatometer Probe
- Robertson Geo Hi-OPTV High Resolution Optical Televiewer

Location: Down the hole testing may conducted within selected indicative borehole locations. Indicative locations are shown on Figure 34 as provided in Appendix A ; however, change can be expected as understanding of the site develops.

2.3 Metocean Surveys

The main purpose of the meteorological and oceanographic (metocean) campaign is to collect accurate wind, wave, temperature, current, water levels, and any other relevant atmospheric parameters from the project site that will be used to;

1. Conduct energy yield assessments
2. Feed into offshore sub-structure design

3. Estimate workability range at offshore sites, for defining the construction and O&M strategies

The proposed survey methods are as outlined in Sections 2.3.1 to 2.3.4. The exact details of the surveys (equipment, locations and deployment/retrieval methods) will be confirmed upon appointment of a preferred contractor.

2.3.1 Equipment Deployment & Recovery Methodology

2.3.1.1 Conventional Deployment and Recovery Vessels

The methodology for deployment of metocean monitoring equipment may be through the use of a suitable vessel to either tow &/or lift and deploy from vessel deck via onboard crane. An example of a suitable vessel for this scope would be a shallow draft anchor handling tug or a utility type vessel such as that shown in Figure 12 or similar.

All monitoring devices will be collected upon decommissioning by detaching the connection moorings and loading the monitoring devices onto a vessel and transporting all equipment to port. All elements of the mooring systems will be removed at the end of the metocean data gathering campaign and no equipment will be left on the seabed.

It is not planned to use divers at any stage during the deployment, maintenance or decommissioning of the monitoring devices noted in Section 2.3.2 (ADCPs), 2.3.3 (Wave Buoys), 2.3.4 (Floating **Li**ght **D**etection **A**nd **R**anging (LiDAR) System (FLS)), 2.4.2 (Static Acoustic Monitors).

An Uncrewed Survey Vessel (USV) may be utilised for the campaigns, either augmenting or replacing the need for a deployment and recovery vessel during certain campaigns. Further details are provided in Section 2.3.1.2.

Figure 12: Dennis Murphy IMO 9268784

2.3.1.2 Autonomous Floating Platform

The applicant may opt to deploy an Autonomous Floating Platform to undertake Wind Resource and Metocean surveys. This may replace or reduce the requirement for deployment and retrieval vessels during certain campaigns.

Background

USVs for MetOcean applications are designed as a generic sensor platform and can collect data on floating LiDAR campaigns, wave and current measurement, environmental surveys, bathymetry and hydroacoustic seabed surveys dependent on the sensor instrumentation chosen. The USV has a built-in navigation system, which enables it to transit from shore at various degrees of autonomy, and it can be controlled remotely. Systems such as the Ørsted USV have a built-in anchoring system so it can perform operations as a moored buoy when obtaining measurements.

Indicative Quantity: 1-2

Method: A USV (see Figure 13) may be deployed within the survey area and held in position via an onboard anchoring system where it transitions from a vessel to operate as a moored Ocean Data Acquisition Systems ODAS (metocean) buoy. The USV would be deployed on location for a period ranging from 12 to 36 months depending on the variability of wind, wave height, ocean currents, and other collected meteorological and sea-state parameters.

Deployment can happen from a Remote Operation Center (ROC) onshore, featuring 360 degree live cameras as well as radar, Automatic Radar Plotting Aid (ARPA) and Automatic Identification System (AIS) view of surroundings.

In case remote operation is not permitted, the USV Operators can conduct Line of Sight operation from a support vessel. The Support vessel can be CTV type or smaller with a crew of 2-3 as well as 2 USV Operators. No offshore crane operation is required.

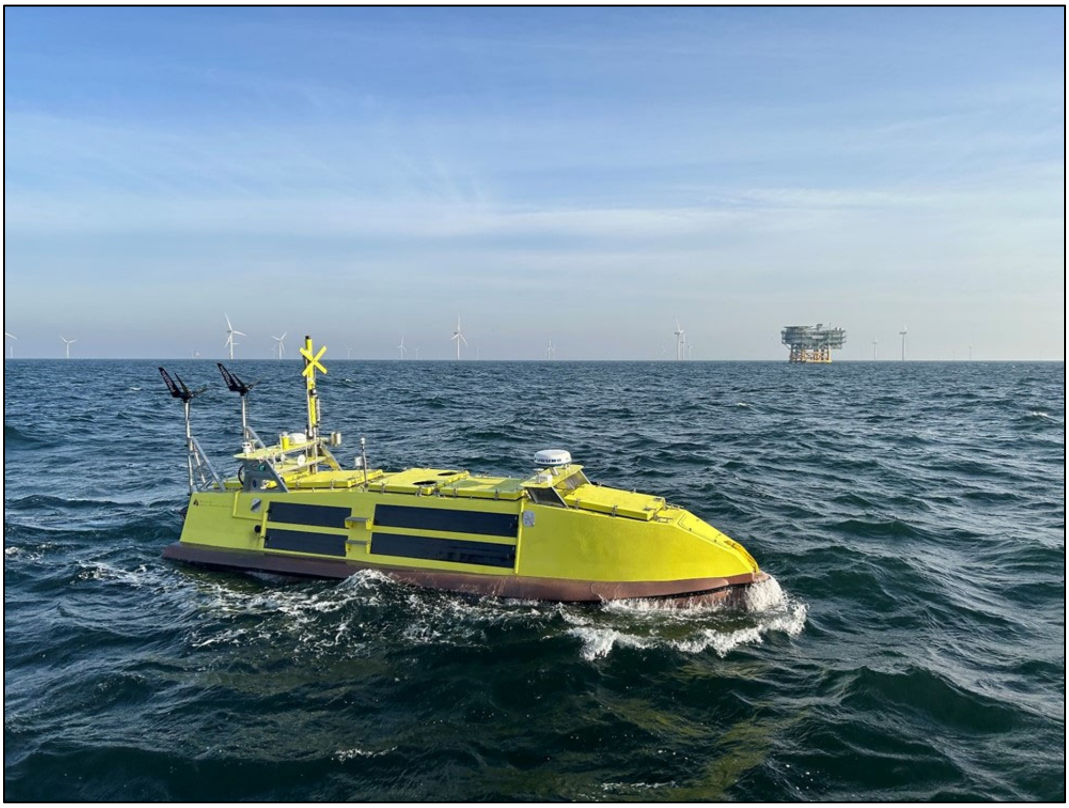

Figure 13: Ørsted USV

Indicative Equipment: Ørsted Uncrewed Surface Vessel (USV), or equivalent

The USV for the site may be a fully equipped and autonomous wind, wave and current measuring system based on LIDAR technology that houses a host of meteo-oceanographic instrumentation.

As an indicative example, the total weight of the Ørsted USV shown in Figure 13 is 14.5 tonnes (fully fuelled and including 400 m chain). The clump weight anchoring the unit to the seabed can weight up to 7 tonnes.

The USV will be equipped with a Class A AIS for USV, and Class B for ODAS Buoy use. When operating as a buoy the Saint Andrew cross is deployed and it flashes with a yellow light, five flashes in a group every 20 seconds. The USV will be equipped with navigation lights, radar reflectors and a flag when operating as a vessel. The USV will be flagged and marked in accordance with Irish Maritime Requirements. The Commissioners of Irish Lights (CIL) standard navigational safety requirements will be adhered to with regards to the positioning, mooring, marking, and lighting of all equipment deployed in the licence area.

Location: Indicative locations are shown on Figure 34 as provided in Appendix A.

Mooring systems: As an example, the Ørsted USV shown in the figure below houses an anchoring system including a 150 kg anchor with 400 m of 13 mm Full Duplex Stainless-Steel chain that can be deployed once the USV arrives at the survey location, and can be retracted once the campaign has been completed and/or when the USV needs to transit.

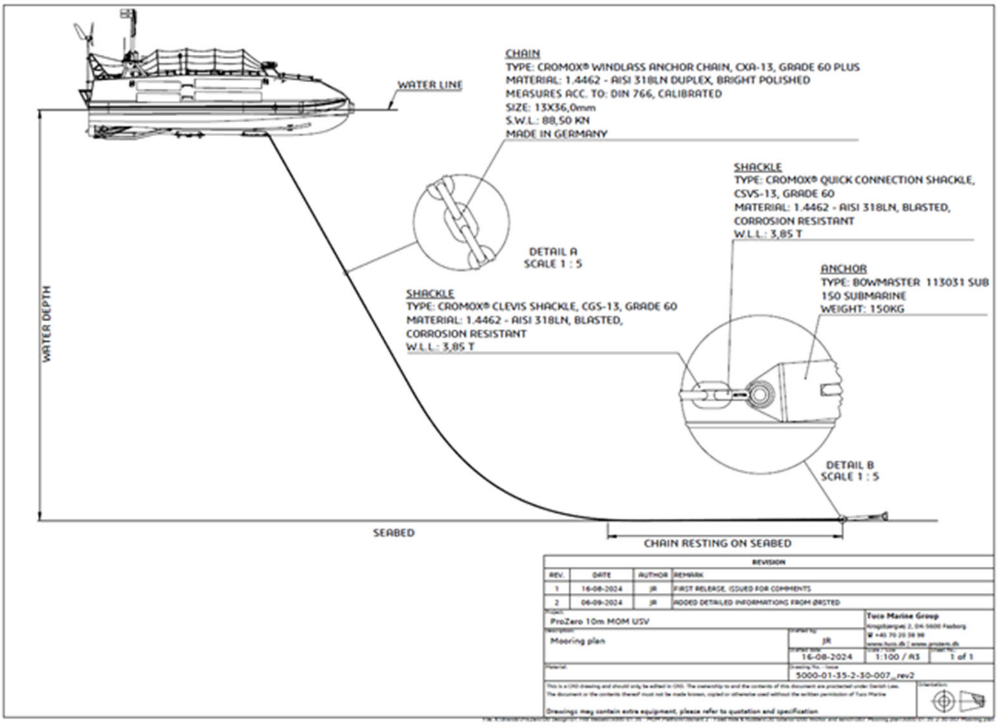

Figure 14: Ørsted USV Mooring Diagram

Operations & Maintenance (O&M) of Device(s)

Maintenance is commonly scheduled to take place every 6 months. The duration of scheduled maintenance is expected to last 2-7 days. Visual inspection will be performed to ensure buoyancy, stability, absence of damage or vandalism, dirt and overall condition.

It will typically be required that a USV is brought to the nearest harbour in order to perform service and maintenance works. USV’s properties facilitate transit of the USV back to a harbour via a remote operator or easy tow operations to shore for works to be performed if needed.

Device Recovery

The USV will retract the Saint Andrew cross demarcating it as a buoy, and transit back to shore via remote operation. Nothing will be left on the seabed and/or at site.

2.3.2 Acoustic Doppler Current Profiler (ADCP) to measure ocean currents

Background

Acoustic Doppler Current Profiler (ADCP) frames will be deployed onto the seabed at positions across the site to collect data on water movements, current speeds and directions at the project site. The data will be used to develop hydrodynamic models for the project and provide information for design of project infrastructure and logistical planning for construction and operations and maintenance phases of the project.

Indicative Quantity: 1 - 4

Method: Deployed to the seabed via a crane from a survey vessel for a duration of at least 12 months.

Indicative Equipment: The ADCP unit simply consists of mechanical measurement instruments housed within a trawler resistant protection frame. The unit presented in Figure 16 shows a version of the equipment without the protective casing (Figure 17 with protective casing). Typical installation layouts consist of the frame being connected to a weighted base (circa 1.8 m wide and 0.6 m high) with a weight of approx. 300 kg. This is attached to a ground line, a clump weight and to an acoustic release system carrying a rope retrieval system. The seabed frame is equipped with a conductivity, temperature and depth sensor (CTD), optical backscatter sensor (OBS), ADCP and wave sensor. Sediment traps can be attached to the seabed frame allowing the top of the sediment trap to be positioned approximately 0.6 m above the seabed. Sediment from the traps will be used to calibrate the OBS sensors.

An example of an ADCP unit is the Nortek Signature500 ADCP shown in Figure 15. The Nortek instrument is both a current profiler and a wave directional system in one unit. It enables the measurement of current speed and direction in layers (0.5 - 4.0 m) from seabed to the surface. The Signature500 will sample currents and waves in water depths up to 60 m, suitable for the water depths at the project sites. Ancillary pressure (water depth), data will also be collected concurrently.

Figure 17 shows a typical ADCP prior to deployment to the seabed, with drawings for a typical unit provided in Appendix 1 - Drawings. The proposed seabed deployment is shown via a schematic in Figure 18.

Figure 15: Nortek Signature 500 (Nortek UK Ltd.)

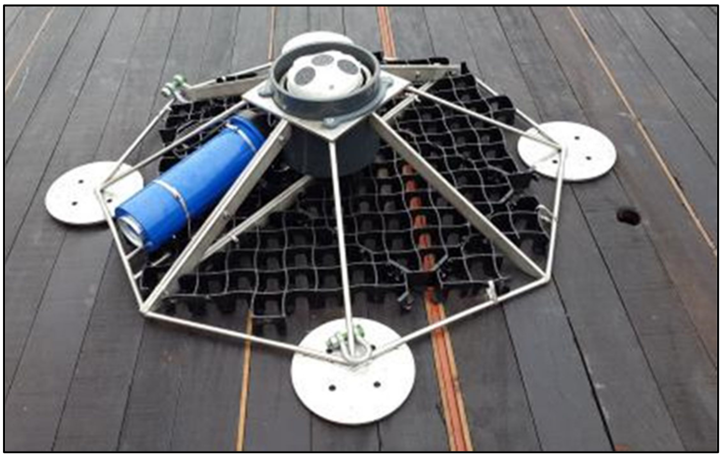

Figure 16: Typical seabed frame with ADCP (Ocean Scientific International Ltd)

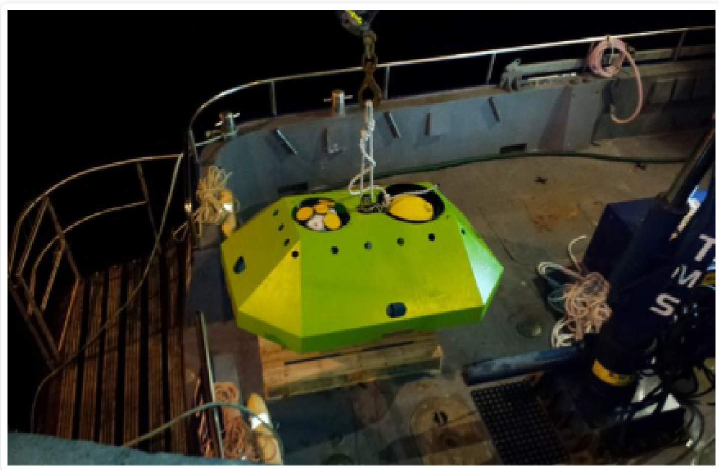

Figure 17: TechWorks ADCP with protective casing ready for offshore positioning (Techworks Marine Ltd.)

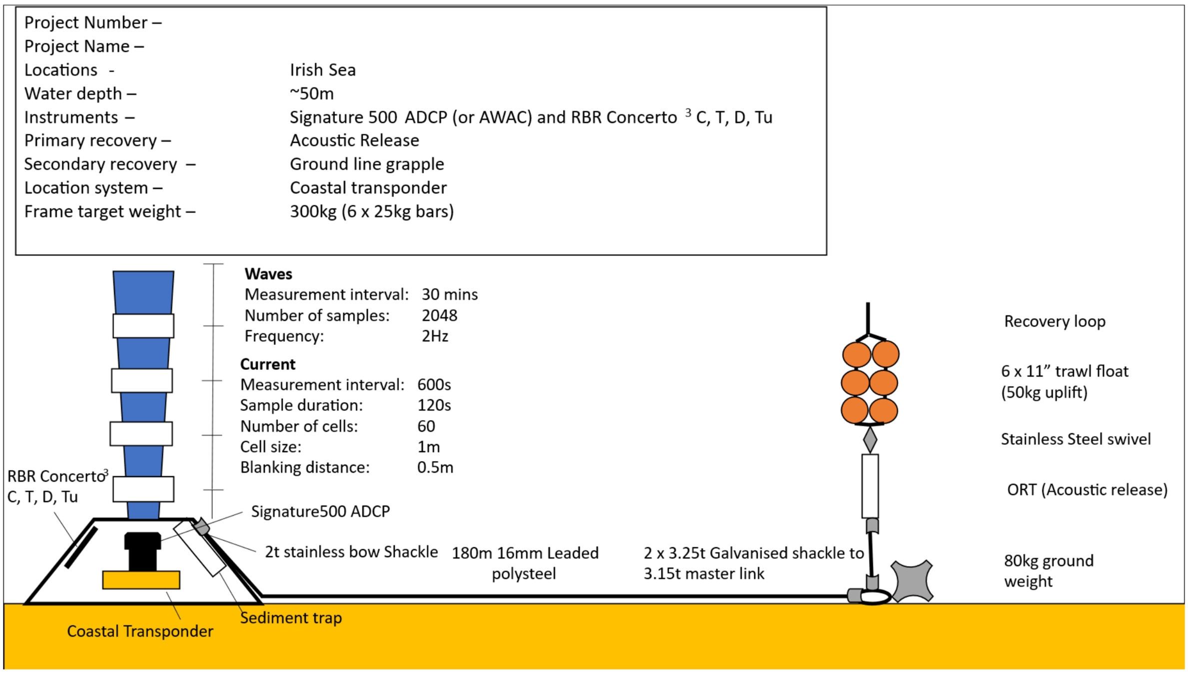

Figure 18: Seabed frame deployment with Signature55 ADCP and RBR Concerto3 CTD, TU sensors (Partrac)

Location: Indicative locations are shown on Figure 34 as provided in Appendix A, however, change can be expected as understanding of the site develops.

Operations & Maintenance of Device(s)

Periodic servicing is carried out typically every 3 months. This includes recovery to a workboat via crane/A-frame with winch. During servicing, an acoustic transponder from a vessel can release a buoy that can be utilized to recover the ADCP as mentioned below. The equipment is brought onto the vessel deck and the line attached to the ground weight is hauled up. Once on board, the ground line is removed from the ground weight and slowly winched in as the vessel moves towards the frame location. When the vessel is vertically above the frame, the frame is slowly lifted off the seabed and brought on board. No items are left on the seabed.

Maintenance involves replacing the batteries on the instruments and cleaning the unit from sediment and bio-fouling. Data is downloaded from the logger and the instrument is redeployed.

During each service visit the following will be completed:

- Shackles will be inspected and replaced as required
- Anodes will be inspected and replaced as required
- Mooring lines will be replaced as required
- Download of the recorded data and check to ensure that the equipment is performing correctly
- Cleaning of the measurement systems (ADCP and CTD Tu sensor) to remove any bio-fouling that may have accumulated
- Installation of new batteries
- Thorough check of the equipment and replacement of any damaged equipment
- Sediment traps will be emptied and washed-out during every service visit.

Once servicing of the equipment is completed the seabed frame will be redeployed to the seabed at the same location.

Mooring systems will also undergo periodic replacement. Over the monitoring period it is recommended that the mooring is replaced after every six months. This is however variable dependent on the findings of the planned mooring inspections.

Device Recovery

The recovery methodology for the ADCP will be refined pending further investigation into the most suitable deployment method at the site however two types of recovery are commonplace. These are an acoustic release method or grapple recovery method as detailed below. Retrieval of the buoys will be assessed to ensure that the process does not pose a hazard to safe passage during recovery operation and a marine notice to advise marine traffic of their presence will be issued prior to retrieval commencement.

Acoustic Release Recovery

After the survey period the frame will be retrieved by a specialist team using a pop-up release buoy, shown in Figure 19, allowing for its recovery. A release transponder will be placed over the side of the vessel and will send a ping to release pins holding the recovery buoy within the ADCP frame. Once the pins release, a spring(s) located under the buoy provides initial upward force for the buoy to rise and then float towards the surface. There will be no surface marker during the extent of deployment so vessel traffic will not need to avoid the area.

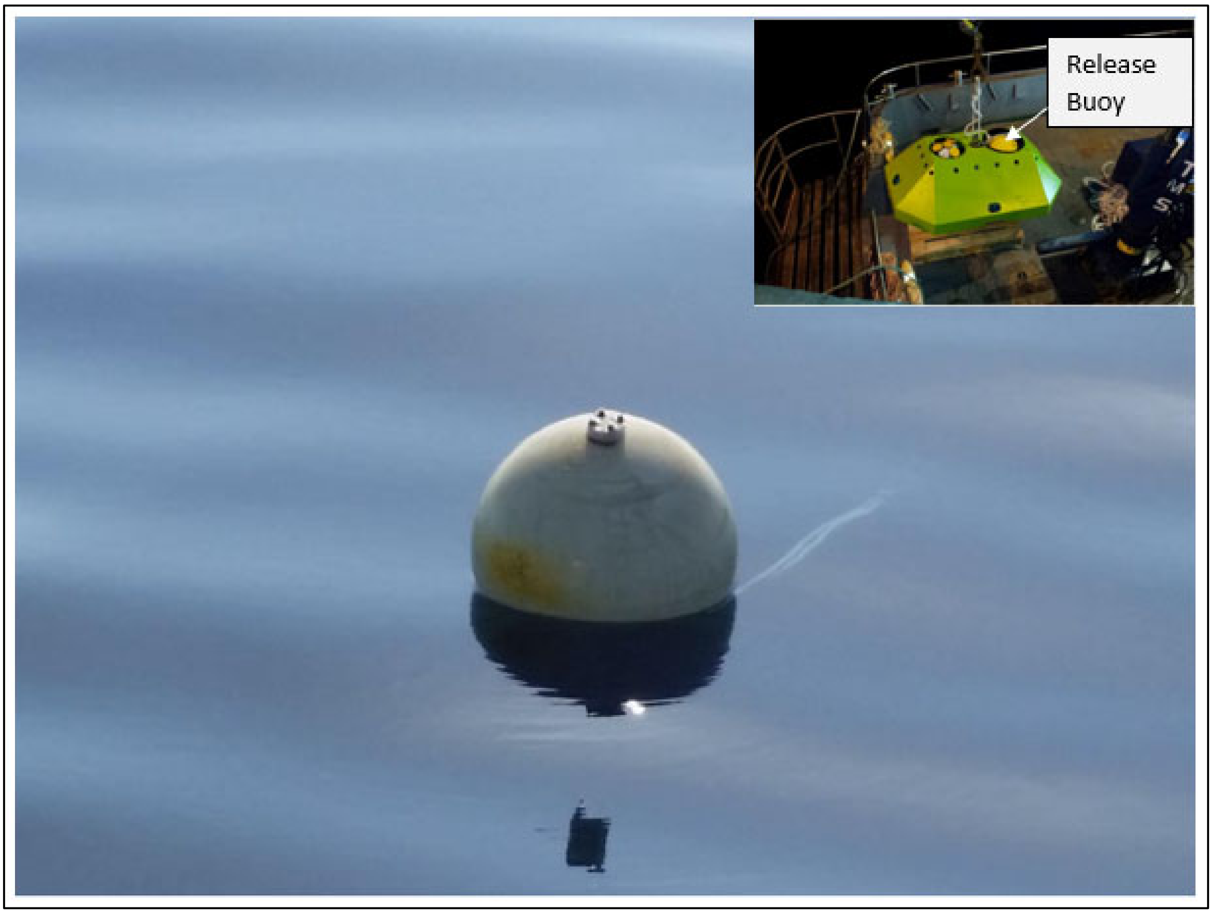

Figure 19: Recovery buoy after surfacing (Inset image shows recovery buoy in position from Figure 17) (Techworks Marine Ltd)

Grapple Recovery

The grapple hook will be lifted over the bow of the vessel and lowered into the water. The vessel will then trawl the grapple hook between the ADCP frame and the deployed grapple anchor location as shown in Figure 20.

Once connection has been made by the grapple hook, the grapple line will be brought to the surface, Figure 21. The grapple anchor will be lifted onto the deck of the vessel and the floating line removed. The ADCP frame is then lifted to the surface and winched onto the vessel deck as shown in Figure 21.

Should the surface marker buoy be damaged through deliberate or inadvertent collision a backup process will be available for retrieval. The ADCP frames set up for the grapple recovery method will be equipped with a standard acoustic release system and a grapple line will be attached to the frame to aid in the recovery should the surface marker buoy be absent upon the retrieval process.

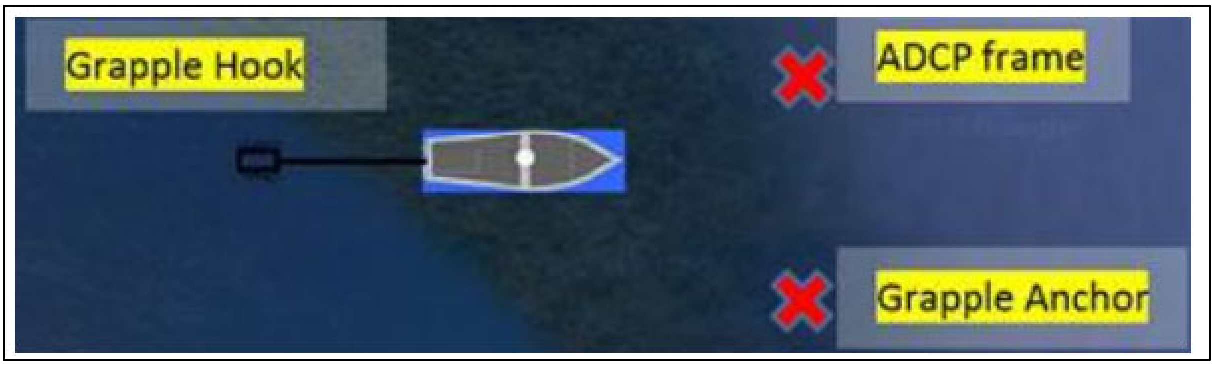

Figure 20: Grapple recovery method (Techworks Marine Ltd)

Figure 21 Left – The grapple hook caught with the grapple line; Right – The floating grapple line is winched into retrieve the ADCP frame (Techworks Marine Ltd.)

2.3.3 Wave Buoys

Background: In order to capture current and wave data, surface tracking wave buoys with an integrated current profiling unit and satellite-based data transmission system m be deployed at the site. This will enable higher resolution current and wave data as well as near-bed sea properties, ensuring higher degrees of accuracy to support project design criteria and logistical planning in the construction and operation and maintenance phases of the project.

Indicative Quantity: 1 - 3

Method: A surface floating wave buoy (see Figure 22 and Figure 23 for examples) will be deployed within the survey area and held in position via a suitable specified mooring configuration comprising a mooring chain/rope and anchor. Wave buoys will be deployed on location for a period of minimum 12 months.

Indicative Equipment: Datawell Directional Waverider, Fugro Seawatch midi 185 buoy

Typical wave measurement buoys such as the Datawell and Triaxys Waves with Currents buoy, shown in Figure 22 and Figure 23 respectively, provide directional waves data for the project location in which they are deployed. The Triaxys model is also equipped with a downward looking Nortek current profiler. The current profiler provides surface current and complete current characteristics throughout the water column. The Signature500 model shown in Figure 23 records current profile from surface to near-bed to depths of 60m.

Location: Indicative locations are shown on Figure 34 as provided in Appendix A ; however, change can be expected as understanding of the site develops.

Figure 22: Typical wave measurement buoy (Datawell)

Figure 23: Triaxys wave and current buoy with mounted current profiler on underside.

The surface buoys can be fitted with an amber flashing obstruction led light, with programmable flashing sequence visible from three miles, to mitigate risk of collision. The wave and metocean parameters recorded by typical wave buoy instruments are;

- Significant wave height (m)
- Total swell and sea wave
- Mean wave direction
- Maximum wave height (m)
- Wave period (s)
- Current profile characteristics (velocity and direction)
- Sea surface temperature

In addition, the following information is also reported;

- GPS position
- Battery Status
- The data recorded and transmitted from the buoy
- Buoy status
- Alarm messages
- Sampling Specifications

The sampling specification of various industry instruments vary however the sampling details for the Triaxys G3 sensor are as follows for reference:

- Triaxys G3 sensor
- Sampling Frequency: 4 Hz.
- Frequency Range: 0.64 Hz (1.56 seconds) to 0.030 Hz (33.33 seconds).
- Frequency Spacing: 0.005 Hz.
- Sample Duration: (17 minutes).
- Sampling Interval: (30-60 minutes).
- Nortek Signature 500 Profiler
- Current speed and direction every 10 mins.
- Profile interval 120 seconds.
- 0.5 - 4 m cells

Mooring systems

Buoy systems and mooring designs have proven capability of being able to withstand harsh metocean conditions at distances far offshore for the oil industry at locations in the North Sea and it is expected that such designs will be suitable for more nearshore locations associated with sites of interest within the offshore wind industry in Ireland. The mooring design will be based on the suppliers recommended configuration and using mooring equipment (ropes, shackles, ground weights etc) that exceed the minimum requirements, to ensure continued data recovery.

Certified mooring components will be utilised to ensure moorings are able to withstand the site-specific metocean conditions. Preliminary discussions with industry leaders suggest use of equipment models like the Triaxys buoy which is currently deployed off the northeast coast of Scotland, where surface current speeds of up to 1.25 ms^{-1} are experienced combined with significant wave heights, in excess of 13 m are recorded.

An example mooring schematic for ~ 50 m depth is shown in Figure 24. Confirmation of the chosen equipment and final mooring line lengths will be provided once designs and depths are confirmed. All mooring components used will be designed to exceed the minimum SWL, 4.75 T in the example below, to ensure the rope section that is to be recovered by winch, is recoverable if buried by mobile sand waves.

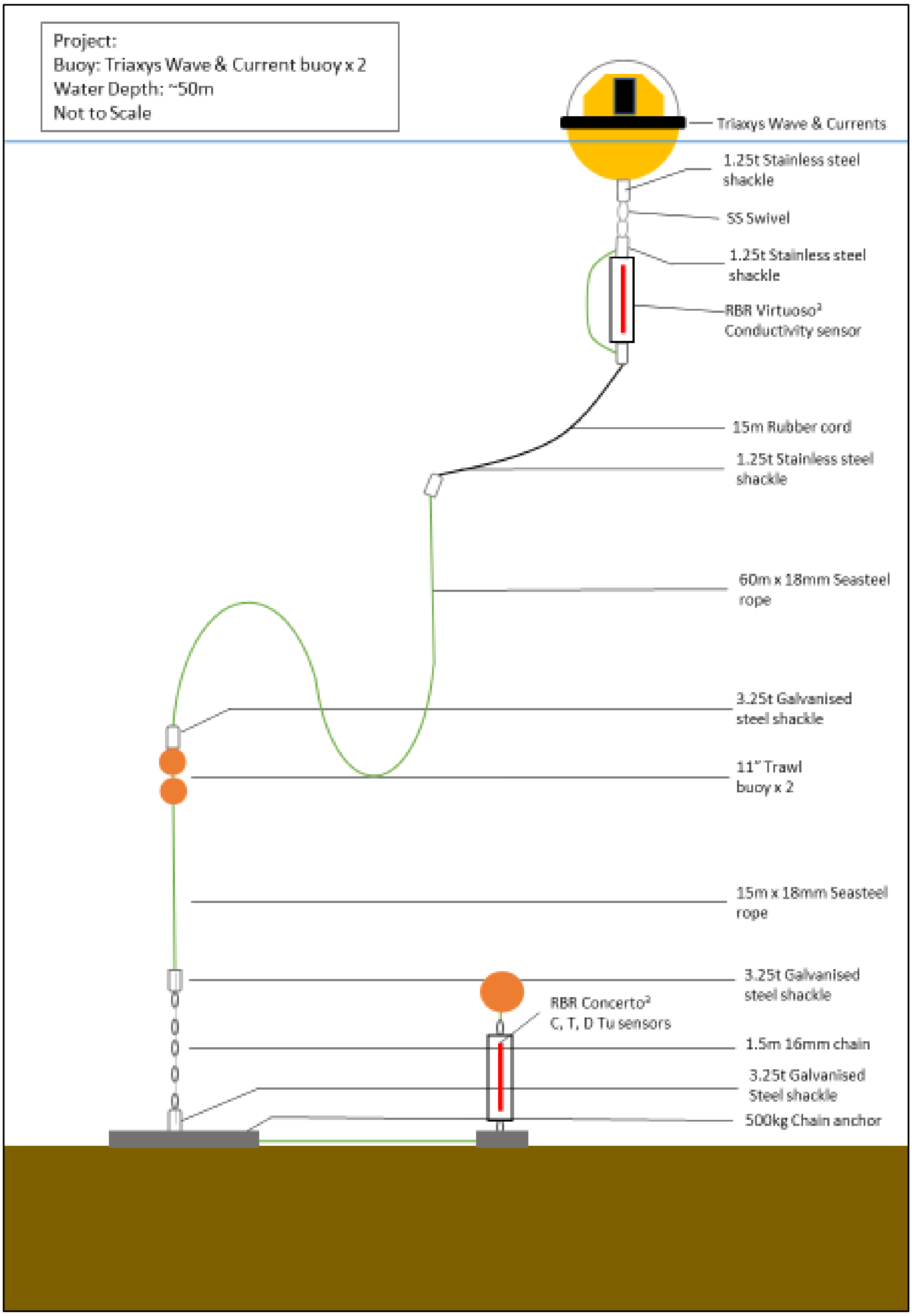

Figure 24: Example mooring design for Triaxys Wave Buoy in 50 m water depth (Partrac)

The mooring shown in Figure 24 is composed of a section of 30 m of extruded 32 mm bungee, consisting of a rubber cord, terminated with stainless steel fittings. The compliant rubber section is attached directly to the swivel located on the buoy's underside. The other end of the bungee is attached to a 'seasteel' mooring line with inline floats and weights. The floats and weights are attached to a sinker weight, with a minimum weight of 650 kg. The mooring line is lifted off the bottom to prevent accelerated wear, using auxiliary floatation on the lower segment of the mooring. The total maximum seabed footprint of each anchor weight is 1m x 1m and the mooring weight is 500 kg.

Mooring line lengths will be provided as per the specifications recommended by suppliers and according to the water depths at the deployment locations chosen. Tidal range expected wave and meteorological conditions will also be factored into the final mooring design.

Operations & Maintenance (O&M) of Device(s)

The metocean buoys will require regular maintenance and inspection to ensure the integrity of the moorings and anodes and ensure battery continuity. All systems will be cleaned to remove any bio-fouling that may have accumulated. All O&M operations will take place onboard the working vessel. The buoys will be attached to the winch and lifted onboard via crane or A-frame.

It is likely that the change out of the mooring system will take place on a six-monthly basis, though this largely depends on the condition of the mooring on inspection during service visits. The bungee cord will not require changing out every six months unless evidence of damage to the structure of the material is found. This includes propeller damage or other signs of excessive wear. Complete spare mooring components including the bungee cord will be taken to site on each visit. During each service visit the following will be completed:

- Inspection of mooring systems,
- Shackles will be inspected and replaced as required,
- Anodes will be inspected and replaced as required,
- Mooring lines will be replaced as required,
- The bungee will be replaced if worn or damaged,
- A spare ground weight will be taken in case of total loss during recovery,
- The outer housing will be inspected for damage,
- Functionality of the LED light will be tested,
- O-rings will be inspected and replaced as necessary,
- Battery status will be confirmed and compared to the transmitted battery status report,
- Data will be downloaded, and the memory card checked for capacity,
- Satellite and data transmission will be verified,

Once servicing of the equipment is completed the systems will be redeployed at the same location.

Device Recovery

The device recovery methodology will be either Acoustic Release Recovery or Grapple Recovery as previously outlined in 2.3.2 for the ADCP.

2.3.4 Floating Lidar System for Wind Resource Measurements

Background

The purpose of the FLS is to collect accurate wind climate and metocean information from the project site that will be used to conduct energy yield assessments, for the wind farm design and, given the importance of the weather downtimes at offshore sites, for defining the construction and O&M strategies. The FLS normally consists of the following essential components: LiDAR, FLS operating system, power system, data logging and communication, safety system, and the floating platform and station-keeping system. The supplier of the FLS shall supply all components as an integrated system suitable for use in a marine environment and have certification and/or warranties that meet the planned campaign duration.[1]

Indicative Quantity: 1-2

Method: A surface FLS (see Figure 25) will be deployed within the survey area and held in position via a suitable specified mooring configuration comprising a mooring chain/rope and anchor. FLS will be deployed on location for a minimum of 12 months to capture the full seasonal variations of the site. The FLS may be deployed for a longer period should the data recover not accurately capture the seasonal variations or in order to more accurately understand the site conditions

Figure 25: Top left: Lifting down installation option, Eolos FLS200 + mooring on vessel deck; Bottom left: Eolos FLS200 towing operation; Right: Eolos FLS200 lifting to vessel deck with upper mooring

Indicative Equipment: Fugro Seawatch Wind LiDAR Platform, RPS Floating Lidar Platform, or similar.

The FLS for the site will be a fully-equipped and autonomous wind, wave and current measuring system based on LiDAR technology that houses a host of meteo-oceanographic instrumentation. Noting other FLS types are available an overview of one particular system is the Eolos FL S200, the structure of which is described below and comprises three main parts:

[1] O. Bischoff et al. IEA Wind Task 32 RP 18. Floating Lidar Systems. Recommended Practice 18. Paris, France: IEA Wind, 2017

- Structural skeleton formed by five cylinders in vertical position, forming a square (with one cylinder in the centre) and attached together by squared profiles. All parts are made with stainless steel.
- Four floaters placed forming a square in upper view of approximately 2 m of side, with a higher diameter of 1.6 m and truncated-cone geometry in their base.
- Shell covering all system composed by stainless steel plates and backing structure.

The total weight of the FL S200 buoy shown in Figure 25 is 3 tonnes (excluding mooring). The clump weight anchoring the unit to the seabed can weigh up to 7 tonnes.

A self-contained LED obstruction lamp will be installed on the floating lidar unit. The lamp displays an amber group flash 5 every 20 seconds repeating (Fl (5) 20s) according to IALA regulations for Aids to Navigation (AToN) for an ODAS buoy visible from 3 NM. The Navigation/Obstruction light is self-sufficient with regards to power including its own solar panel and battery with average 5-years life.

Location: Indicative locations are shown on Figure 34 as provided in Appendix A; however, change can be expected as understanding of the site develops.

Mooring systems: Final mooring designs will be site specific and will require analysis of combinations of currents, winds and waves included in order to establish the suitability of a specific mooring design. A typical FLS mooring system consists of two main differentiated parts as shown in Figure 26.

- The upper mooring, consisting of multiple lines connected to the Platform gathered in its bottom to a single line (common design for any site).
- The lower mooring, designed specifically for sites (final mooring design and calculations are specifically performed for each project).

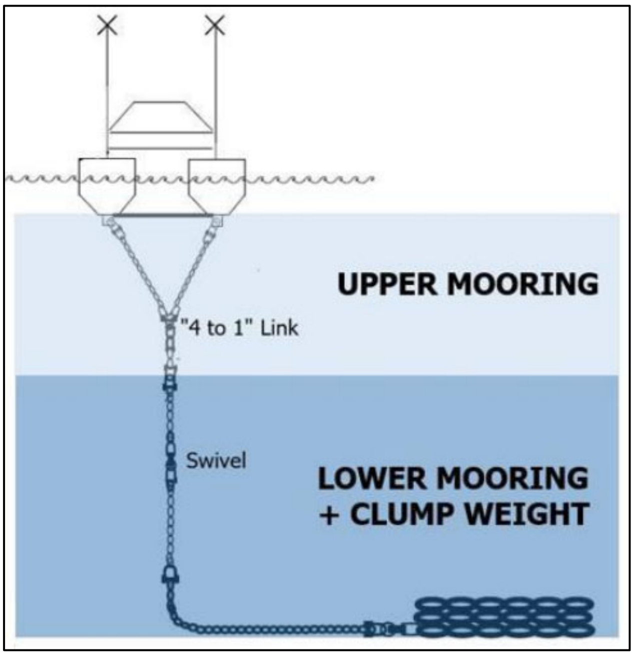

Figure 26 Typical Floating Lidar Buoy Mooring System (Marine Scotland)

An example of a mooring system deployed for floating lidar in depths of 22 m is presented in Figure 26.

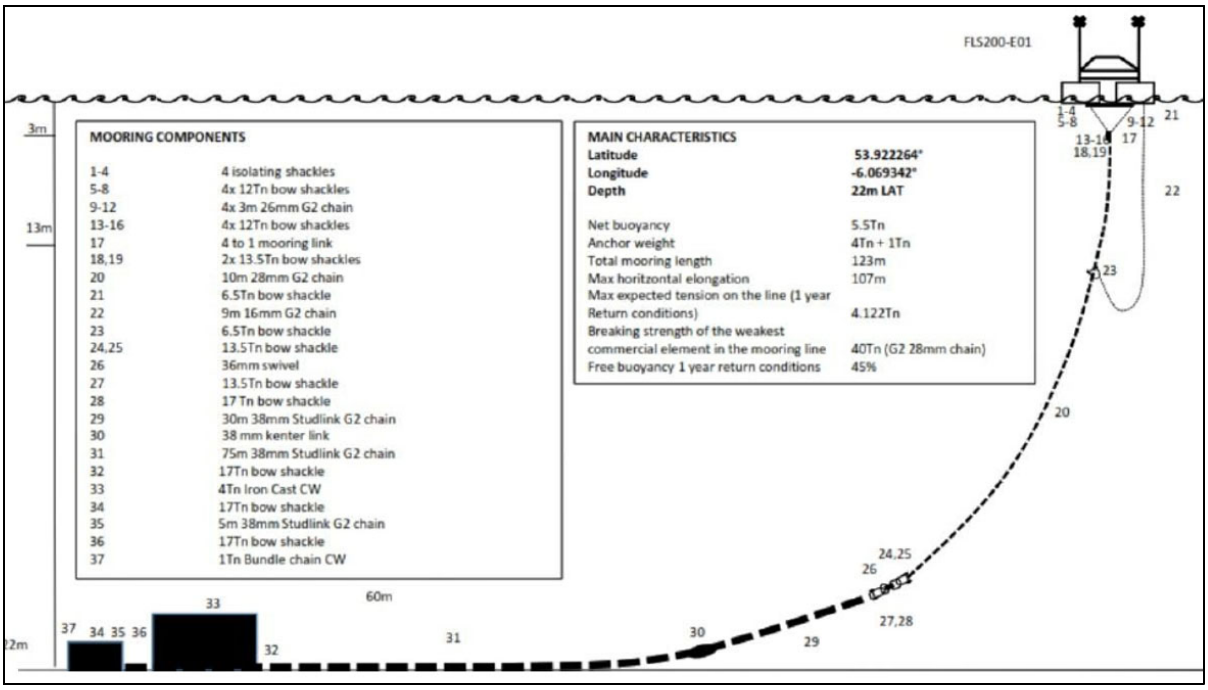

Figure 27 Buoy and mooring configuration and components for installation in 22 m WD

Operations & Maintenance (O&M) of Device(s)

Maintenance is commonly scheduled to take place every 6 months. The duration of scheduled maintenance is expected to last up to two days. Accessing the Buoy may be required to execute maintenance checks. Visual inspection will be performed to ensure buoyancy, stability, absence of damages or vandalism, dirt and overall condition.

It is often required that the Buoy is brought onshore to perform additional corrective maintenance works. The Buoy's properties enable easy tow operations to shore for onshore works to be performed.

Device Recovery

The device recovery methodology will be either Acoustic Release Recovery or Grapple Recovery as previously outlined in 2.3.2 for the ADCP.

2.4 Environmental / Ecological Surveys

The aim of the proposed environmental surveys is to collect baseline data which will be used to inform the EIAR. This will comprise a benthic sampling programme using grab sampling, and video or still photographs, and static acoustic monitoring to measure marine mammal activity and other background noise.

Environmental surveys requiring a MUL are as noted in Sections 2.4.1 to 2.4.3.

2.4.1 Benthic Sampling

Seabed samples will be recovered to inform benthic habitat distribution mapping as well as contamination testing (where relevant). Standard sampling techniques for subtidal collection will be employed to include collection of macrofauna and associated sediment particle size and organic content.

This will be complimented by video and still photography (see Figure 28). Seabed sampling will likely be undertaken as part of either the geophysical or geotechnical surveys or may be a standalone survey and may include contamination testing (where relevant).

Indicative Quantity: It is anticipated that approximately 100 no. stratified random sampling stations (to ensure all habitat types are sampled) within the MUL boundary will be required to be sampled for macrofauna particle size and organic content.

Method: Surface grab sample by mini-Hamon grab, box corer, grab sampler (e.g. day grab, van veen grab or similar - see Figure 29a) or similar. These devices are typically deployed from a crane on the vessel (See Figure 29b).

Figure 28: Example Benthic Survey - Seabed photo log image detailing Mixed pebble gravel with sandy background sediment. Empty bivalve shells in upper left are probably Venus casina. Barnacles are visible on the large pebble just left of centre.

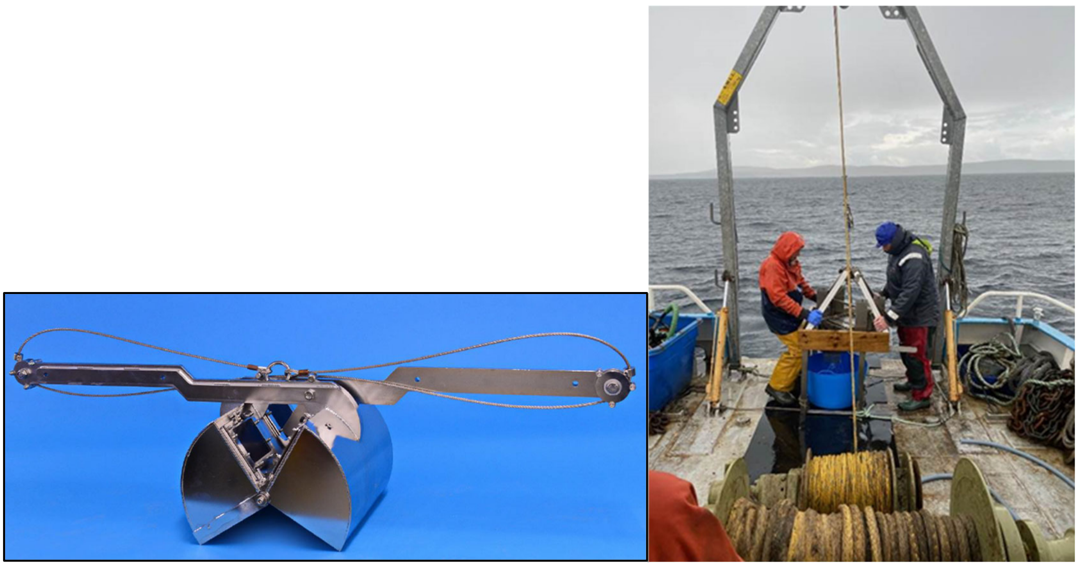

Figure 29: (a) Typical grab sample (KC Denmark A/S)
(b) Deployment of a Day grab for benthic sediment analysis.

Depth: Grab sample up to 0.1m^2 per sample

Location: Indicative locations shown on Figure 34 as provided in Appendix A are shown as Grab Samples. The final sampling locations will be determined based upon interpretation of the geophysical data and selected to sample different habitats.

2.4.2 Static Acoustic Monitoring

Static Acoustic Monitors will be deployed from within the proposed licence area to measure marine mammal acoustic activity and other background noise. The F-POD/C-POD data provide assessment of dolphins, porpoises and other toothed whales occurrence based on diagnostic acoustic patterns of clicks from deployment locations inside and outside the wind farm area.

Indicative Quantity: 2 – 6

Equipment: F-POD/C-PODs, sound traps, or similar

To fulfil the requirements of a typical acoustic monitoring survey a broadband recorder and hydrophone will be deployed at the site. All equipment will be tested, checked and calibrated prior to mobilisation to ensure sensitivity to the receiving environment.

Examples of acoustic monitoring systems include a Porpoise 500 recorder and Geospectrum M36-900 hydrophone. The porpoise 500 recorder, shown in Figure 30, is a broadband underwater acoustic recorder, processor and real-time acquisition system that supports single hydrophone channel and high sapling rates. This device is recommended within the industry as it is easy to configure and deploy. It can also collect data that can be streamed in real-time or recorded internally to memory. TRAC software is provided with the Porpoise recorder which enables visualisation of data. Real-time monitoring can also be carried out if required. To operate in real-time the unit requires connection wi-fi or direct connection. The data can then be monitored by associated software.

This acoustic system will capture marine mammals and fish, marine traffic and ambient sound and natural noise. Data will be recorded onto an internally stored memory card which typically ranges from 128GB – 4TB, the latter safeguarding against data loss to insufficient memory space.

The data is commonly collected at 3-month intervals to coincide with the servicing of the metocean buoys. The data card will be removed and replaced with a new card. Duty cycles will be confirmed prior to survey commencement however typically for a deployment of 3 months, the proposed duty cycles for differing sampling frequencies are:

- 192 KHz - 88% duty cycle, allows 22.1 hrs sampling per day,
- 256 KHz - 66% duty cycle, allows 15.1 hrs sampling per day,
- 384 KHz - 44% duty cycle, allows 10.1 hrs sampling per day,

Prior to deployment the Porpoise 500 is configured for the required frequency and duty cycles. The Porpoise 500 is be mounted in a purpose-built frame, as shown in Figure 31.

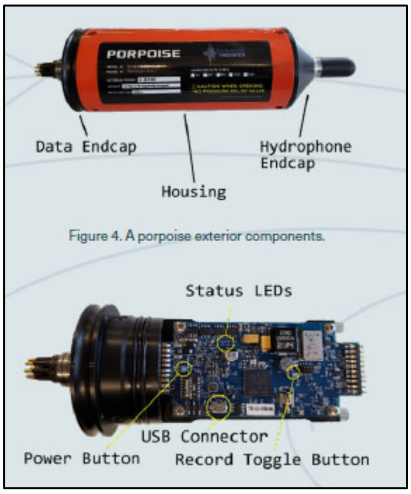

Figure 30: Porpoise 500 - Interior electronics, user button and connectors

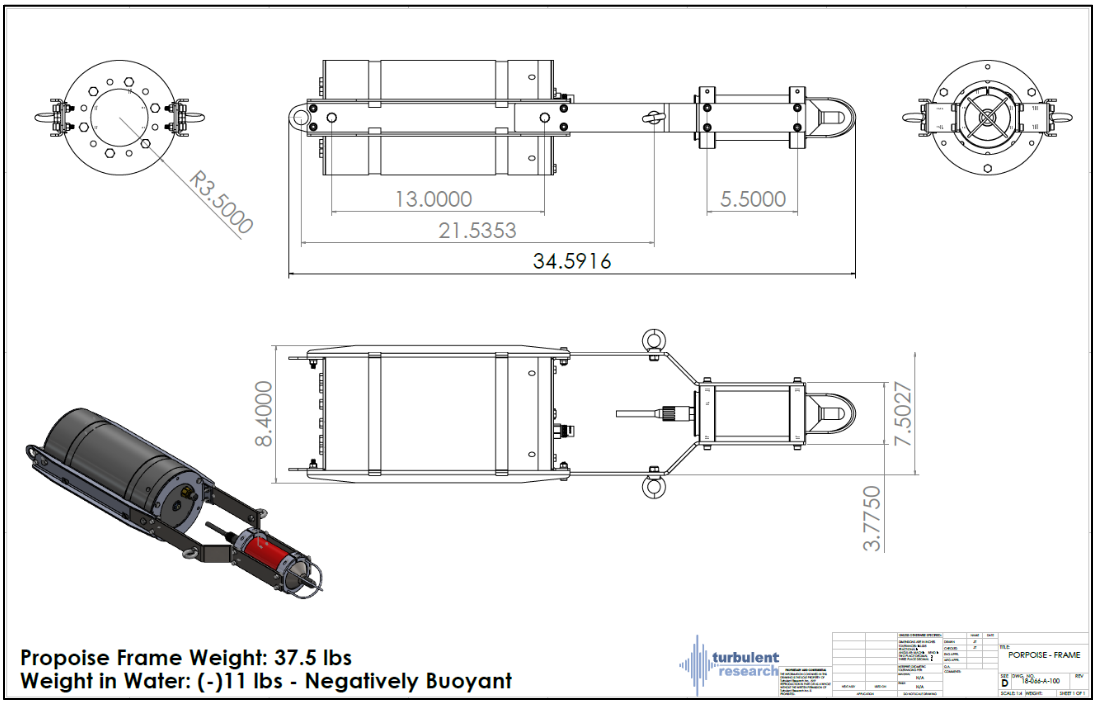

Figure 31: Porpoise 500 mounting frame (dimensions in inches & pounds weight)

Location: Indicative locations are shown on Figure 34 as provided in Appendix A; however, change can be expected as understanding of the site develops.

Mooring systems: The design of the mooring will be confirmed and agreed following initial assessments of the site conditions. Sample mooring options for consideration in this project are outlined below and shown in Figure 32.

- A single line mooring with acoustic release and no surface b
- oy or presence. This approach allows for unrestricted navigation and has been used in water depths from 20 m to 2,000 m and tidal currents up to 2.5 knts. It is vulnerable to disturbance by fishing gear but rovnot wave action and is protected from intentional malicious disturbance.

- ‘J’ shaped mooring with a ground line from the instrumentation to a large clump weight and surface buoy. This is used in water depths up to 60 m where there is a risk of interference from fishing activity. However, it is more vulnerable to significant wave action.

In all cases, moorings will be “silent”, with no metal-on-metal contact. The viability of de-coupling the hydrophone from a surface buoy is particularly challenging if data quality is to be maintained, due to potential interference. It is also highly dependent on the design of the buoy and the mooring.

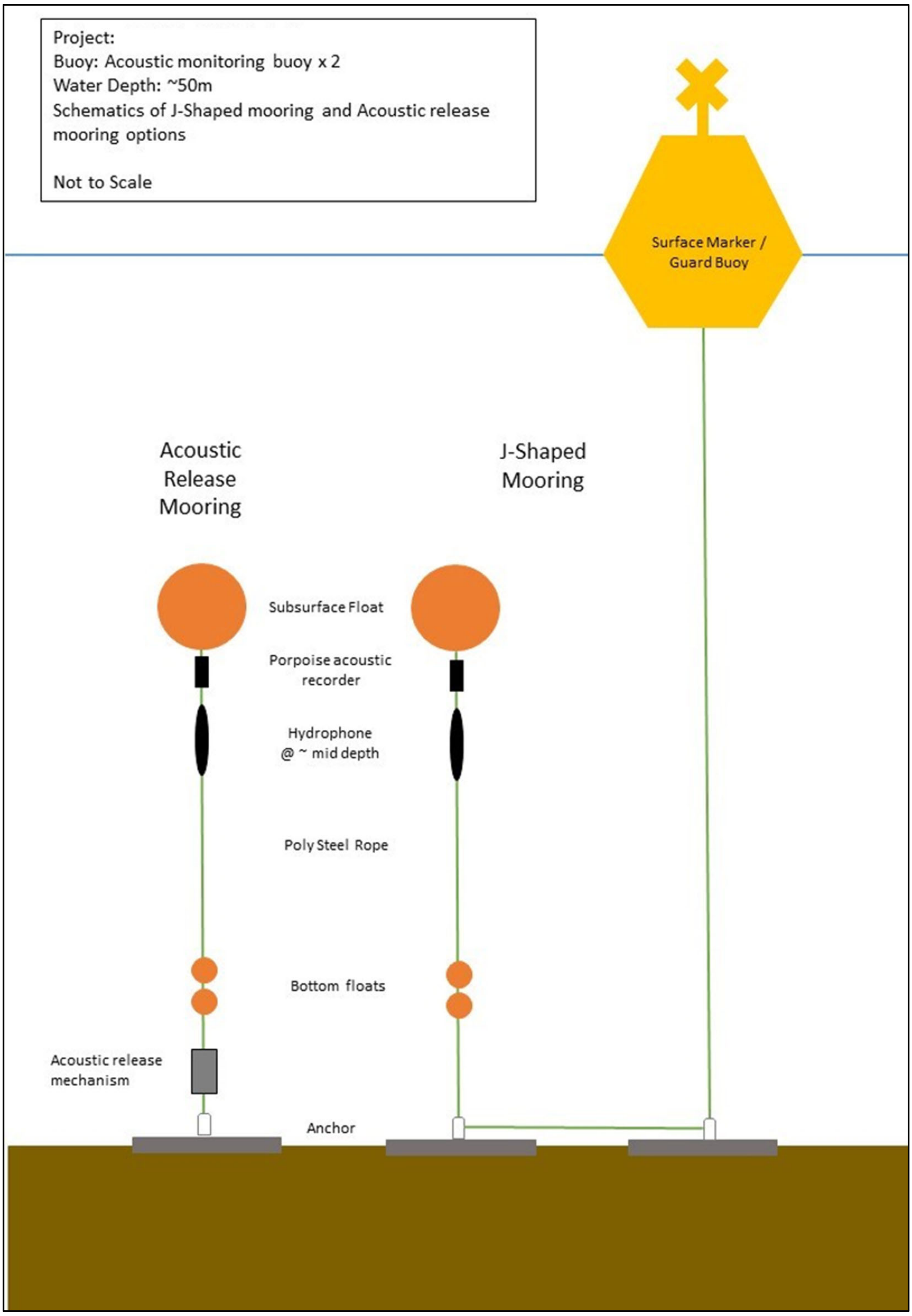

Figure 32: Acoustic Monitoring Mooring - Single line mooring (left); J-shaped mooring (right) (Partrac)

Operations & Maintenance (O&M) of Device(s)

It is envisaged that service visits will be conducted every 3 months. At each service visit the equipment will be visually checked for damage and function tests will ensure its continued operation. Batteries will be replaced during each service and the storage card withdrawn for data analyses and replaced with a new one.

The hydrophone and data endcaps, connectors and o-rings will be checked for damage and replaced where necessary.

A set of spares for the monitoring equipment will be taken on board during the service visits to be available in the event that any damage to the system has occurred.

Device Recovery

The device recovery methodology will be either Acoustic Release Recovery or Grapple Recovery as previously outlined in 2.3.2 for the ADCP.

2.4.3 Archaeological Survey / Assessment

The aim of the proposed archaeological surveys, which will be undertaken by a suitable qualified archaeologist, are to collect baseline data which will be used to inform the EIAR.

Such surveys will be incorporated into multipurpose Geophysical campaigns, and utilise data acquired during these works. Assessment will primarily comprise an identification programme using marine magnetometer survey (see 2.1.4) and side scan sonar (see 2.1.2) data analysis.

2.4.4 Fisheries, Fish and Shellfish surveys

Survey requirement, type and methods will be dictated in consultation with the Sea Fisheries Protection Authority (SFPA) and other relevant stakeholders as appropriate.

The exact nature of the survey requirements would be agreed with SFPA to match local requirements and may include eDNA water sampling.

2.4.5 Further Environmental Surveys

Further marine environmental surveys will be undertaken during the course of the project's development comprising the following:

- Ornithology surveys
  - Bird sighting surveys will be undertaken either from a vessel or aerially in addition to onshore vantage point locations.
- Marine Mammal surveys
  - Complimentary to the Static Acoustic Monitoring, vessel or aerial based sighting surveys will be undertaken.
- Shipping and Navigation Surveys
  - The need for Shipping and Navigation surveys will be determined following consultation with the relevant stakeholders.

2.5 Noise Level Summary

All survey works that involve the use of acoustic instrumentation will follow the Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters, 2014.

See Table 2 for a summary of the noise sources for the main activities proposed to be undertaken as part of the project surveys.

Table 2: Summary of noise sources

Noise Source	Typical Frequency**	Typical Sound Pressure Level (dB re 1μPa @ 1m)**
Survey Vessel	maximum 100 kHz	118 -145 dB
MBES	400 to 700 kHz	200-228 dB
SSS	300 to 900 kHz	228 dB
SBP – Pinger/Chirp	2 to 115 kHz	149-247 dB
UHRS – Boomer	0.3 – 2.5 Hz	212 – 215 dB
UHRS – Sparker	0.3 – 4.0kHz	185 - 226 dB
Rotary Boreholes	maximum 600 Hz (low frequency)	145-190 dB
CPT	20 - 200 Hz	118 -166 dB
Vibrocorer	50 Hz (low frequency)	188 dB
USBL	18-30 kHz	170 – 220 dB
ADCP	300-600 kHz	114 dB

**Where applicable, typical frequency and sound pressure values have been sourced from the peer reviewed publication: Ruppel, C.D.; Weber, T.C.; Staaterman, E.R.; Labak, S.J.; Hart, P.E. *Categorizing Active Marine Acoustic Sources Based on Their Potential to Affect Marine Animals.* J. Mar. Sci. Eng. 2022, 10, 1278. https://doi.org/10.3390/ jmse10091278

3 GENERAL SURVEY REQUIREMENTS

All appointed survey contractors shall obtain and comply with all necessary marine operational permits including routine and customary vessel/crew/equipment clearances from Customs Agencies, Port Authorities, Marine Survey Office, etc.

Marine notices will be published in advance of the surveys and investigations to warn other users of the activities to be undertaken, where and when, and the vessel call-signs. The Commissioners of Irish Lights (CIL) standard navigational safety requirements will be adhered to with regards to the positioning, mooring, marking, and lighting of all equipment deployed in the licence area. Vessels will display lights and other internationally recognised identification and warning signals.

3.1 Quality Assurance

Each of the appointed survey contractors shall comply with the following as a minimum:

- Quality and Environmental Management Systems based on ISO9001:2015.
- Provision of Quality Management Plans for all the marine operations.
- Provision of site and activity specific Method Statements for all the marine operations within their scope.

3.2 Health & Safety

Health, safety, environment and welfare considerations will be a priority in the evaluation of possible contractors for the various survey scopes and will be actively managed during the course of the survey scopes of work.

Appointed contractors will be required to comply with all legislation relevant to the activities within their scope of work.

Prior to survey works taking place under a Licence, both Project Supervisor for Design Process (PSDP) and Project Supervisor for Construction Stage (PSCS) will be appointed, where applicable, under the relevant legislation and project / survey specific HSE plans will be put in place which will form part of the survey project execution plans.

3.3 Environmental Procedures

Environmental procedures and mitigation measures to be followed by the appointed survey contractors are detailed within the environmental reports which accompany this Licence application submission.

3.4 Vessels

All vessels will be fit for purpose, certified and capable of safely undertaking all required survey work.

Vessels shall have a Health, Safety and Environmental Managements system which should conform to the requirements of the latest International Maritime Organization (IMO), Safety of Life at Sea (SOLAS) and environmental requirements for their classification and with any national requirement of the territorial or continental / EEZ waters to be operated in.

SI will be undertaken from vessels in accordance with the relevant guidelines required to manage the risk to marine mammals from man-made sound sources in Irish waters.

APPENDIX 1 - DRAWINGS

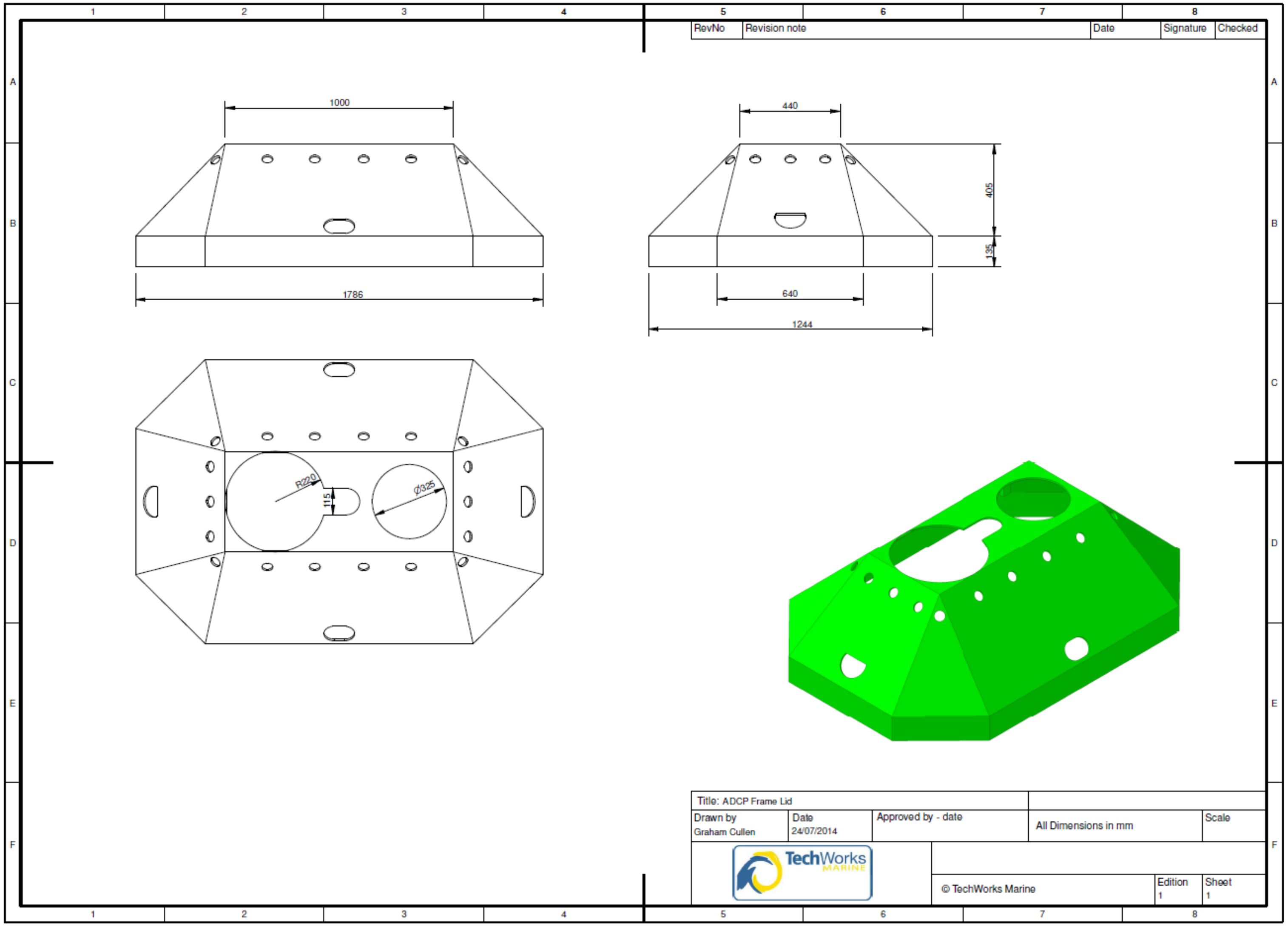

Figure 33 Typical detail drawing for an ADCP Frame (Ref: TechWorks Marine)

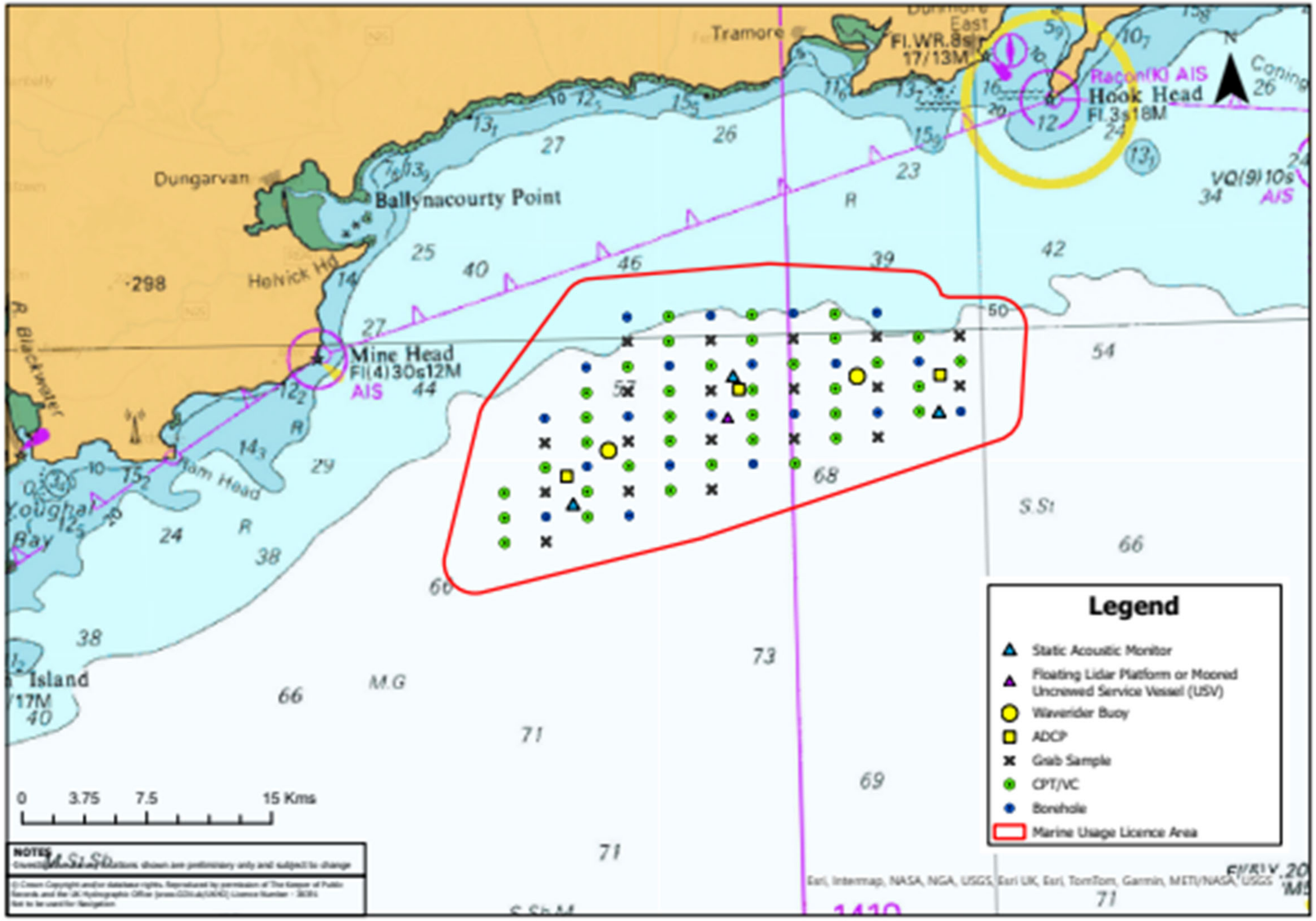

Figure 34 Indicative Survey Locations (Subject to change)