REPORT

Hywind Scotland Pilot Park Scotland Main Component Exchange 2024 - Environmental Report for Temporary Deposits Marine Licence Application v3

Client: Equinor

Reference: PB2438-111-100-RHD-XX-XX-RP-X-01

Status: Final/v3

Date: 26 January 2024

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Project related

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1 Purpose of this Report

This Environmental Report has been prepared to inform the Marine Licence application for the temporary deposit of rock / sand bags, 'pipemat' mattresses and 'mudmat' mattresses required for Hywind Scotland Pilot Park's main component exchange (MCE) works which are being undertaken in Q2 and Q3 2024. An assessment of the proposed works on the relevant marine receptors is provided. The report is structured as follows:

- Section 2: Hywind Scotland Pilot Park summary and background
- Section 3: Outline of the proposed works
- Section 4: Legislative and policy context
- Section 5: Data sources
- Section 6: Environmental baseline
- Section 7: Impact screening and assessment
- Section 8: Conclusion
- Section 9: References

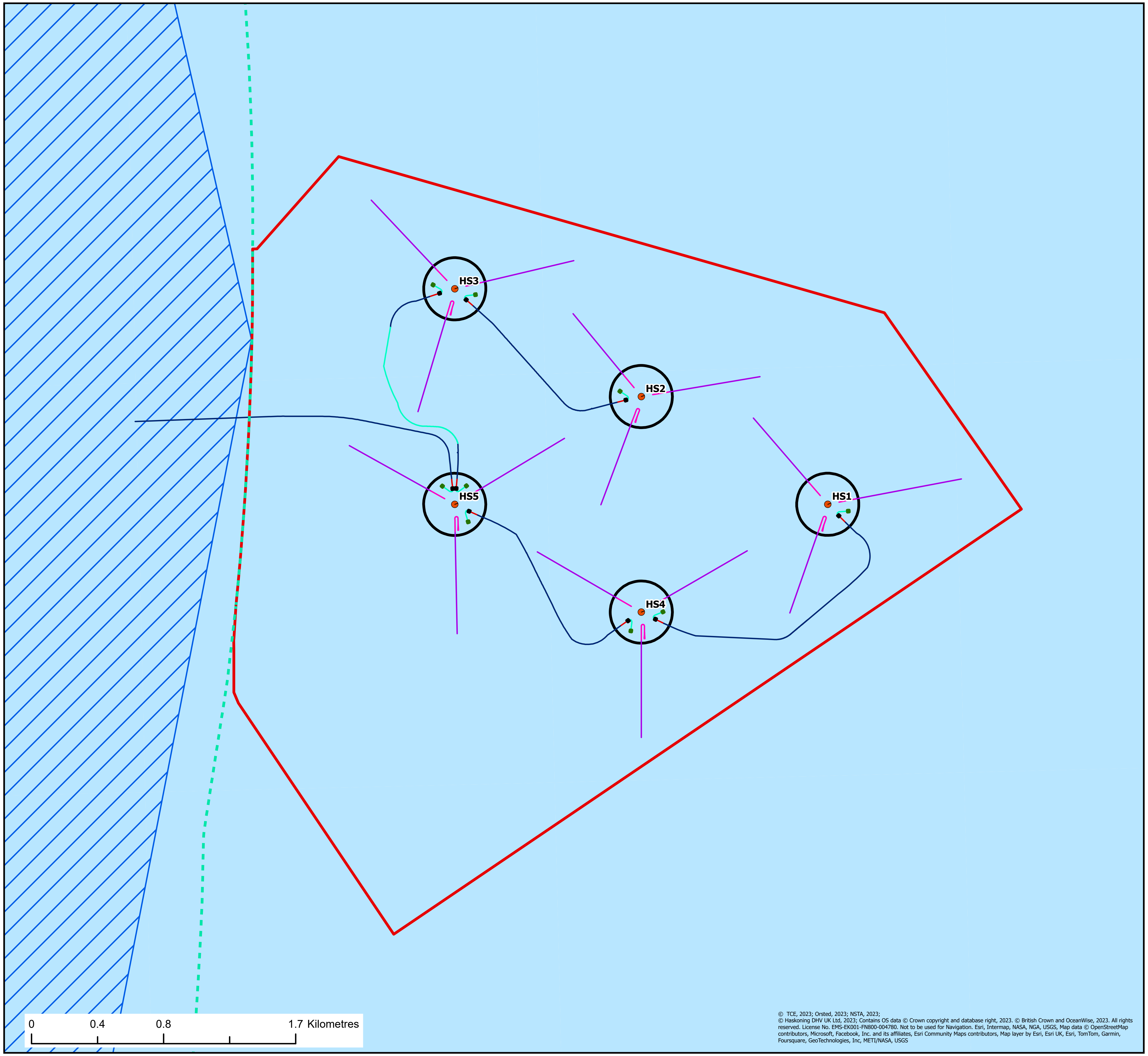
Version 2 of this report has been prepared to describe a simplified additional potential method for disconnection and reconnection of mooring line (ML) #2 from each Hywind turbine and confirm that the assumptions and assessments provided within Version 1 of this Environmental Report on 09 January 2024 are based on the worst-case scenario for disconnection, mooring line laydown and reconnection of each Hywind Scotland Pilot Park turbine. The simplified method requires a shorter length of ML #2 to be laid down and therefore provides a reduced potential for seabed disturbance. The simplified method also significantly reduces risk to both personnel and the infrastructure assets during disconnection and reconnection by reducing the complexity of the operation and reducing the required duration. It should be noted that the methodology for ML#1 and ML#3 is unchanged from that originally presented.

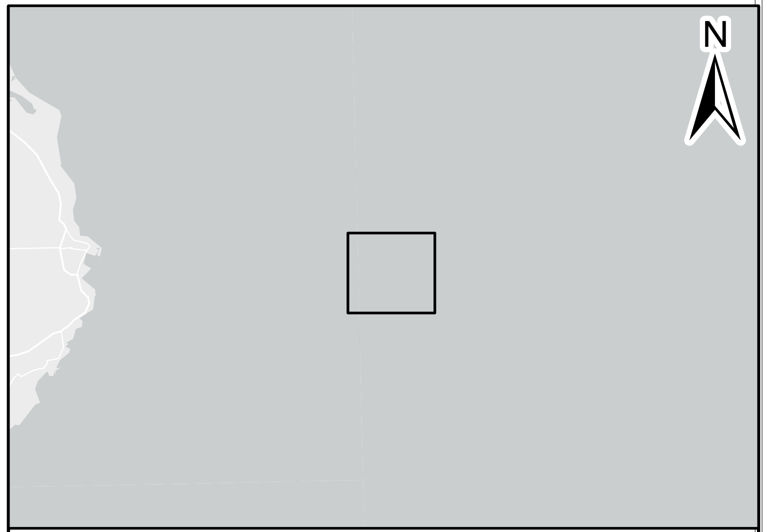
The updated methodology is described in Appendix D of Appendix 1 Main Component Exchange Works Method Statement.

In addition, a description of an anchored weather buoy to be installed within the Hywind Scotland Pilot Park windfarm site has been provided (Section 3.4).

2 Hywind Scotland Pilot Park Summary and Background

Hywind Scotland Pilot Park is a floating offshore windfarm located approximately 25km off the Peterhead coast in northeast Scotland (Figure 1). Water depths across the windfarm site range from approximately 100-120m. Hywind Scotland Pilot Park consists of five 6 megawatt (MW) turbines utilising spar-buoy foundations each of which are attached to the seabed with three anchors. Inter-array cables link individual turbines and a single export cable transmits power to the landfall. Hywind Scotland Pilot Park entered operation in October 2017.





Legend:

- Hywind site location
- Mattresses
- Rock bags
- Proposed laydown areas
- Southern Trench MPA
- Turbine
- Territorial sea limit

Inter-array cables

- Buried inter-array cable
- Laid down inter-array cable
- Inter-array water column
- Laid down mooring line
- Mooring line

Client:	Report:
Equinor	Hywind Scotland Pilot Park Project

Title:

Hywind Main Component Exchange Works
Marine License Application for Temporary Deposits

Figure: 1 | Drawing No:

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
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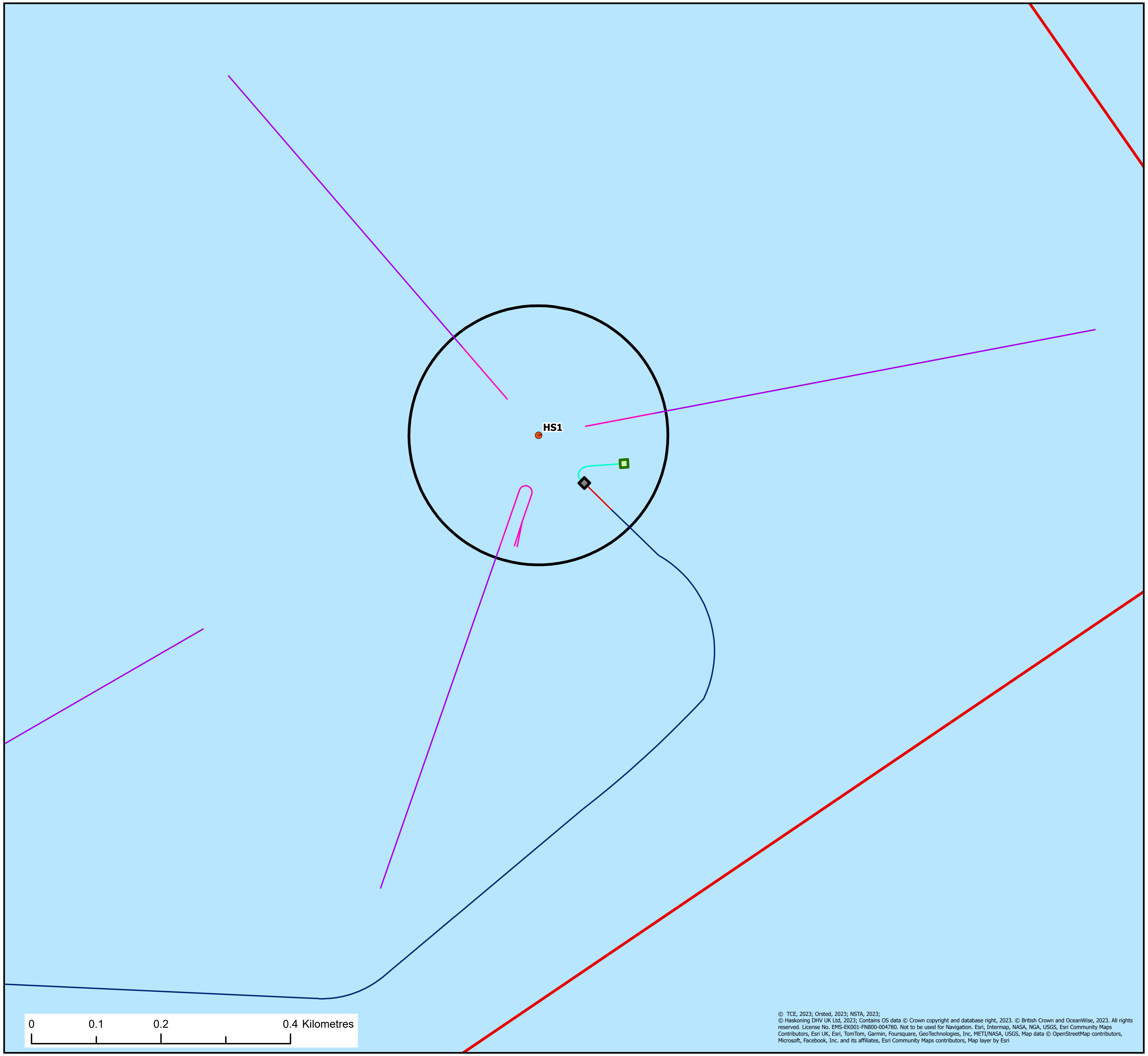
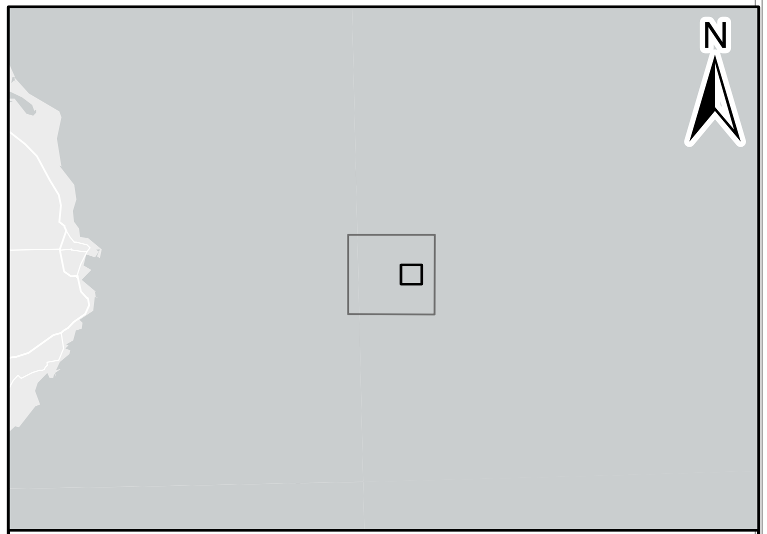
3 Outline of the Proposed Works

A detailed method statement for the proposed works is provided in Appendix 1.

As described in Section 1, an additional potential wind turbine disconnection, mooring line laydown and reconnection method has been included within Appendix D of Appendix 1 which reduces the risk of seabed disturbance as well as the complexity and required duration of the operation. However, the original method described in Version 1 of this report submitted on 09 January 2024, which is outlined below and described fully in Appendix 1, would result in a slightly increased risk of seabed disturbance because a greater length of ML#2 would be required to be laid on the seabed. Therefore, any seabed disturbance effects as a result of the simplified method would be less than those described for the original method and therefore the assessments provided are considered to represent the worst-case scenario.

The proposed works involve the disconnection and laydown of mooring lines, inter-array cables and export cable (for turbine HS5 only) from each of the five Hywind Scotland Pilot Park turbines prior to them being towed to the Wergeland Base in Gulen, Norway, where the MCE works will be undertaken. Works will be restricted to the Hywind Scotland Pilot Park windfarm site (i.e. no activities are required to be undertaken in the export cable corridor) and therefore all works required to be considered under this licence relate to the Scottish offshore marine region (12-200 nautical miles (nm)). Figures 2 to 6 below show the temporary laydown locations for inter-array cables, mooring lines, rock bags and mattresses.





Legend:

- Hywind site location
- Mattresses
- Rock bags
- Proposed laydown areas
- Turbine

Inter-array cables

- Buried inter-array cable
- Laid down inter-array cable
- Inter-array water column
- Laid down mooring line
- Mooring line

Client:	Report:
Equinor	Hywind Scotland Pilot Park Project

Title:

Hywind Main Component Exchange Works
Marine License Application for Temporary Deposits

Figure: 2 Drawing No:

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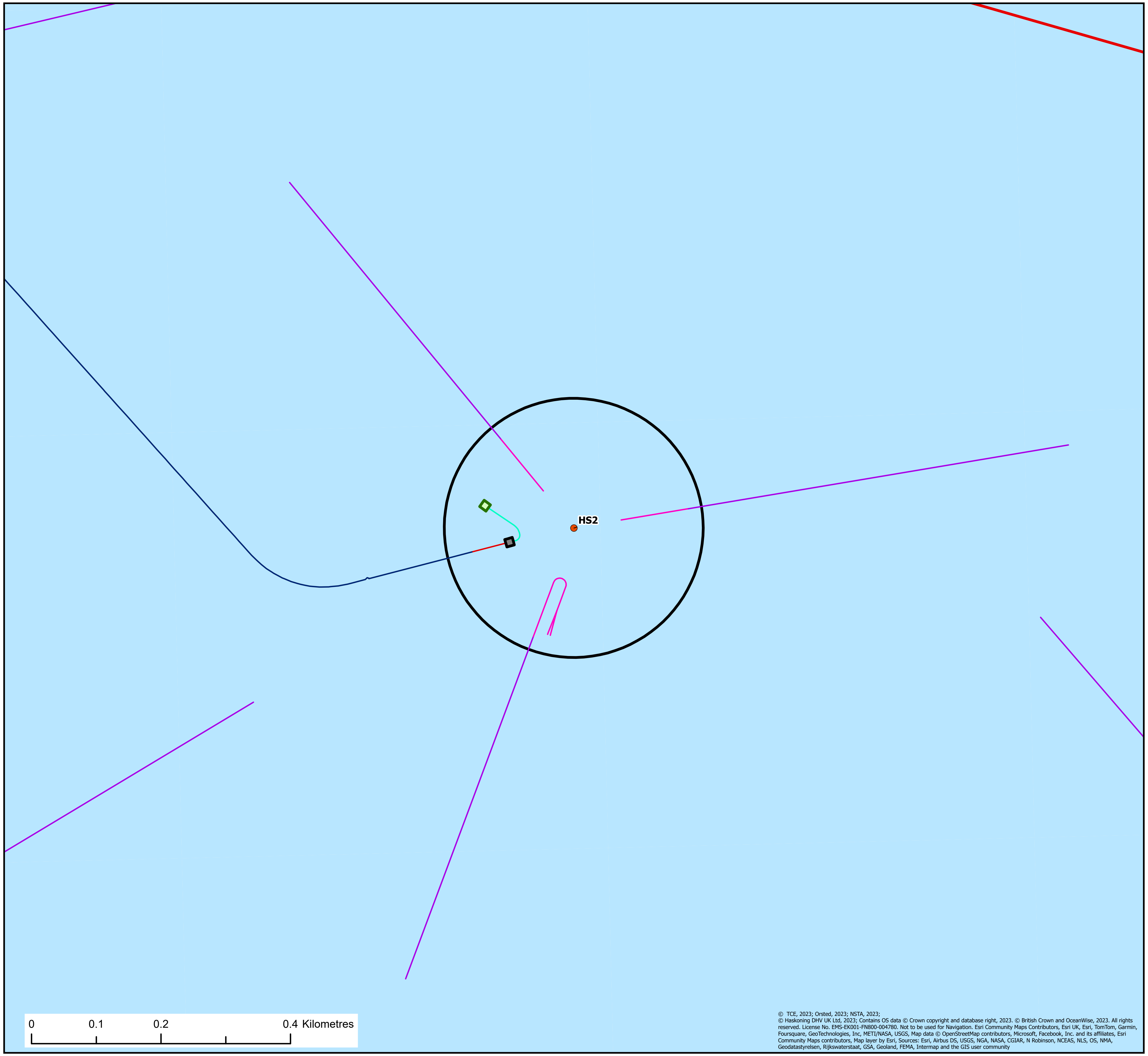

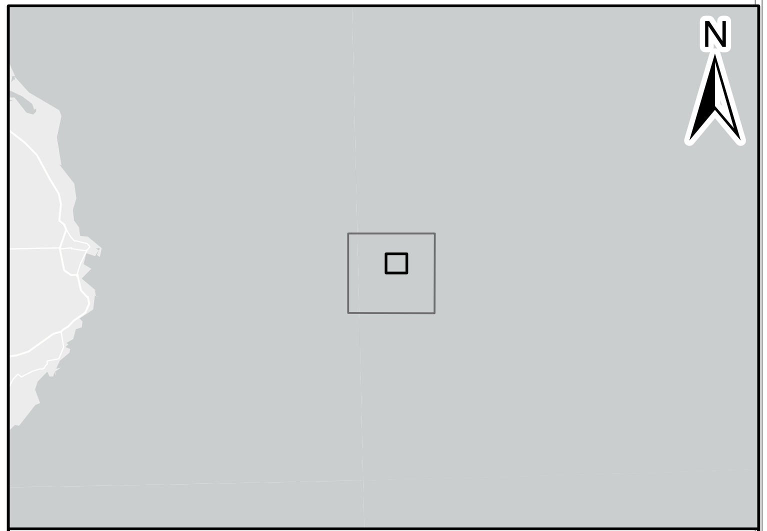

Legend:

- Hywind site location
- Mattresses
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- Turbine

Inter-array cables

- Buried inter-array cable
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- Mooring line

Client: Equinor

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Title:

Hywind Main Component Exchange Works
Marine License Application for Temporary Deposits

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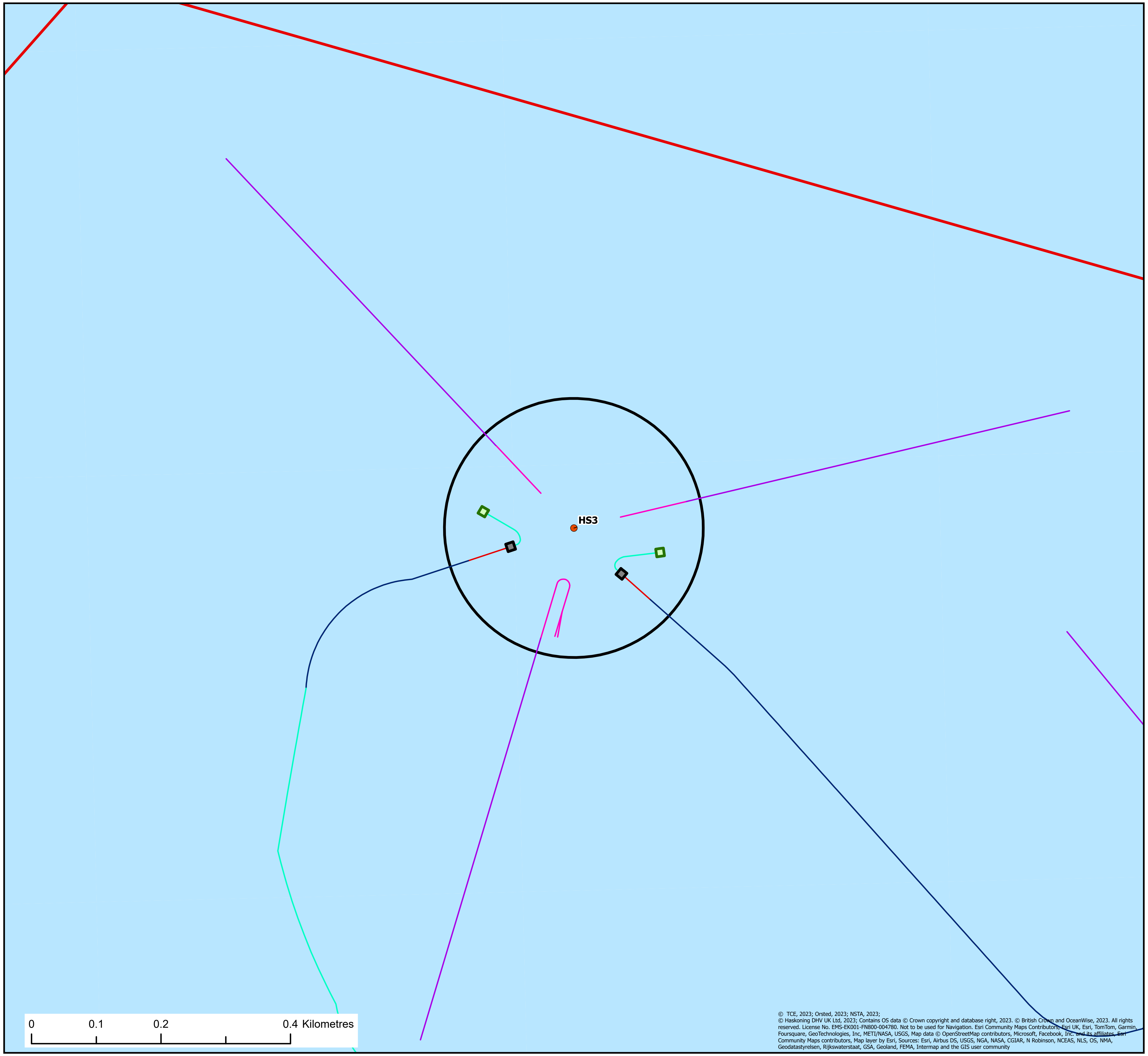

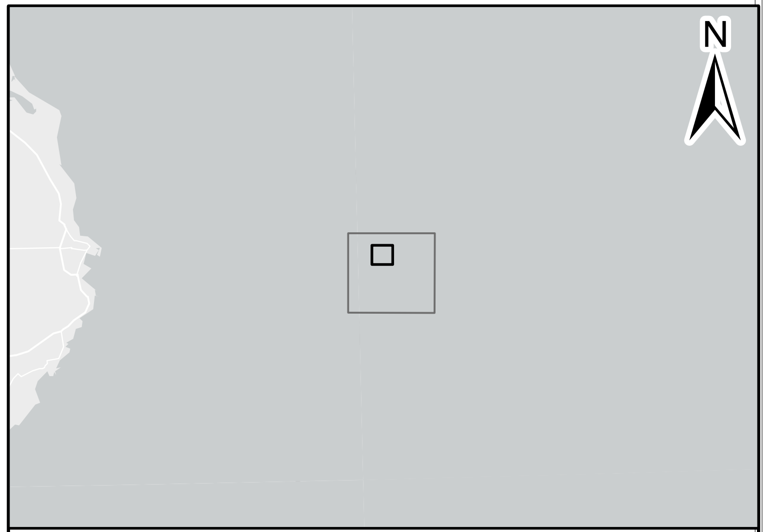

Legend:

- Hywind site location
- Mattresses
- Rock bags
- Proposed laydown areas
- Turbine

Inter-array cables

- Buried inter-array cable
- Laid down inter-array cable
- Inter-array water column
- Laid down mooring line
- Mooring line

Client: Equinor

Report: Hywind Scotland Pilot Park Project

Title: Hywind Main Component Exchange Works Marine License Application for Temporary Deposits

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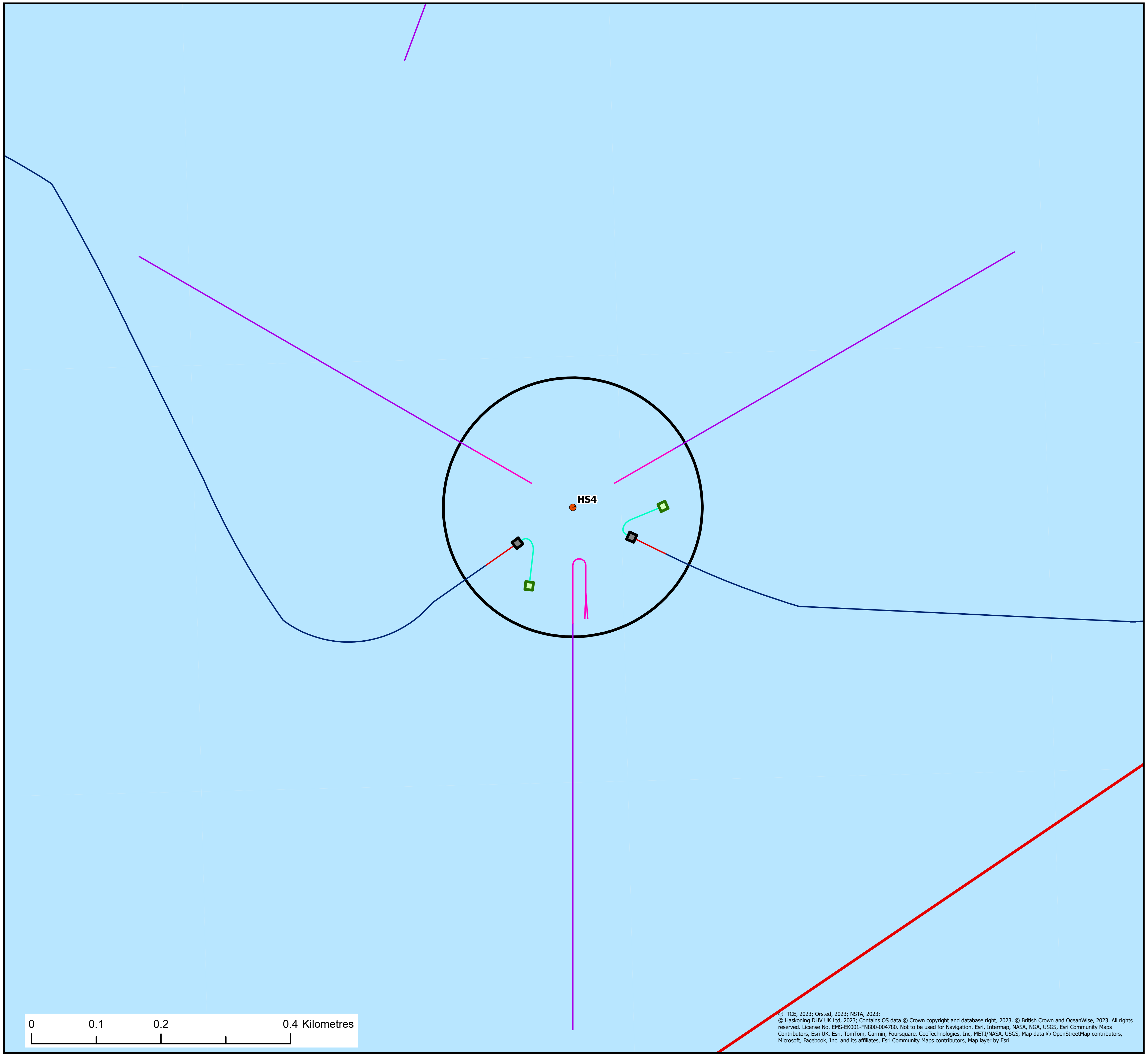

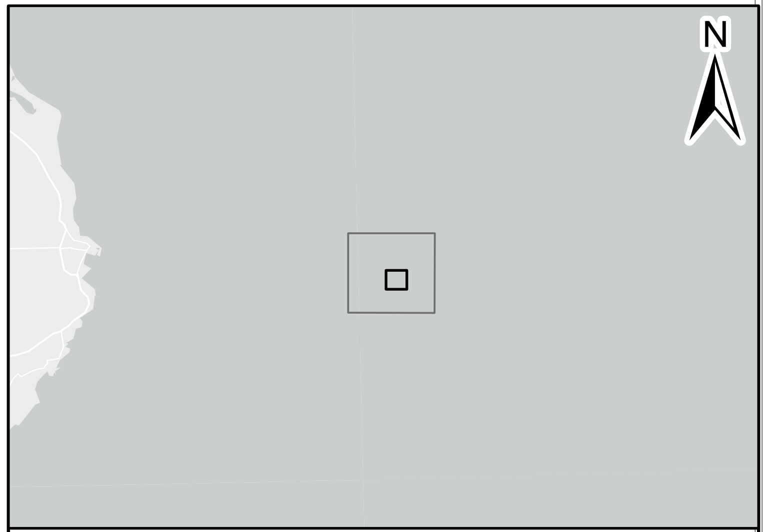

Legend:

- Hywind site location
- Mattresses
- Rock bags
- Proposed laydown areas
- Turbine

Inter-array cables

- Buried inter-array cable
- Laid down inter-array cable
- Inter-array water column
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Client: Equinor

Report: Hywind Scotland Pilot Park Project

Title: Hywind Main Component Exchange Works
Marine License Application for Temporary Deposits

Figure: 5 | Drawing No:

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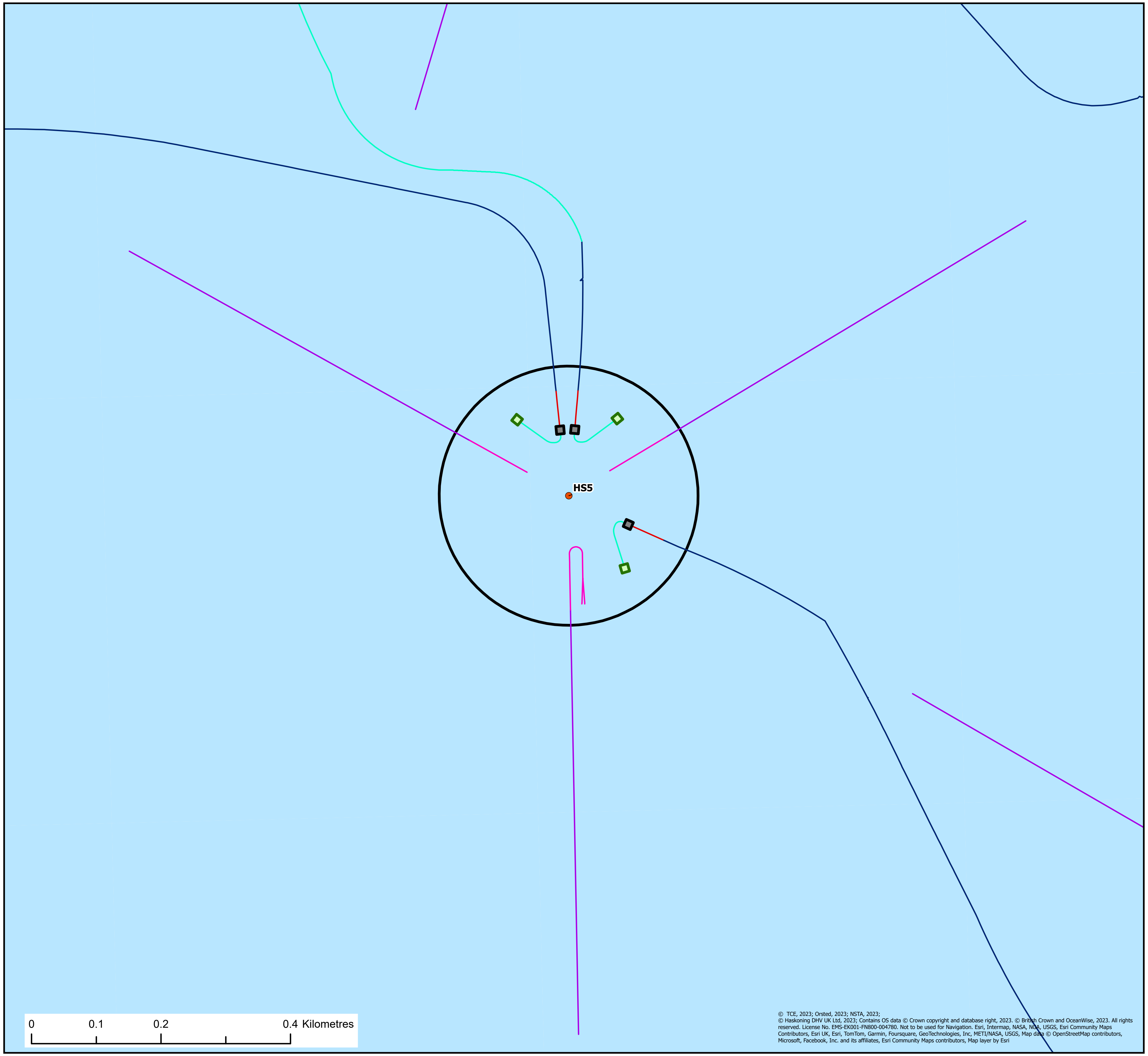

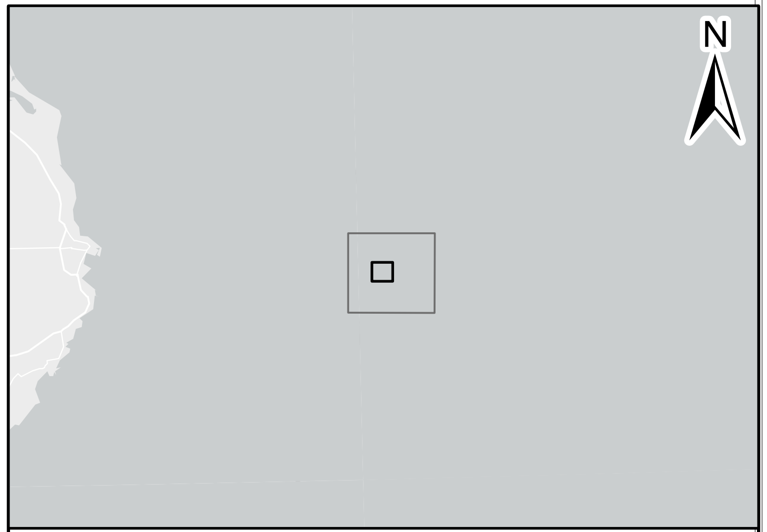

Legend:

- Hywind site location
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- Buried inter-array cable
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Client: Equinor

Report: Hywind Scotland Pilot Park Project

Title: Hywind Main Component Exchange Works
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Figure: 6

Drawing No:

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
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3.1 Temporary Deposit Parameters and Laydown Configuration

The parameters of the temporary deposits which inform the assessment in Section 7 are provided in Table 1.

Table 1 Parameters of the temporary deposits to be installed

Item	Quantity	Material	Total Footprint (m^2)	Total Volume (m^3)
Rock bags[1]	144	Polypropylene bags with rocks sourced from Scotland	650.9	390.2
Sand bags[1]	162	Polypropylene bags with sand sourced from Scotland	1,312.2	236.2
Pipemat mattress	9	High density polyethylene	144	7.2
Mudmat mattress	9	Heavy-duty polyurethane	129.6	3.9
Total worst-case footprint and volumes of deposits*			**1,585.8**	**255.0**
Subsea connection frame (for simplified dis/re-connection method for ML#2)[2]	1 deposited in 5 separate locations	Steel	80	N/A

[1] Note that either rock bags or sand bags or a mixture of the two will be used to stabilise the touchdown position of the cables. The selection of rock bags or sand bags is yet to be determined and therefore, as a worst-case scenario for temporary habitat loss and physical disturbance, it is assumed that sand bags will be used since they have a larger footprint.

[2] Installation of a subsea connection frame would be required if the simplified disconnection, laydown and reconnection method for ML#2 is used. However, the subsea connection frame will sit on top of a pipemat or mudmat mattress so there would be no temporary seabed disturbance / habitat loss in addition to that caused by the mattresses. Therefore, there is no requirement to include these calculations within the disturbance totals for the assessment although the relevant parameters for the subsea connection frame have been included in an update to the Marine Licence Application Form submitted on 09 January 2024.

If rock bags are used, it is anticipated that they will consist of cobbles with dimensions 64.0 ≤ to < 256.0 mm or gravel with dimensions 2.00 ≤ to < 64.0. This will be determined nearer to the time of the works. In order to avoid double-counting, the marine licence application form only includes provision for rock bags consisting of cobbles with dimensions 64.0 ≤ to < 256.0 mm. The different dimensions would have no effect on the assessments provided within this environmental report.

The quantity of rock bags required to be deposited per cable end would be 16. The quantity of sand bags to be deposited per cable end would be 18.

Visual representations of the rock bags, sand bags, pipemats and mudmats to be installed are shown in Figure 7.

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Figure 7 Visual representation of the rock bags (top left), sandbags (top right), pipemat (bottom left) and mudmat (bottom right) to be temporarily installed

A schematic taken from Appendix 1 is provided in Figure 8 and shows the prospective inter-array cable and mooring line laydown locations and rock / sand bag and mattress locations for HS5. This laydown configuration is applicable to all wind turbines although that shown for HS5 in Figure 8 also includes the export cable laydown configuration which will not be required for other turbines as the export cable only connects at HS5 (see Figure 1). The solid red lines indicate areas where the cables would not be on the seabed i.e. they would be floating in the water column.

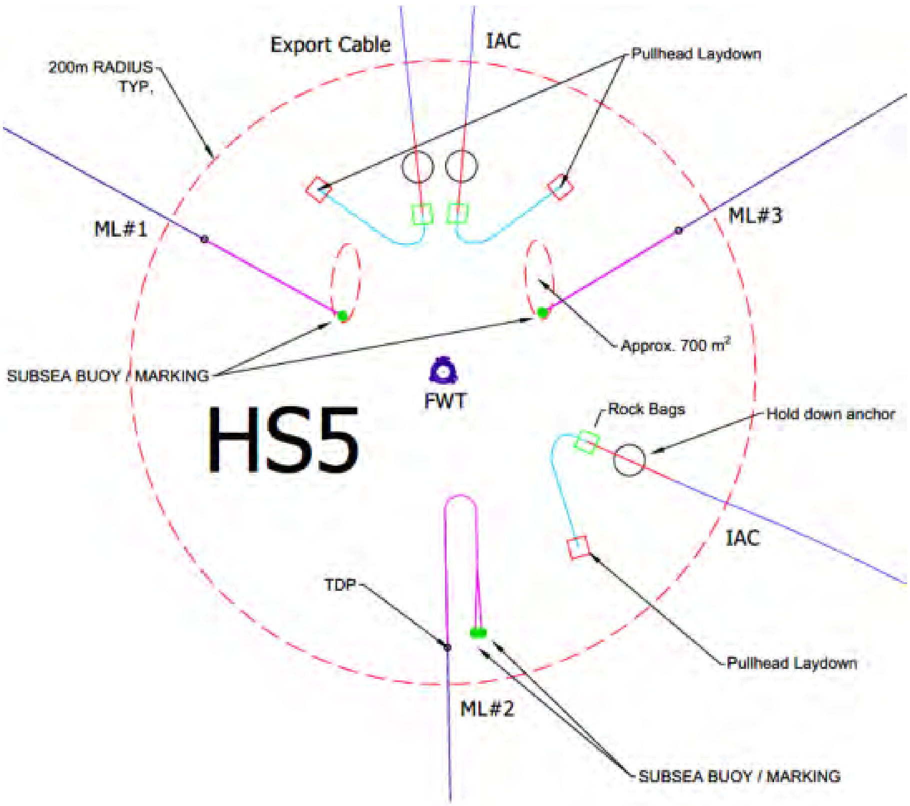

Figure 8 Mooning line and inter-array cable laydown locations and temporary rock / sand bag and mattress deposit locations for HS5. Pink lines indicate mooring line lay down locations. Light blue lines indicate inter-array cable lay down locations. Green squares are rock / sand bag locations and red squares are mattresses (both not to scale).

An alternative laydown configuration could be required, pending detailed on-bottom stability analysis. This is shown in Figure 9. In this configuration, most of the 16 rock / 18 sand bags would be located in the touchdown location (i.e. the green square) with the remaining rock / sand bags being located along the cable length at approximately 10m intervals.

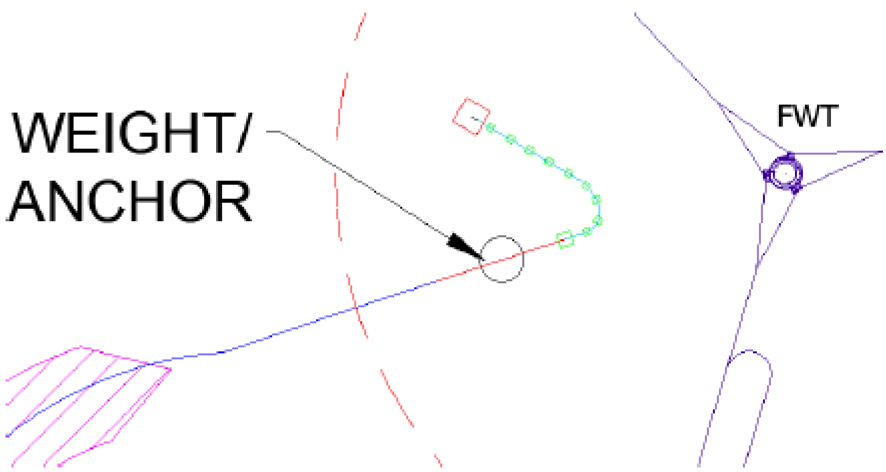

Figure 9 Alternative rock / sand bag laydown configuration

Following laydown of the mooring lines, there is potential for lateral movement of these as they move with the tide. The visual benthic survey took account of this by widening the survey area to encompass the area where lateral movement of mooring lines could potentially occur. See Appendix 2 for further details.

3.2 Vessels

A maximum of four anchor handling supply vessels (AHSV) and one walk-to-work (W2W) vessel will be on site at any one time. As a worst-case, it is assumed that each AHSV would spend 45 days on site which equals 180 days for a total of 4 vessels. The worst-case duration for the W2W vessel is 115 days.

It should be noted however that this scenario is considered to be an overestimation of the number of vessel days since towing turbines with four vessels has not yet been optimised. The most likely option is to use two AHSV vessels (i.e. a total of 90 days on site) and one W2W vessel (as above for a duration 115 days).

Vessel mounted transponder systems operating at frequencies below 100 kHz (but not less than 10kHz) are likely to be required for the survey operations and therefore a European Protected Species (EPS) risk assessment will be undertaken and submitted separately to this marine licence application in early 2024.

The particular vessels to be used and their home ports is yet to be decided however it is likely that at least some of the vessels will be from Norway.

3.3 Ballasting / De-ballasting of Turbine Foundations

As noted in Appendix 1, it is unlikely that offshore ballasting / de-ballasting operations will be required. However, should it be necessary to ballast / de-ballast the turbines to reach a desired draft, the lightweight pumping skids acquired for offshore draft adjustments can be used. The ballast water is a solution of water and lye, with a pH level of ~10. In accordance with the Hywind Scotland Pilot Park Environmental Management Plan (Equinor, 2020), this water-lye solution cannot be pumped directly into the sea. Therefore, should de-ballasting operations be necessary, the water will be pumped into tanks onboard a vessel for treatment onshore.

3.4 Weather Buoy Installation

An anchored weather buoy will be installed at the approximate coordinates Latitude: 57º 28' 26.706" N Longitude: -1º 23' 33.468" E within the Hywind Scotland Pilot Park windfarm site. An example of the type of and dimensions for the weather buoy to be installed is shown in Figure 10. The weather buoy will either be installed by an anchor handling vessel or service operation vessel and contain a Seawatch mid buoy (approx. weight: 550kg) with a clump weight of approximately 1000kg which will be laid on the seabed. Further details are provided in Appendix F of Appendix 1.

Installation of a weather buoy is exempt from requiring a marine licence. However, there is a requirement to confirm with relevant stakeholders that the weather buoy will not cause a danger to navigation or have a likely significant effect on designated sites. Therefore, separate consultation with the MCA, Northern Lighthouse Board and NatureScot is being undertaken to confirm that the criteria for the exemption is met.

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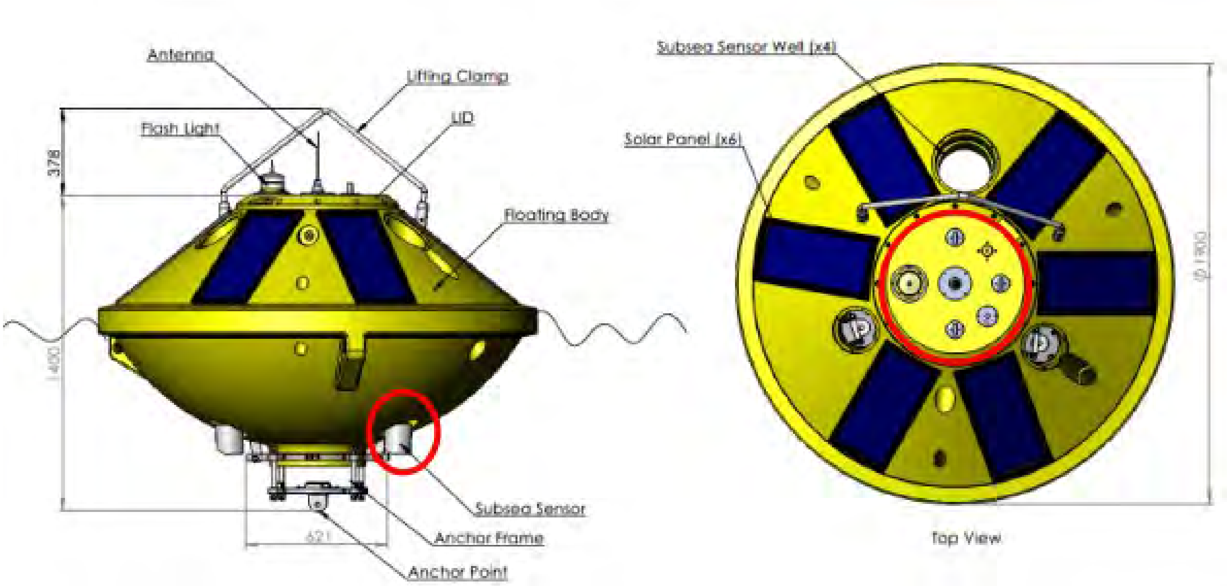


Figure 10 Typical example and dimensions of the type of weather buoy to be installed

3.5 Outline Programme of Works

The disconnection, towing and MCE work will be undertaken for each turbine sequentially. Once the MCE work for each turbine is completed in Norway, turbines will be towed back to site, reconnected, and then the next turbine disconnected and towed for its MCE. It is anticipated that the MCE work will be undertaken in the following sequence (turbine numbers correspond to Figure 1): HS2, HS3, HS5, HS1 and HS4. At any one time, there will be a maximum of two turbines at Gulen since, based on current programming, the second turbine to be towed (HS3) to Norway could occur whilst the first turbine (HS2) is already at port in Norway. However, it is anticipated that once MCE works have been completed in Norway, each turbine would be towed back to site, reconnected and then the same vessels used to tow the next turbine to Norway. Therefore, for the majority of the time, there would only be one turbine in Norway at any one time. From initial disconnection and towing, it is anticipated that each turbine will be towed back to site and reconnected within around 4-5 weeks, dependent on appropriate weather windows.

The outline programme of the works is provided in Figure 11.

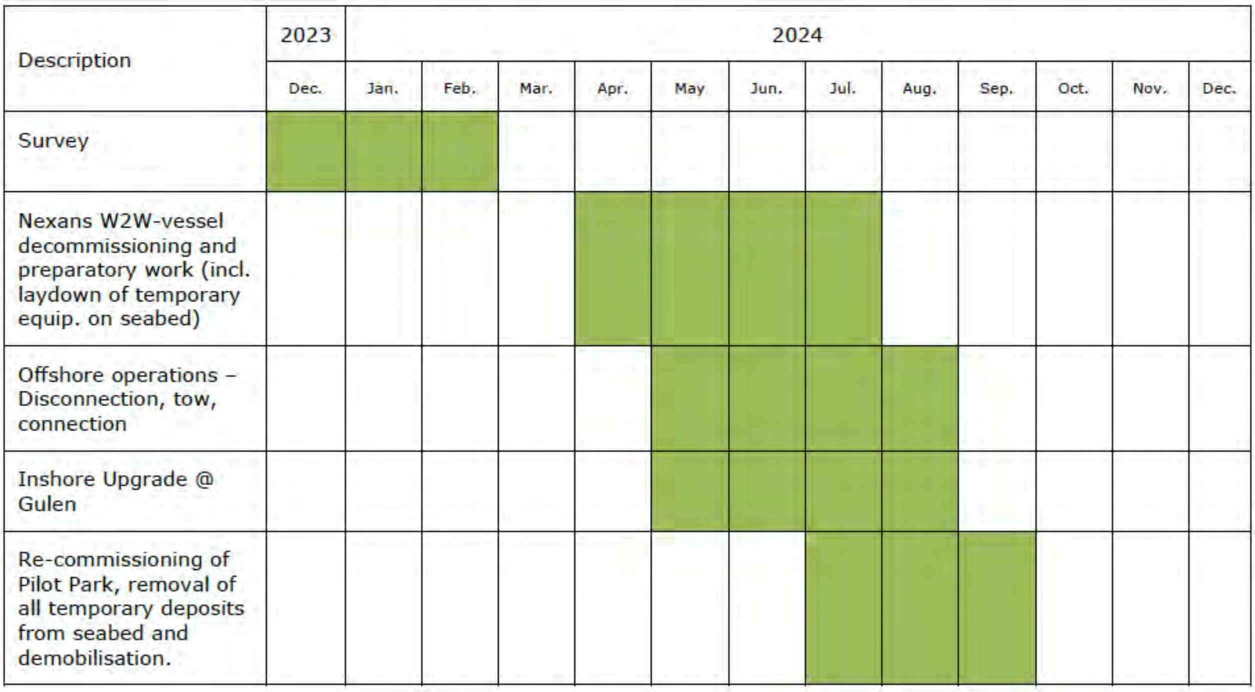


Figure 11 Proposed schedule of the works

4 Legislative and Policy Context

4.1 The Marine and Coastal Access Act (2009)

The 2009 Act established provisions for the management and protection of the marine environment. In relation to Scotland, the Act applies to the offshore marine region (12 -200 nm). It sets out requirements for a UK Marine Policy Statement, a marine licensing regime, powers to designate MPAs, a duty to contribute to a UK network of marine sites (see Section 6.3 for further information on designated sites), and associated enforcement powers. Under the Marine and Coastal Access Act 2009, Scottish Ministers have responsibility for marine licensing and enforcement in the Scottish offshore marine region (12 -200nm).

4.2 Marine (Scotland) Act 2010

The Marine (Scotland) Act 2010 applies to the Scottish inshore region (0-12 nm) and came into force in March 2010 in response to demands for improved management of the marine environment and its resources. The Act introduced provisions for marine planning, marine licensing, marine conservation, seal conservation and enforcement. Under the Marine (Scotland) Act 2010, the Scottish Ministers are responsible for marine licensing and enforcement in the Scottish inshore region (out to 12 nm) and it is an offence to carry on, or cause or permit another person to carry on, a 'licensable marine activity' without a Marine Licence. The proposed works will be undertaken in the Scottish offshore marine region (12 -200nm), and therefore this licence application should be determined under the Marine and Coastal Access Act (2009).

4.3 National Marine Plan (2015)

In March 2015, the Scottish Government published 'Scotland's National Marine Plan – a Single Framework for Managing our Seas' (the NMP) (Scottish Government, 2015). The National Marine Plan 2015 sets out strategic policies for the sustainable development of Scotland's marine resources out to 200 nm (370 km). It is required to be compatible with the UK Marine Policy Statement and existing marine plans across the UK. The National Marine Plan was reviewed in 2018 and 2021 and an announcement was made in October 2022 on the development of the National Marine Plan 2.

This marine licence application has been considered against the NMP general policies with the following considered to be relevant:

- GEN 9 natural heritage with specific respect to designated sites, is considered in Section 6.4;
- GEN 10 regarding invasive non-native species is relevant and an assessment of the potential risk of introduction of invasive non-native species has been included in Section 7; and
- GEN 12 water quality and resource has been considered in respect of Water Framework Directive waterbodies (see Section 4.5 and Section 7).

The National Marine Plan (2015) sets the wider context for planning within Scotland, including what should be considered when creating local, regional marine plans. Regional marine plans are currently in the process of being prepared within a number of Scottish Marine Regions where there is an established Regional Marine Planning Partnership. The planning competence of these Regional Marine Planning Partnerships extends out to 12 nm. Regional marine plan considerations are therefore not considered within this marine licence application.

4.4 The Marine Works (Environmental Impact Assessment) Regulations 2007 (as amended)

The Marine Works (Environmental Impact Assessment) Regulations 2007 (referred to as 'the MWR'), (as amended), sets out the requirement for an Environmental Impact Assessment (EIA) of the effects of certain public and private projects on the environment.

The MWR includes two schedules of development:

- Schedule A1: development of this type requires that an EIA is undertaken.
- Schedule A2: development of this type may require that an EIA is undertaken depending on the scale of the development, its characteristics and the sensitivity of the environment in which the development will take place.

The proposed works do not fall within Schedule A1 or Schedule A2 of the MWR, therefore there is no requirement to consider the proposed works under the MWR.

4.5 Water Framework Directive / The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (and further amendments)

The Water Framework Directive (WFD) (2000/60/EC) establishes a framework for the management and protection of Europe's water resources. It is implemented in Scotland through the Water Environment (Controlled Activities) (Scotland) Regulations 2011 (referred to as 'Controlled Activities Regulations' (CAR)) which enables controls over many activities that can affect the water environment.

The overall objective of the WFD is to achieve Good Ecological Status (GES) / Good Ecological Potential (GEP) and Good Chemical Status (GCS) in all inland and coastal waters. There is also a general "no deterioration" provision to prevent decline in water body status.

A screening exercise for potential effects on WFD waterbodies is provided in Section 7.

5 Data Sources

5.1 December 2023 Visual Survey

Appendix 2 Hywind Scotland Pilot Park Scotland Visual Benthic Survey report describes the methodology, results and interpretation of a Remotely Operated Vehicle (ROV) video and associated sonar survey which was undertaken from 06 December 2023 to 16 December 2023 in order to inform this marine licence application. The survey covered the laydown areas for the mooring lines, inter-array cables, export cable, rock / sand bag and pipemat / mudmat mattresses for each turbine.

The survey report is provided in Appendix 2 and is summarised in Section 6.

5.2 Previous Environmental Surveys

One pre-construction and three post-construction environmental surveys have been undertaken at Hywind Scotland Pilot Park. The purpose of and main findings from these surveys is described in Section 3.1 of Appendix 2 and is not repeated here.

6 Environmental Baseline

The environmental baseline, including descriptions of sediment type, infauna and epifauna, are informed by the sonar and ROV surveys undertaken to inform this marine licence application and the previous environmental surveys described in Section 3.1 of Appendix 2. Also, the Hywind Scotland Pilot Park Environmental Statement (ES) has been a key information source.

6.1 Sediment characterisation

Chapter 9 Benthic and Intertidal Ecology of the Hywind Scotland Pilot Park ES states that sediments are largely composed of medium to fine sand. Appendix 2 describes a dominance of muddy / sandy substrate along the survey transects with the presence of mega-ripples. Whilst there are occurrences of macroalgae and boulders along the survey transects, sediments are largely homogenous.

6.2 Seabed Habitats

Other than *Sabellaria spinulosa* (which is described below), no other species or habitats have been identified which are evaluated as threatened or have a protective status. Appendix 2 provides a comprehensive analysis of the video survey data used to inform this application.

6.2.1 Sabellaria Spinulosa

S. spinulosa is a sedentary, tube-building polychaete worm that forms aggregations or biogenic reefs on the seabed. These reefs are habitats of special conservation interest under the EC Habitats Directive Annex I (OSPAR, 2010). They are found mostly solitary and in small groups, but also less frequently in dense aggregations on mixed and rocky substrata.

S. spinulosa reef is considered threatened and/or declining in OSPAR regions II and III (Greater North Sea and Celtic Sea) due to physical disturbance including dredging, fishing, coastal engineering, and other human activities. Moreover, this habitat is of conservation importance considering its topographically complex structure and high associated biodiversity. Thus, it is protected under the OSPAR convention, the EU Habitats Directive and the UK Biodiversity Action Plan (OSPAR, 2010; Pearce and Kimber, 2020). More specifically it has been identified as a priority habitat for conservation in European waters and nationally, and the reef structures are protected through their inclusion as features of MPAs (Pearce and Kimber, 2020). Conservation management should include the protection of both living and dead reefs, as both tube structures support the settlement and metamorphosis of *S. spinulosa* larvae (OSPAR, 2010).

Chapter 9 of the Hywind Scotland Pilot Park ES describes that the pre-construction survey identified some areas offshore as supporting the biogenic reef *S. spinulosa*, however none of this biotope was recorded in the proposed windfarm site with aggregations being concentrated outside of the windfarm site to the south (see Figure 9-5 of the Hywind Scotland Pilot Park ES).

Appendix 2 describes the distribution of *S. spinulosa* throughout the areas where mooring lines and cables will be laid down and where rock / sand bags and mattresses will be deposited. Appendix 2 has analysed the extent / percentage coverage and attempted to analyse the height of the identified *S. spinulosa* reef in order to provide a 'reefiness' score. The 'reefiness' score was then used to generate a heat map to illustrate the species distribution and density within the survey area.

For HS1 and HS2, only very small aggregations of *S. spinulosa* were identified which do not meet the criteria of a reef and which were outside of the areas where mooring lines, cables, rock / sand bags and mattresses will be laid down (see Figure 5-1 and 5-2 of Appendix 2 respectively).

For HS3, HS4 and HS5, aggregations of *S. spinulosa* were identified within or in close proximity to the laydown areas. At HS4, only a small aggregation of *S. spinulosa* reef, located well outside of the area of influence was given a 'reefiness' score of medium to low (see Figure 5-14 of Appendix 2). None of the other aggregations identified at HS4 were considered to represent a reef.

At HS3, *S. spinulosa* reef with a 'reefiness' score of low to high was identified adjacent to but outside of the laydown location for the southeast inter-array cable and also in the area underneath the turbine (Figure 12). It should be noted that the classification of 'reefiness' is precautionary because an assumption that all aggregations were greater than 10 cm high was made. This is because height was not able to be accurately determined as it was difficult to ascertain whether an *S. spinulosa* aggregation grew over a boulder or a flat seabed based on seabed imagery alone. It should also be noted that estimating the elevation has proven difficult and inaccurate (Pearce and Kimber, 2020), and studies have shown a lack of relationship between reef height and ecological function (Pearce et al, 2011; Pearce and Kimber, 2020).

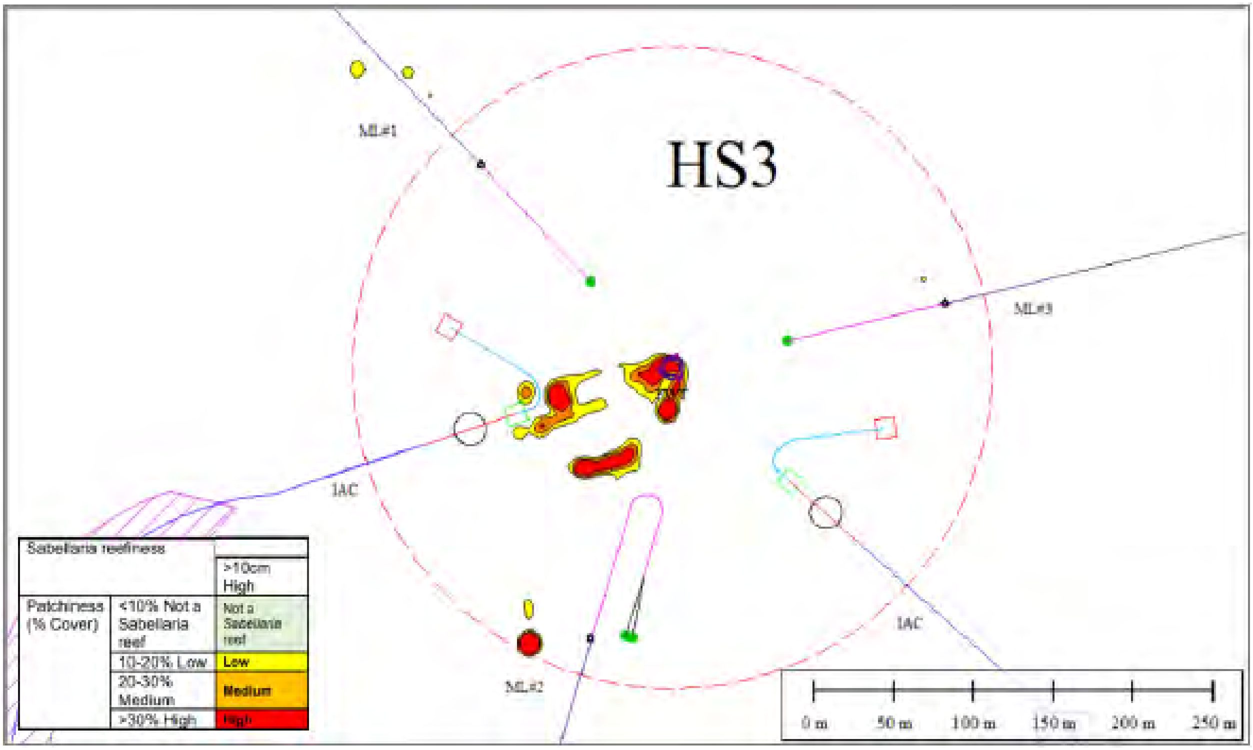


Figure 12 Sabellaria reefiness areas from density calculations based on presence/absence data of Sabellaria observations at HS3. Taken from Appendix 2

At HS5, areas of reef with 'reefiness' score of low to high were identified within the proposed laydown area for the southwest inter-array cable (Figure 13).

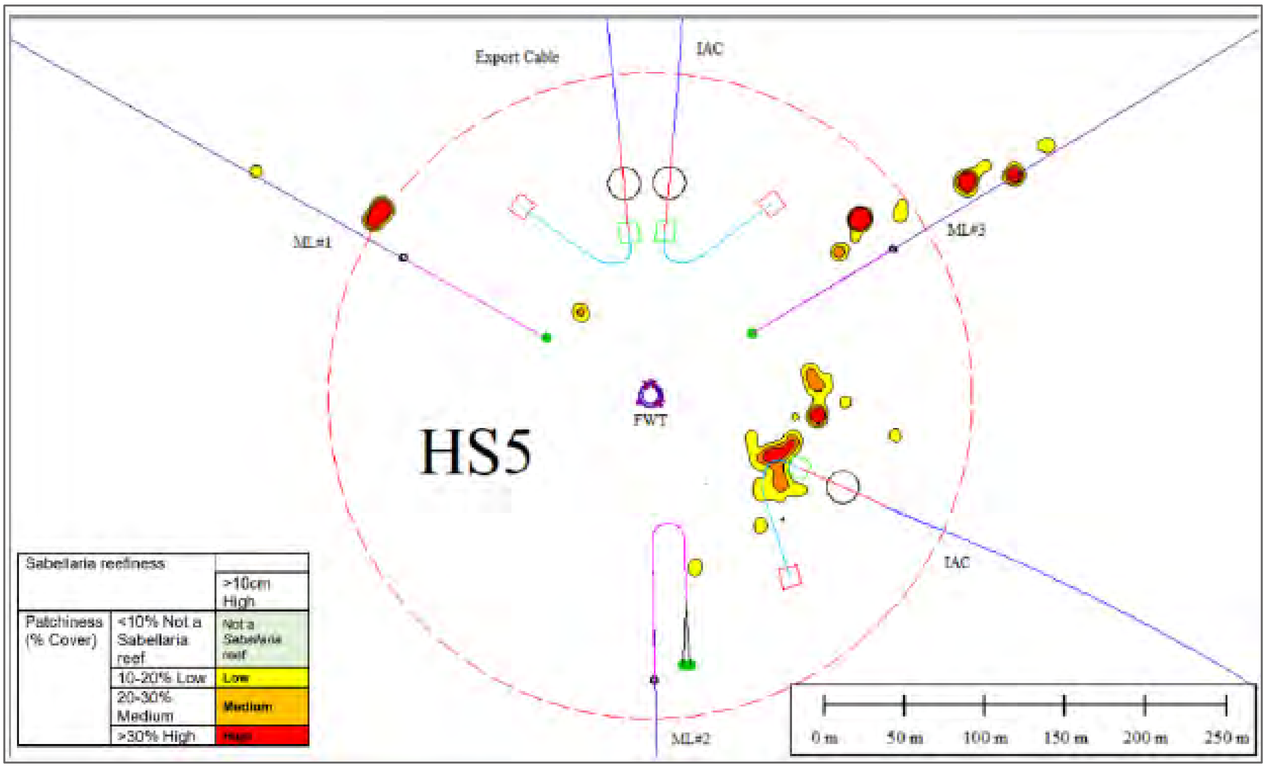


Figure 13 Sabellaria reefiness areas from density calculations based on presence / absence data of Sabellaria observations at HS5. Taken from Appendix 2

Figure 14 and Figure 15, provide still images from the ROV video survey for HS3 and HS5 respectively which are replicated from Appendix 2. These include areas considered to potentially represent *S. spinulosa* reef of low, medium and high quality. However, as can be seen, reefs with large extents, heights and biodiversity value are not observed which reflects the precautionary nature of the 'reefiness' scoring system that has been applied. The assessment provided in Section 7.1, should therefore be considered precautionary.

Further details on *S. spinulosa* as determined from the December 2023 survey are provided in Appendix 2.

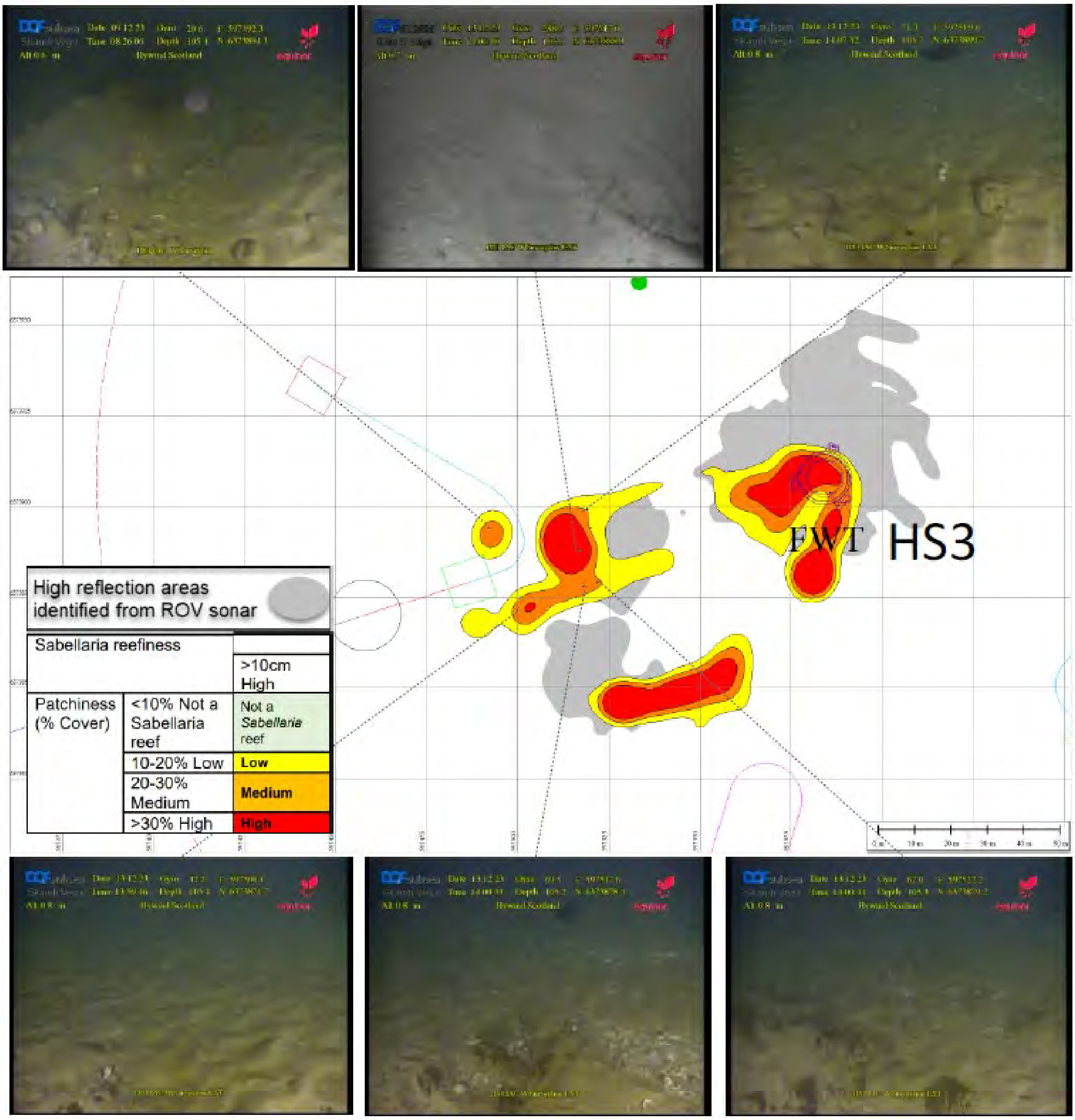


Figure 14 ROV still images of the areas in the vicinity of the laydown locations for HS3 considered to represent S. spinulosa reef of medium to high quality

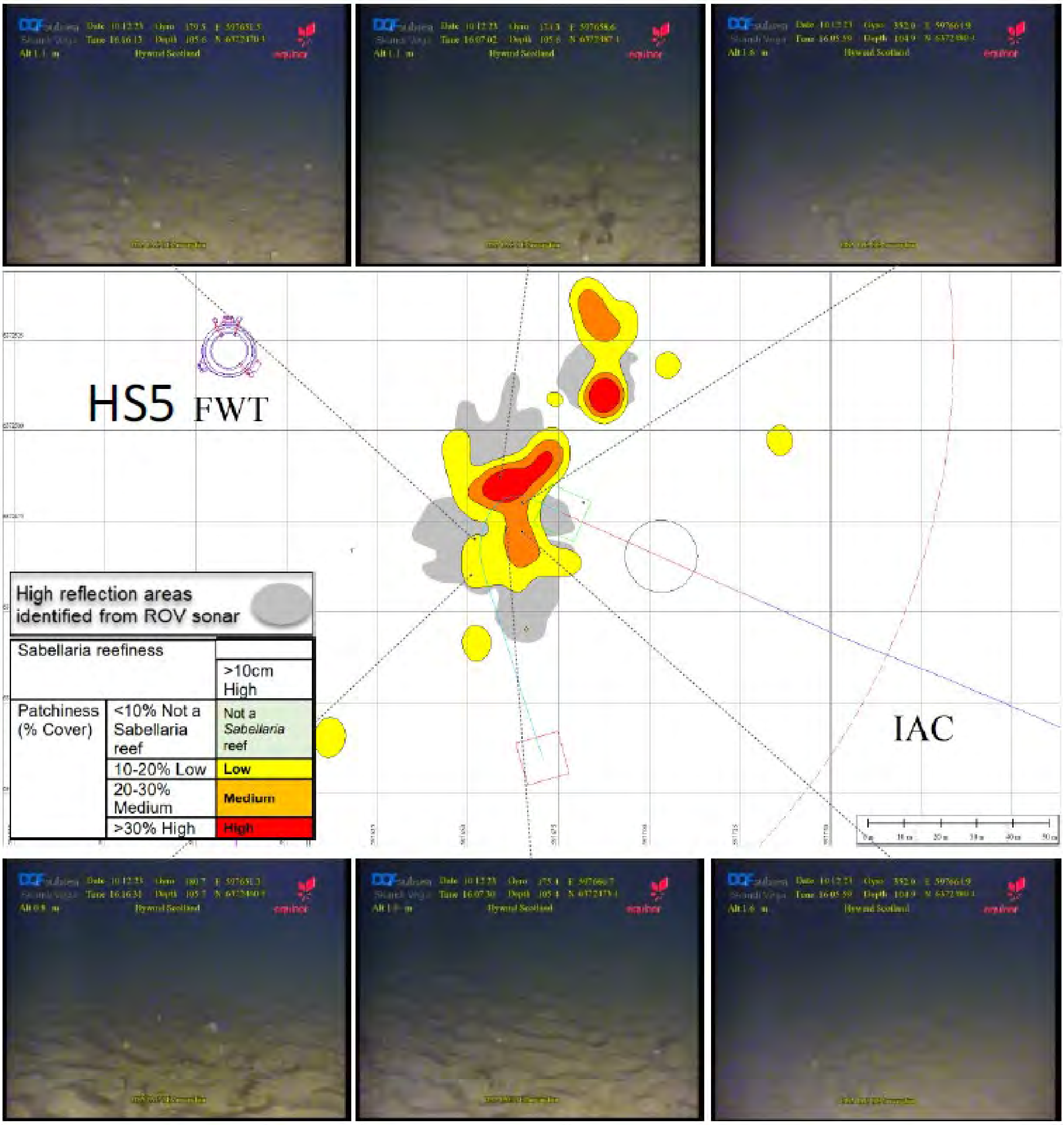


Figure 15 ROV still images of the areas in the vicinity of the laydown locations for HS5 considered to represent S. spinulosa reef of low to high quality

6.3 Megafauna

Chapter 10 Fish and Shellfish Ecology of the Hywind Scotland Pilot Park ES describes the fish species likely to be present at the site. Demersal species found in the region include gadoids (soft finned fish species of the family Gadidae), flatfish, sandeel and elasmobranchs.

Section 5.3.2 of Appendix 2 describes the megafauna observed during the recent survey with a full list of species identified being provided in Appendix B of that document. The various megafauna noted included hermit crabs (Paguridae), sea stars such as *Luidia ciliaris*, , brown crabs *Cancer pagurus* and a variety of fish species such as haddock *Melanogrammus aeglefinus*, flounders, *Raja* sp. and European angler *Lophius piscatorius*.

None of these species are evaluated as threatened or have a protective status (see Appendix 2).

6.4 Designated Sites

The Southern Trench MPA abuts the Hywind Scotland Pilot Park windfarm site and is designated for the following qualifying features:

- Burrowed mud (inshore sublittoral sediment)
- Fronts (large scale feature)
- Minke whale
- Quaternary geology and geomorphology

There will be no impact on inshore areas given that the works are restricted to the Hywind Scotland Pilot Park windfarm site and therefore there is no pathway for effect on burrowed mud. Fronts are a large scale feature that would not be affected given the very small footprints and volumes of the items to be installed temporarily (Table 1). Minke whale would not be sensitive to the installation of the temporary deposits which would not have a direct effect on them or on their prey species, again, given the very small area of effect and temporary nature of the activities. Given that the deposits would be placed on the surface of the seabed temporarily there is no potential for effect on quaternary geology and geomorphology. Therefore, there is no potential for likely significant effect on any features of the Southern Trench MPA

All other designated sites are located at least 17.6km (Turbot Bank MPA) from the Hywind Scotland Pilot Park windfarm site and therefore there is no potential for likely significant effect.

7 Impact Screening and Assessment

A screening exercise of potential impacts has been undertaken and is provided in Table 2.

Table 2 Potential impact screening

Receptor	Potential Impact	Screening Assessment
Benthic ecology	Temporary habitat loss / disturbance due to seabed placement of rock / sand bags, pipemats, mudmats, mooring lines and sections of inter-array cables and the export cable (HS5 only).	There is potential for temporary habitat loss / disturbance of the seabed and *S. spinulosa* reef due to placement of structures on the seabed and **therefore this potential impact is screened in for further assessment**.
	Introduction and spread of invasive non-native species	Turbines will be towed to and from Norway and therefore there is potential for the spread of invasive non-native species. **Therefore, this potential impact is screened in for further assessment**.
Fish and shellfish ecology	Underwater noise from vessels	There is potential for behavioural effects on fish species from underwater noise from vessels however as this potential impact was assessed as negligible in the Hywind Scotland Pilot Park ES and the vessel activity required for MCE operations would be significantly less than during construction

Receptor	Potential Impact	Screening Assessment
		of the windfarm, this potential impact has been screened out of further assessment.
	Electromagnetic field effects	Following disconnection and laydown of inter-array cables there would be no current circulating and therefore no potential for EMF effects. This potential impact has therefore been screened out of further assessment.
	Entanglement risk	Large fish species such as basking shark are the only classes of fish potentially sensitive to this impact however there are no published records of basking sharks becoming entangled in cables or chains and basking shark occurrence is rare in the North Sea. Mooring lines and inter-array cables will be laid on the seabed and therefore the risk of entanglement of basking shark is likely to be lower than that during normal operation. Section 12.7.4 of the Hywind Scotland Pilot Park ES assesses entanglement risk for marine mammals as negligible which is also considered to be the case for basking shark. Therefore, this potential impact has been screened out of further assessment.
Marine mammal ecology	Underwater noise from vessels	Assessed in Section 12.6.1 and 12.7.1 of the Hywind Scotland Pilot Park ES. The assessment predicts that for AHSVs such as the ones that will be used for MCE exchange (Section 3.2), the maximum number of animals predicted to be in the behavioural disturbance zone at any one time is less than one for all species considered. Therefore, this potential impact has been screened out of further assessment.
	Marine mammal entanglement	Mooring lines and inter-array cables will be laid on the seabed and therefore the risk of entanglement of marine mammals is likely to be lower than that during normal operation. Section 12.7.4 of the Hywind Scotland Pilot Park ES assesses entanglement risk as negligible. Therefore, this potential impact has been screened out of further assessment.
	Accidental release of contaminants	Assessed as negligible in section 12.6.5 of the Hywind Scotland Pilot Park ES and mitigated by measures described in the Hywind Scotland Pilot Park Project Environmental Management Plan[1]. This potential impact is therefore screened out of further assessment.
Offshore ornithology	Vessel disturbance	Effect assessed as negligible to minor in Section 11.6.1 and 11.7.1 of the Hywind Scotland Pilot Park

[1] *https://marine.gov.scot/sites/default/files/hywind_scotland_pilot_park_emp_2023_-_clean_redacted.pdf*

Receptor	Potential Impact	Screening Assessment
		ES for construction. Vessel activity for the MCE works will be lower than that assessed for during construction. Therefore, this potential impact has been screened out of further assessment.
	Accidental release of contaminants	As above for marine mammal ecology.
Shipping and navigation	Vessel collision	Section 15.7 of the Hywind Scotland Pilot Park ES assesses potential impacts on shipping and navigation receptors during operation and maintenance. Risks of 'Low (broadly acceptable)' to 'Moderate (tolerable)' were concluded. The same standard industry practice measures as described in Section 15.5.4 of the Hywind Scotland Pilot Park ES will be implemented during the MCE works. Therefore, this potential impact has been screened out of further assessment.
Marine archaeology	Potential direct damage to or destruction of marine cultural heritage	Section 16.8.1 of the Hywind Scotland Pilot Park ES evaluates the potential for vessel anchors to impact on marine archaeology receptors, stating that *"no direct effects on known or previously unrecorded marine cultural heritage were predicted"*. Given that vessels will not drop anchors during the MCE works, this potential impact has been screened out of further assessment.
WFD waterbodies	Deterioration in water quality	There is no requirement for dredging or disposal of sediment for any of the proposed works. Therefore, there is no potential for a deterioration in water quality due to increases in suspended sediment. Furthermore, as noted in Section 2, in the unlikely event that de-ballasting of the floating foundations is required, the water will be pumped into tanks onboard a vessel for treatment onshore. Therefore, potential impacts on WFD waterbodies have been screened out of further assessment.

Based on the information provided in Table 2, the following potential impacts have been taken forward for further assessment

- Temporary habitat loss / disturbance due to seabed placement of rock / sand bags, pipemats, mudmats, mooring lines and cables.
- Potential introduction and spread of invasive non-native species (INNS)

An assessment of these potential impacts is provided in the following sections.

7.1 Temporary Habitat Loss / Physical Disturbance

Direct temporary habitat loss / physical disturbance will occur during the laydown of the mooring lines and cables and placement of rock / sand bags, pipemat and mudmat mattresses.

Temporary habitat loss will occur over an area of up to 1,585.8 m^2 from installation of rock / sand bags and mattresses (Table 1) which is very small in the context of the extent of similar habitats across the wider northern North Sea. Temporary physical disturbance will occur in the areas where mooring lines and cables are laid down on the seabed.

For turbines HS1, HS2 and HS4 (Figure 1), no *S. spinulosa* reef or other species and habitats of conservation concern were identified in the vicinity of the laydown areas or where bags and mattresses will be placed. Temporary habitat loss and physical disturbance would be restricted to the period when the turbines are being towed to and maintained in Norway. During reconnection operations at Hywind Scotland Pilot Park, the installed rock / sand bags and mattresses will be removed from the seabed and stored on vessels for transit to shore. As described in Section 3.4, for each turbine, the time period for towing, MCE works, towing back to site and reconnection is anticipated to take around 4-5 weeks and therefore any habitat loss / physical disturbance effects would be short term and intermittent in nature.

Following removal of rock / sand bags and mattresses, the underlying sediment and any infauna and epifauna that was present prior to its installation would be anticipated to recolonise the area. This, combined with the small scale and temporary nature of the effect allow evaluation of a non-significant effect for which no mitigation would be required with respect to HS1, HS2 and HS4.

For turbines HS3 and HS5, potential interactions between the proposed laydown areas for inter-array cables have been identified (see Figure 14 and Figure 15 respectively and Appendix 2). All except one of the identified locations for the placement of rock / sand bags and mattresses do not overlap with the identified *S. spinulosa* reef for these turbines. The one exception relates to HS5 and can be seen on Figure 15, where the north western boundary of the rock / sand bag location (i.e. the green square) encroaches very slightly into an area with a 'reefiness' score of low.

Inter-array cable laydown or rock / sand bag placement on *S. spinulosa* reef could damage this protected habitat and therefore Equinor is committed to implementing avoidance mitigation through micro-siting or other techniques to ensure that physical disturbance impacts on *S. spinulosa* reef are avoided. It is likely that micro-siting mitigation i.e. laying down the cables and mooring lines in a configuration that avoids the *S. spinulosa* reef areas can be achieved with relative ease in the majority of locations. This is because the areas of reef largely fall outside of the areas identified for laydown of rock / sand bag and mattress placement. However, with respect to HS5, in order to avoid interaction between the identified reef and inter-array cable laydown area, a buoyancy solution could be implemented for the cable over the most sensitive areas of the reef (i.e. the red areas in Figure 13) if micro-siting was deemed not to be possible at the time of the MCE works.

Given that the identified areas of *S. spinulosa* reef will be avoided through micro-siting or a buoyancy solution, no significant effects are predicted.

7.2 Potential introduction and spread of invasive non-native species (INNS)

Potential INNS impacts are a growing consideration for offshore developments. The primary pathway for the introduction of INNS is from the use of vessels and infrastructure that has originated from outside the North Sea and Northeast Atlantic region, particularly from regions that are ecologically distinct from the northern North Sea. Ship ballast water appears to be the largest single vector for INNS, and bio-fouling communities on ships are also a contributor (Glasby et al. 2007). However, since it is most likely that vessels from Norway and / or the UK will be used, the risk of introduction of INNS is considered to be low.

As noted in Section 6.2 of Appendix 1, as per the Invasive Alien Species Regulation (Regulation (EU) 1143/2014), measures will be taken to avoid unintentional introduction of INNS.

The Carpet sea squirt, *Didemnum vexillum*, is an invasive species that has been found in different areas along the coast of Norway (and also off the west coast of Scotland i.e. around the Clyde and Inner Hebrides (Marine Scotland, 2020)). *D. vexillum* is capable of forming large colonies which can overgrow on rocks and gravel, smother benthic organisms and change the ecological balance of the benthic community. *D. vexillum* has been found in harbours and shallow waters in Norway between 5-20m and has also been recorded at depths of 85m in Canada.

It should be noted that no invasive species were identified in the 2023 visual benthic survey (Appendix 2) or the 2022 benthic survey at Hywind Scotland Pilot Park (DNV, 2022).

The proposed deep water quay / base in Norway is Wergeland. Wergeland is located in Vestland fylke. According to the Artsdatabanken[2], no *D. vexillum* has been registered in close proximity to the Wergeland deep water quay. The nearest registration is approximately 1.6 nm north.

In accordance with the Hywind Scotland Pilot Park Environmental Management Plan (Equinor, 2020), Equinor requires that all vessels involved in all stages of the Hywind Scotland Pilot Park Scotland project adhere to all relevant guidance regarding ballast water and the transfer of INNS, including the International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM Convention).

In addition, the following measures will be implemented to reduce the risk of transporting *D. vexillum* (and other INNS) from Norway to Scotland:

- Subsea visual inspection of the area near the Wergeland base to identify any INNS;
- Visual inspection and/or on-land storage of equipment to be used if possible; and
- If de-ballasting of wind turbines is required, ballast water will not be released to sea but pumped to a tank on vessel before being transported onshore for appropriate treatment.

Based on the above, it is concluded that the potential for spread of INNS will be appropriately mitigated and therefore no significant effect is predicted.

8 Conclusion

This Environmental Report is provided in support of a marine licence application for the temporary deposit of rock / sand bags, pipemat mattresses and mudmat mattresses and the associated laydown of mooring lines and cables. It has been informed by a visual benthic survey undertaken in December 2023 (Appendix 2) alongside previous surveys undertaken at Hywind Scotland Pilot Park. The 2023 visual survey identified areas of *S. spinulosa* reef with 'reefiness' scores of low to high in the vicinity of the laydown locations for the inter-array cables at turbines HS3 and HS5 although these classifications should be considered precautionary. These areas will be avoided by micro-siting or, in the case of HS5, a buoyancy solution which, if required, will avoid contact with the areas identified as reef. Therefore, no significant effects are predicted.

[2] *https://www.artsdatabanken.no/*

Consideration of INNS impacts has also been undertaken. Given the proposed mitigation, the risks of introduction of INNS are considered to be low and no significant effects are predicted.

Royal HaskoningDHV

9 References

DNV. (2022). Environmental benthos survey, Hywind Scotland Pilot Park Scotland. Equinor Energy AS.

Equinor. (2020). Hywind Scotland Pilot Park Scotland Pilot Park Environmental Management Plan. Document number 2020-003027.

Glasby TM, Connell SD, Holloway MG, Hewitt CL. (2007). Nonindigenous biota on artificial structures: could habitat creation facilitate biological invasions? Mar Biol 151:887–895.

Marine Scotland. (2020). Case study: Carpet sea squirt. Available at: https://marine.gov.scot/sma/assessment/case-study-carpet-sea-squirt [Accessed 05/01/24].

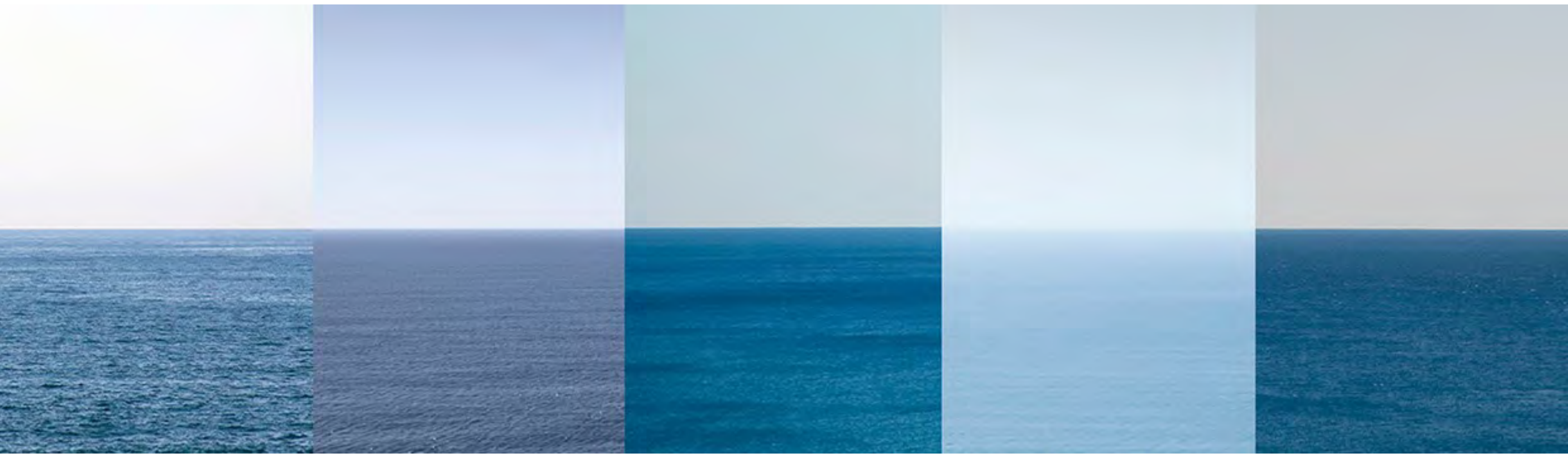
OSPAR Commission. (2010). QUALITY STATUS REPORT Case Reports for the OSPAR List of threatened and/or declining species and habitats – Update. [Accessed 04/01/24].

Pearce, B., Hill, J.M., Wilson, C., Griffin, R., Earnshaw, S. and Pitts, J. (2011). Sabellaria spinulosa Reef Ecology and Ecosystem Services. The Crown Estate 120 pages ISBN 978-1-906410-27-8. First Published 2013.

Pearce, B., & Kimber, J. (2020). The Status of Sabellaria spinulosa Reef off the Moray Firth and Aberdeenshire Coasts and Guidance for Conservation of the Species off the Scottish East Coast. Scottish Marine and Freshwater Science. [Accessed 04/01/24].

Scottish Government (2015). Scotland's National Marine Plan A Single Framework for Managing Our Seas. Marine Scotland. Available from: https://www.gov.scot/publications/scotlands-national-marine-plan/ [Accessed 03/01/2024].

Appendix 1 Main Component Exchange Works Method Statement



Input to Marine License Application

For Equinor Energy AS

GM-PRJ115131-HSEQ-RP-0001

			Project Engineer	Project HSEQ Manager	Project Manager
4	23-Jan-2024	Issued for Client Review		[Redacted]	
			Betina Celin Kingell	Jochem Verweij	Mats Olsvik
Rev	Date	Document Status	Prepared by	Reviewed by	Approved by

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Figures

Tables

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Rev	Date	Status	Prepared by	Reviewed by	Approved by
1	28.11.2023	Issued for Client Review	Andreas Isaksen Andreas Bohinen Kvernmo	Anja Elisabeth Føli	Mats Olsvik
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DOCUMENT CHANGE RECORD

Rev	Section(s)	Page(s)	Brief Description of Change
1	All	All	Original Issue to Client
2	4.2.9	12	Paragraph rewritten to give better explanation of purpose for rock bags
2	4.2.8	12	Figure added to illustrate alternative rock bag/sand bag installation
2	Table 4-1	13	Quantity of rock bags increased, from 10 per cable end lay down to 16 Big bags/sand bags added to table
2	4.2.11	14	Figure added to illustrate sand bags/big bags
2	4.2.5	10	Section added to describe the alternative rock bags locations
2	4.2.6	10	Section added to describe the potential use of big bags/sand bags
2	4.2.7	10	Text updated to emphasized the given coordinates
3	4.1.3	9	Added subsection with information regarding simplified method for mooring disconnection and reconnection.
3	Appendix D	-	Appendix added to report with description of Simplified method of mooring disconnection and reconnection.
3	Appendix E	-	Mooring laydown area updated with 5 new sheets which illustrate mooring laydown area of simplified method.
4	4.1.4	9	Added subsection with information regarding weather buoy.

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4	Appendix D	Table 6-2	Added weight and dimension information for SCF.
4	Appendix F	-	Location and installation description for weather buoy added to report.

DOCUMENT HOLD RECORD

Section(s)	Page(s)	Brief Description of HOLD

1. INTRODUCTION

1.1 General

1.1.1 The purpose of this document is to briefly describe the schedule, method, and project footprint on the seabed when doing the upgrade of the Hywind Scotland Pilot Park.

1.1.2 The wind turbines will be disconnected at the field using to Anchor Handling Tug Supply (AHTS) vessels and towed to the west coast of Norway to perform the main component exchange. Electric chain hoist will be used to disconnect and lower the IAC. The two AHTS will be present at the field to perform the subsea handshake, cable laydown and filter unit installation.

1.1.3 The towing vessels (Skandi Vega and Normand Ferking) will disconnect and lay down the mooring lines. As the vessels will use bridle chains for the tow, two of the mooring lines will be disconnected at the bridle, while the third will be disconnected at the turbine and the whole line will be laid down.

1.1.4 A benthic survey shall be performed for the lay down areas where cables, mooring lines and other equipment are to be landed on the seabed. This is to assure that the environment and biological diversity are maintained.

1.1.5 The water depth in the area is approximately 90-120 meters. Previous surveys have identified 4 external cables present in the turbine area.

1.1.6 Appendix D describes a simplified method for disconnection of mooring line ML#2. This method is considered safer and will decrease mooring re-installation risk and footprint on seabed.

1.2 Abbreviations

AHTS	Anchor Handling Tug & Supply
CTV	Crew Transfer Vessel
CVI	Close Visual Inspection
DOB	Depth of Burial
DP	Dynamic Positioning
FCS	Fairlead Chain Stopper
FWT	Floating Wind Turbine
GVI	General Visual Inspection
HYS	Hywind Scotland
IAC	Inter Array Cable
LOA	Length Over All
ML	Mooring Line
ROV	Remotely Operated Vehicle
UXO	Unexploded Ordnance
W2W	Walk-to-work
WROV	Work-Class Remotely Operated Vehicle
WTG	Wing Turbine Generator

1.3 References

1.3.1 A list of documents used as reference is provided in Table 1-1, below. For the documents with no title or document number, the file name is used as the reference.

Table 1-1: References

Ref No	Document Number	Document/Drawing title	Rev No
A1.	C178-MMT-G-RA-00005 / ST16826	Marine Survey Report – Hywind Scotland UXO Survey 2016	May 2016
A2.		PipeMat – Product Information	
A3.		MudMat – Product Information	
A4.	Environmental Benthos survey, Hywind Scotland	Report No.: 2023-0244 Document No.: 1836305	Rev.03

2. FIELD LOCATION

2.1 General

2.1.1 The field is located approx. 25 km from Peterhead on the east coast of Scotland, with water depths ranging from 90 to 120 meters. The area consists of five WTG stations, four infield cable route corridors, one export cable route corridor, in addition to three mooring line corridors per turbine.

2.1.2 The FWT and suction anchor coordinates can be seen in Appendix A.

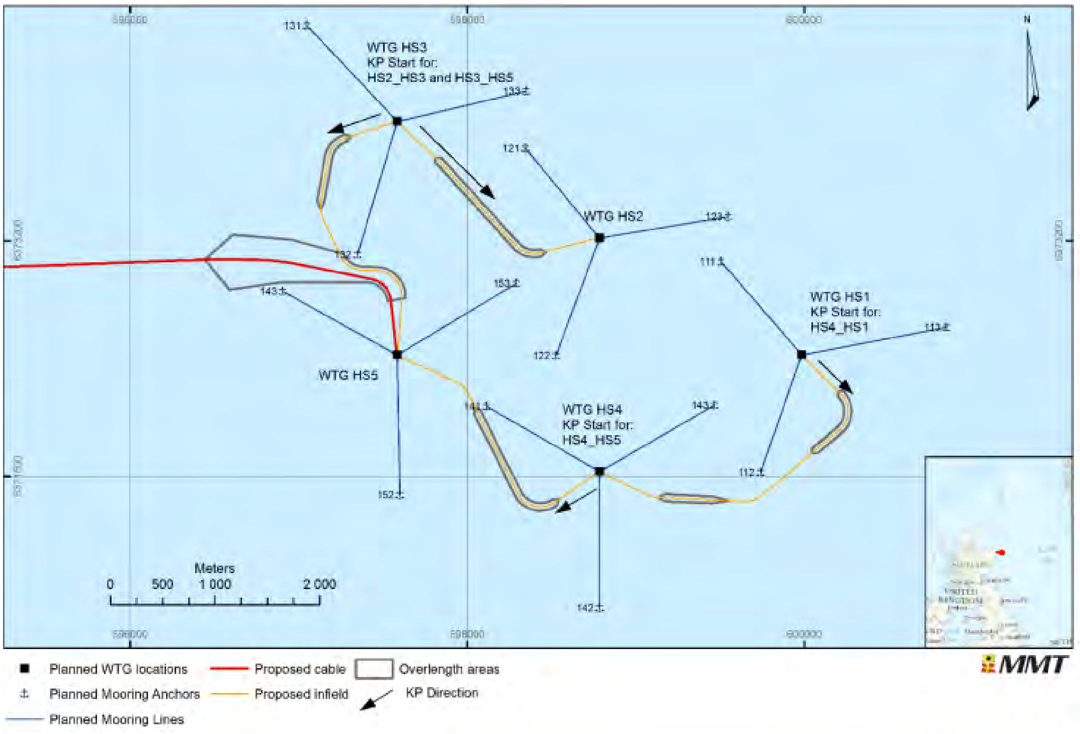


Figure 2-1 HYS Pilot Park area (Ref. /A1/)

3. PROJECT SCHEDULE

3.1.1 The project schedule can be seen in Table 3-1. Light green indicates that offshore operations are finished, only finishing work left.

Table 3-1: Initial schedule for the HYS upgrade

Description	2023	2024											
	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Survey (*No application needed*)													
Nexans W2W-vessel decommissioning and preparatory work (incl. laydown of temporary equip. on seabed)													
Offshore operations – Disconnection, tow, connection													
Inshore Upgrade @ Gulen													
Re-commissioning of Pilot Park, removal of all temporary deposits from seabed and demobilisation.													

4. METHODOLOGY - HYS UPGRADE – SCOPE OF SERVICES

4.1 Introduction

4.1.1 This section will describe the various activities planned for the HYS upgrade, mainly the activities to take place outside Scotland.

4.1.2 The project will primarily reverse the installation procedure used when the Hywind Scotland Pilot Park was installed in 2017.

4.1.3 A simplified method for mooring disconnection and reconnection of ML2 is presented in Appendix D. This method is a simplification of the original method to reduce risk of injury to personnel, damage to assets and seabed impact.

4.1.4 Prior to commencing operation, a weather buoy will be installed at field. Information regarding the weather buoy is presented in Appendix F.

4.2 Method statement - Dynamic cable disconnection and reconnection

4.2.1 There are in total 5-off dynamic cables as part of the HYS Pilot Wind Park, in total 9 cable ends. These 5 cables can further be divided into 4-off Inter-Array cables (IAC) and 1-off export cable. The dynamic cables are seen in Figure 4-1 as grey lines.

4.2.2 The Inter-Array and export cables have the same interface and cable properties towards the floating wind turbine, i.e., the laydown and disconnection method is the same for both types. The cable configuration can be seen in Figure 4-2.

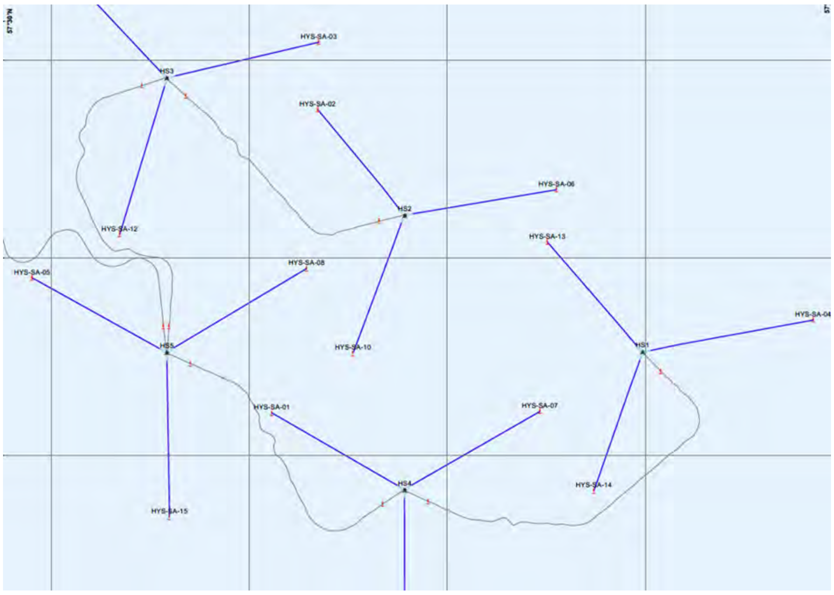


Figure 4-1: HYS Field Layout

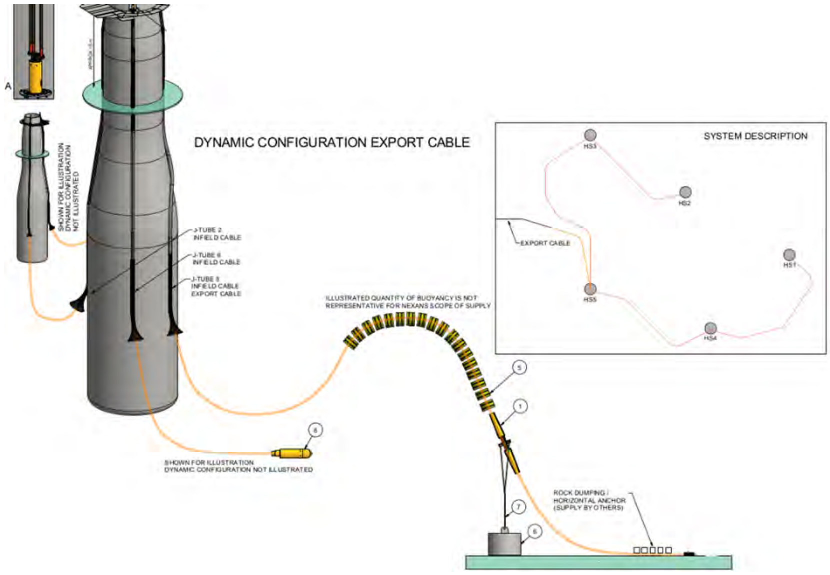


Figure 4-2: HYS Cable configuration

4.2.3 Figure 4-3 shows how the initial plan is to lay down the dynamic cables on seabed with subsea mattresses and rock bags/big bags. For the Orcaflex analysis of the cable laydown process, both min. compressions and min. bending radius are accounted for.

4.2.4 Figure 4-4 shows an illustration of the field layout and the location of the cables when laid down. Mooring is still attached to the FWT when cables are disconnected. Red squares indicates mattresses, green squares are rock bags/big bags, and the black circles are the hold-down anchor for the floating part of the dynamic cable.

4.2.5 As the rock bags locations are not finalized, pending detailed on-bottom stability analysis, Figure 4-5 illustrates an alternative rock bag configuration. Here most rock bags will be located in the touch down region, while the rest will be located along the cable laid on the seabed, in approximate 10m intervals.

4.2.6 Big bags/sandbags will potentially be used for stabilizing the cable length (i.e. not touchdown point), instead of rock bags. This will then follow the same description as in 4.2.5 and Figure 4-5. Then one big bag/sand bag will be installed on each side of the cable.

4.2.7 The coordinates for the mattresses and bags on the different FWTs can be seen in table in Appendix C. These rock bag coordinates are for the touchdown point, as illustrated in Figure 4-4.

4.2.8 The drawings for the rest of the FWTs can be seen as attachments in Appendix B.

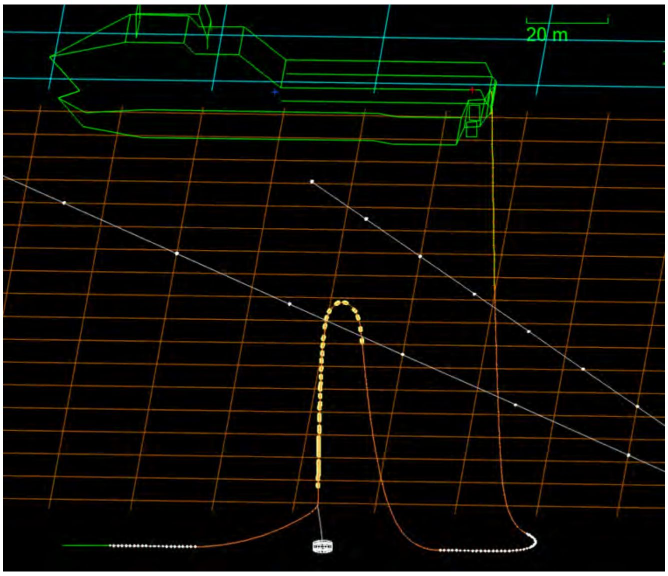


Figure 4-3: AHV laying down cable on seabed. Min. compression and min. bending radius accounted for.

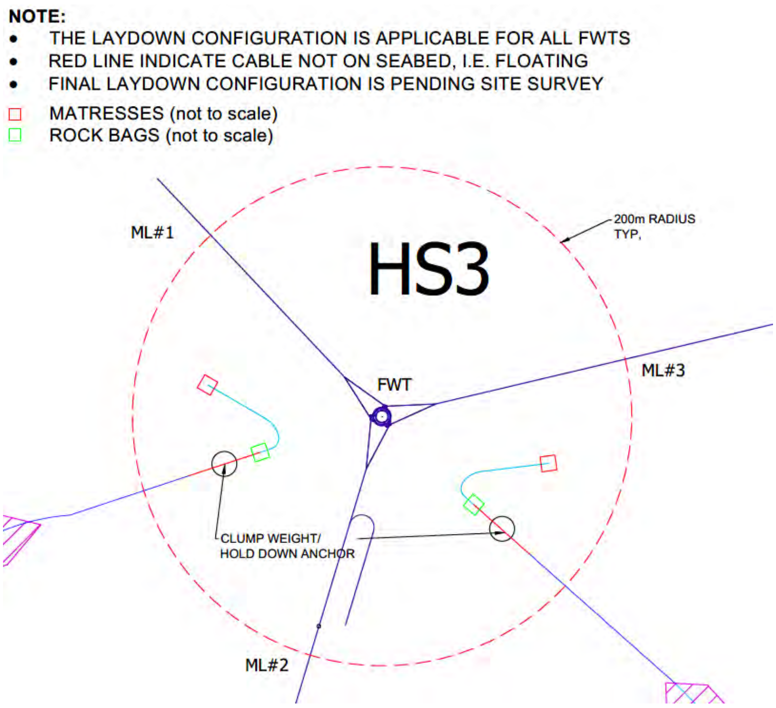


Figure 4-4: Cable on seabed with subsea mattresses and rock bags. Red line indicate cable not on seabed.

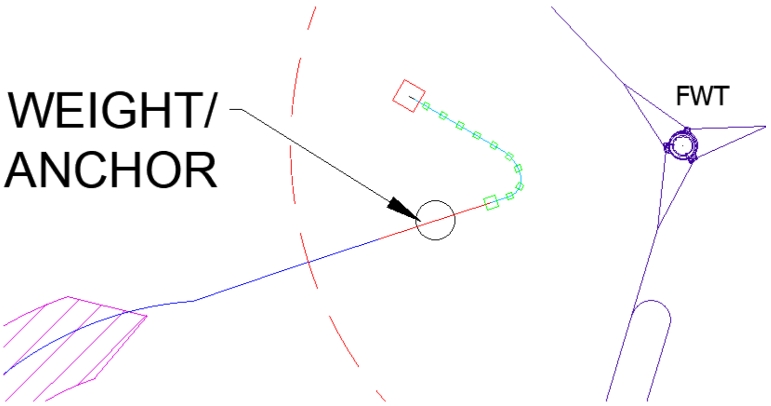


Figure 4-5: Alternative rock bag installation pattern.

4.2.9 Rock filter bags will be used to stabilize the touchdown position of the cable.

4.2.10 The pull in head will be placed on either a mudmat or a pipemat, pre-installed by the project during the operation phase. The characteristics and footprints of the mattresses and bags are described in Table 4-1 below.

4.2.11 All components on seabed are temporary and will be removed when 5-off FWTs have been upgraded and re-installed at the HYS field.

Table 4-1: Material characteristics of the installation aids used for the cable laydown

Equipment	Quantity	Dimension LxWxH [mm]	Weight (air/seawater) [kg]	Material
Rock bags	144	$\pi \cdot (1200)^2 \cdot 600$	4000	Scottish rocks
Big bags/sand bags	162	$90 \cdot 90 \cdot 180$	2000	Polyproylene fabric, sand inside
Pipemat	9	$4000 \cdot 4000 \cdot 50$	323/55	High Density Polyethylene
Mudmat	9	$3600 \cdot 4000 \cdot 30$	330/45	Heavy-duty polyurethane

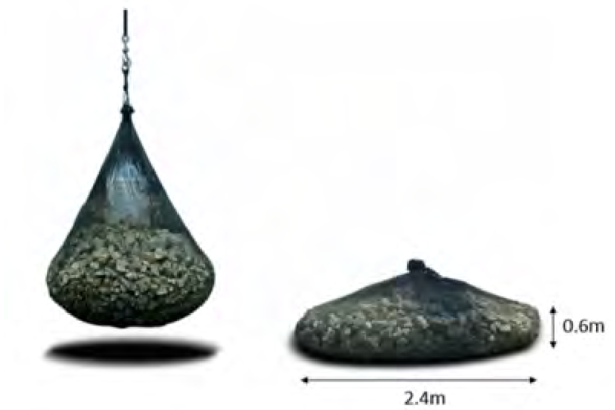


Figure 4-6: Rock bags to be used for cable laydown. Rocks are sourced in Scotland.

Figure 4-7: Big bags/sand bags potentially to be used for cable laydown

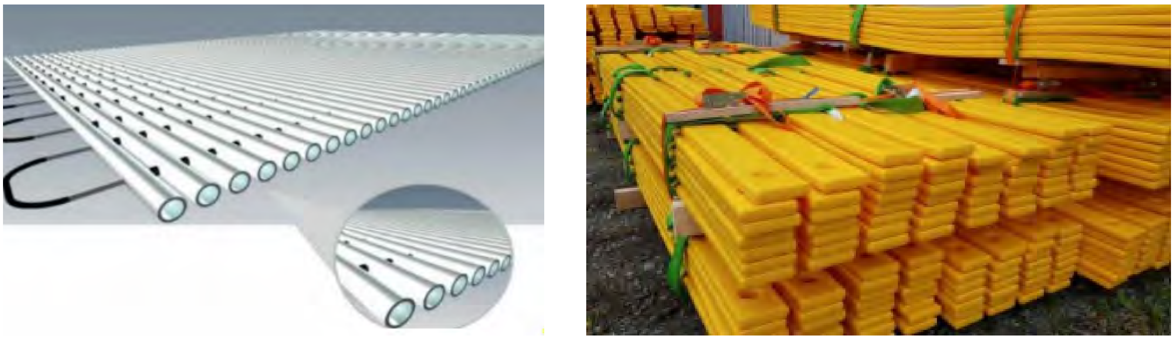


Figure 4-8: Pipemat (Ref. /A2/) and Mudmats (Ref. /A3/)

4.3 Method Statement - Mooring disconnection and reconnection

4.3.1 Figure 4-9 shows a top view of the upper part of the mooring system of the FWTs. Each FWT has 3 main mooring lines connected to a triplate where each mooring line is split into two bridle legs. On ML#1 and ML#2 the bridle legs are terminated at strongpoints on the FWT while on ML#2 the chain is pulled through a Fairlead Chain Stopper (FCS). This is used to tighten the mooring system and locks the chain after tightening.

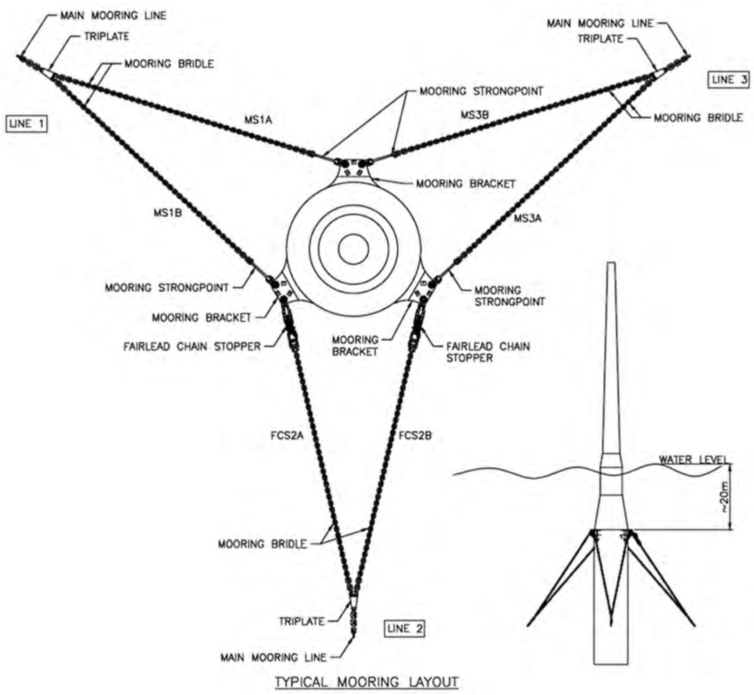


Figure 4-9: Top section of mooring system

4.3.2 Considering the laydown process, for ML#2, the whole mooring line is laid on the seabed, bridle included. The mooring line is disconnected from the FCSs and lowered to the seabed as illustrated in Figure 4-10. The ends are laid down on mattresses. See Figure 4-11 for mooring line build-up.

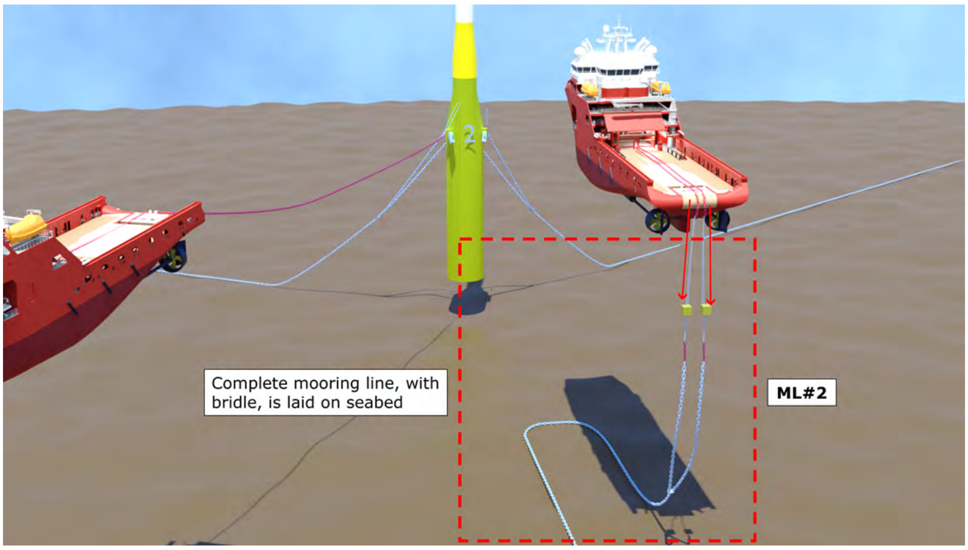


Figure 4-10: ML#2 laydown

4.3.3 For ML#1 and ML#3, the bridles are used for towing and therefore the mooring line is spilt in the H-link. See Figure 4-11 and Table 4-2 below for mooring line build-up.

4.3.4 This means that for ML#1 and ML#3 the bridles are still connected to the FWT and used for the towing. The H-link however, is lowered to the seabed and laid down with subsea buoy as marking in the chain end, as illustrated in Figure 4-12.

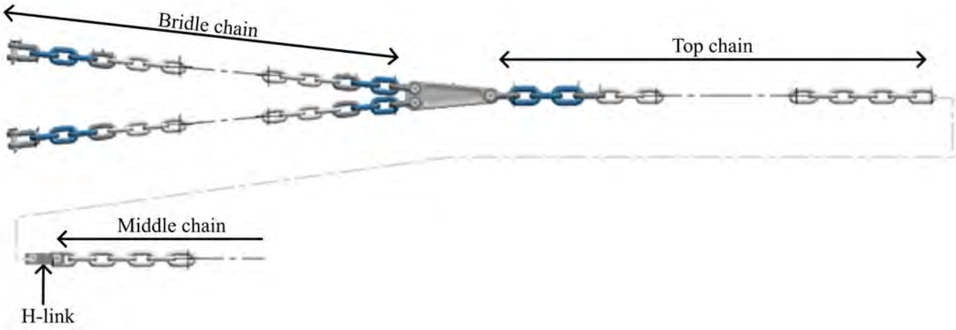


Figure 4-11: Mooring chain build-up

Table 4-2: Mooring general arrangement

	ML#1, ML#2 and ML#3		
	Length [m]	Chain Diameter [mm]	Type
Bridle Chain	41.5	Ø132	Studless
Top Chain *(In front of H-link)*	30	Ø147	Studless

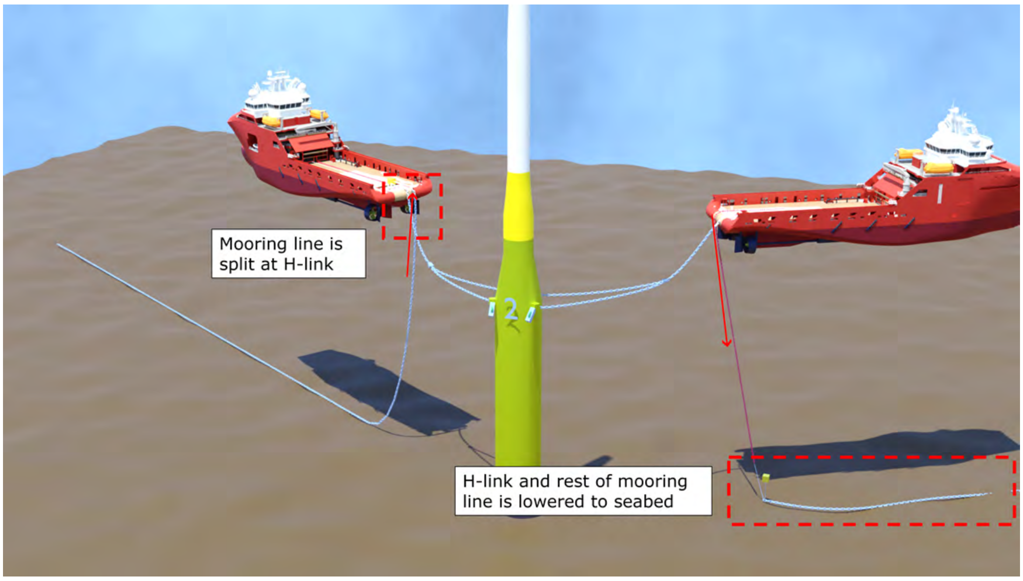


Figure 4-12: ML#1 and ML#3 laydown. ML is split in H-link

4.3.5 See 0 for drawings of locations of the mooring chain laydown. Figure 4-13 shows an example of the field layout drawings, in this case for HS5. In this scenario the cables are already laid down. Light colors (Light pink and light blue) indicate locations where content is laid down.

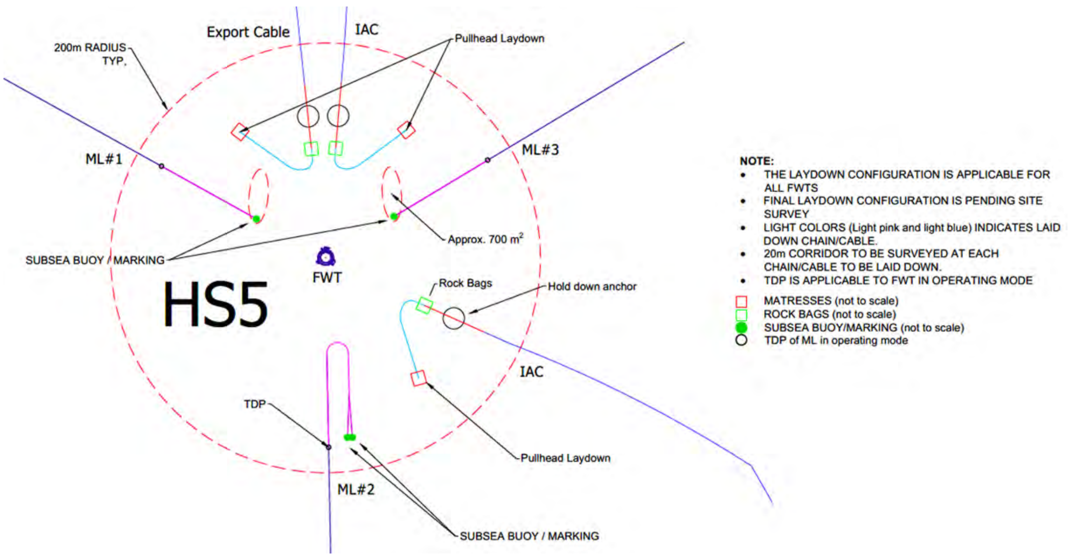


Figure 4-13: Mooring laydown field layout

4.3.6 Due to extended forces when the mooring are disconnected a more comprehensive Orcaflex analysis is required to be able to provide the exact laydown location for ML#1 and ML#2. The chain end laydown locations are subject to change, and therefore a wider area should be investigated in this case. The red oval circle north of the subsea buoy indicates the approximate extended survey area. ROV to survey approximately 20-25m north of the initial location.

4.3.7 Coordinates for the planned subsea buoy locations can be seen in the table in Appendix C.

4.4 Method Statement – Towing from Scotland to Norway

4.4.1 The FWTs will be towed to Gulen using the 2017 tow route for the majority of the route with alterations close to the Norwegian coast as shown in Figure 4-14.

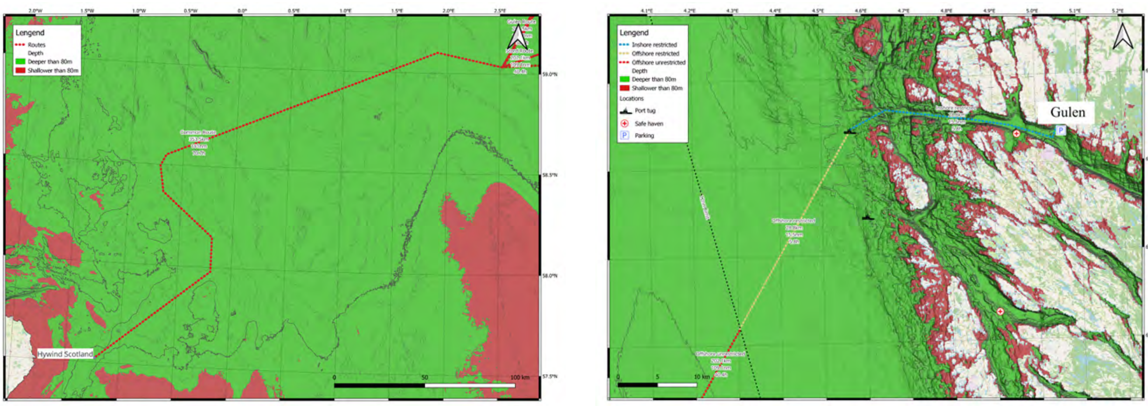


Figure 4-14: Planned offshore (left) and inshore (right) tow route

4.5 UXO survey area from 2016

4.5.1 To avoid UXO, the same mapped corridors from the installation in 2017 will be used. The project footprint will not exceed these areas.

4.5.2 The field layout has been surveyed and checked for UXO back in 2016. The area surveyed can be seen in Figure 4-15 and covers:

- A 200m radius disc around the 5 FWTs.
- A 40m corridor centered on the middle of the chain (+/- 20m on both sides).
- A 50m radius disc around the suction anchors.

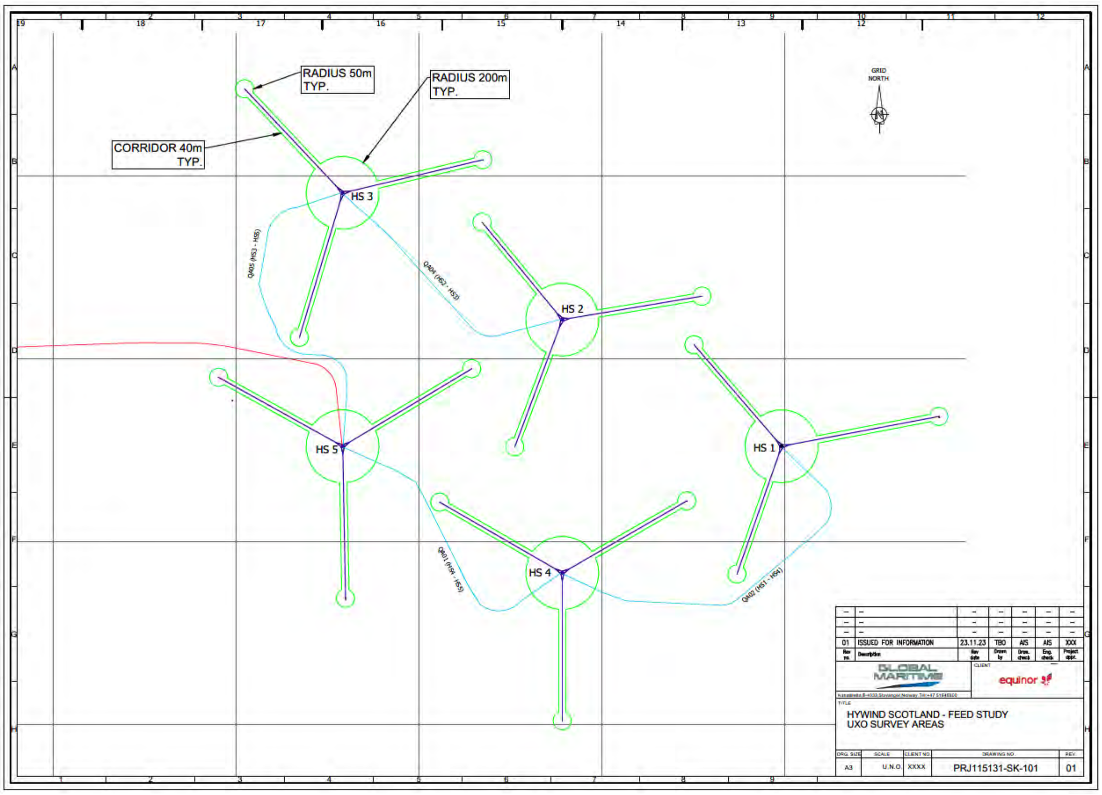


Figure 4-15: UXO surveyed area from 2016

4.6 Vessel Specification

4.6.1 The vessel requirements for the operation are given in Table 4-3.

Table 4-3: Vessel requirements

Phase	Vessel requirement
Preparatory – subsea	AHTS
Preparatory – topside	W2W
Preparatory – topside	CTV
Cable lay down and recovery	AHTS

4.6.2 For the preparatory work subsea, it is required that the vessel has an ROV to perform the cleaning operations.

4.6.3 The CTV will be used for transferring personnel to/from shore while the W2W vessel will be used to transfer personnel and equipment onboard the FTWs. The W2W will therefore require the following:

- DP class 2
- Motion compensated gangway
- Offshore crane
- Sufficient accommodation
- Survey spread

4.6.4 In addition, a motion compensated crane with a capacity of ≥2 Te is preferred on the W2W vessel, but not required. This could be used to mobilize all the equipment on the FWT external platform. WROV on vessel is also preferred but not required. This could be used to do e.g., pre-surveys, install rock bags, perform laydown of the IAC.

4.6.5 For the cable laydown and recovery AHTSs Skandi Vega and Normand Ferking have been used as base case. Relevant specifications of the vessels are given in Table 4-4. The W2W vessel has not yet been decided and an example vessel is given in the table. Should other vessels be needed due to unforeseen circumstances the requirements are as follows:

- DP class 2
- One WROV
- Either:
  - Typical AHTS with stern roller and work winch/AH winch
  - Small crane
- Rail cranes with sufficient capacity to deploy rock bags (>4 Te) or A-frame
- Survey spread

Table 4-4: Vessel specifications

	Skandi Vega	Normand Ferking	W2W example vessel
LOA	109.5 m	89.35 m	83 m
Crew capacity	88 people	32 people	60 people
Deck specifications	1070 m^2 deck 3050 t deck capacity 10 t/m^2 68 m^2 ROV hangar	745.2 m^2 deck	305 m^2 deck
Deck cranes	1 x knuckleboom 2 x Cargo roll 1 x SWL 3 t	Triplex MDH 45 t traverse crane	3 t 3D crane Ampelmann compensated gangway

4.6.6 All vessels will operate according to SOLAS/ISM regulations.

5. BALLASTING – CONTINGENCY

5.1 Offshore ballast operation

5.1.1 It is unlikely that offshore ballasting operations are required. However, should it be necessary to ballast/de-ballast the FWT to reach a desired draft, the lightweight pumping skids acquired for offshore draft adjustments can be used. These skids have a pumping capacity of approx. 2 m^3/h each. The need for ballasting will depend on e.g., the amount of marine growth, equipment detached from the FWTs and the current draft etc.

5.1.2 The ballast water is a solution of water and lye, with a pH level of ~10. This water-lye solution cannot be pumped directly into the sea, and should ballasting operations be necessary, the water will therefore be pumped into tanks onboard a vessel for onshore treatment. Ballast water treatment methods include adding hydrochloric acid (HCl) to the solution, which neutralizes the solution, producing H_2O and NaCl (water and salt).

6. ENVIRONMENT

6.1 Ecology- benthic habitats

6.1.1 A visual survey shall be performed for the areas where equipment is temporarily deposited on the seabed (cable, mooring chain, rock bags, mattresses, and buoy arrangement). Section 4 present the method statement including the Dynamic cable disconnection and reconnection and Mooring disconnection and reconnection.

6.1.2 Reference is made to 4.2 for material characteristics for the temporary deposits in connection with the dynamic cable disconnection and lay down.

6.1.3 Reference is made to 4.3 for information on temporary buoy pick up arrangement used in connection with the mooring disconnection and laydown.

6.1.4 Reference is made to Appendix B, C and D for further information on coordinates and footprint of the temporary deposits and benthic survey.

6.2 Ecology- Invasive species

6.2.1 FWTs will be transported from the current positions outside of Scotland to Norway and then returned to Scotland. As per the Invasive Alien Species Regulation (Regulation (EU) 1143/2014), project will take action to avoid unintentional introduction of invasive species.

6.2.2 The Carpet sea squirt, Didemnum vexillum, is an invasive species that has been found in different areas of the coast of Norway (and also of the coast of Scotland/UK). Didemnum vexillum is capable of forming large colonies which can overgrow rocks and gravel, smother benthic organisms and change the marine balance of the seafloor community.

6.2.3 The Didemnum vexillum, have been found in harbours and shallow waters (in Norway between 5-20m), however it has been found in Canada 85m below surface.

6.2.4 No invasive species were identified in the benthos study in 2022, ref. *DNV– Report No. 2023-0244 Environmental benthos survey, Hywind Scotland*.

6.2.5 The proposed deep water quay/ base in Norway is Wergeland. Wergeland is located in Vestland fylke. According to the Artsdatabanken no Didemnum vexillum have been registered in near proximity of the Wergeland deep water quay. The nearest registration of Didemnum vexillum. is approximately 1.6 nm north.

6.2.6 Before transporting the FWT from Scotland to Norway, measures will be taken to reduce the risk of transporting the Didemnum vexillum from Norway to Scotland:

- Subsea visual inspection of area near base
- Visual inspection and/or on- land storage of equipment to be used if possible
- Ballast water of FWT not released to sea but pumped to tank on vessel before transported onshore for appropriate treatment.

6.3 Marine growth on FWT

6.3.1 The project plan to remove marine growth from some equipment on the FWT prior to disconnection and tow. Typically, the bell mouth areas to ensure safe laydown of the power cable. In addition, the FCSs are to be cleaned.

6.3.2 The removal of the marine growth is considered a low-risk operation regarding the environment. Thus, no more assessment is planned.

APPENDICES

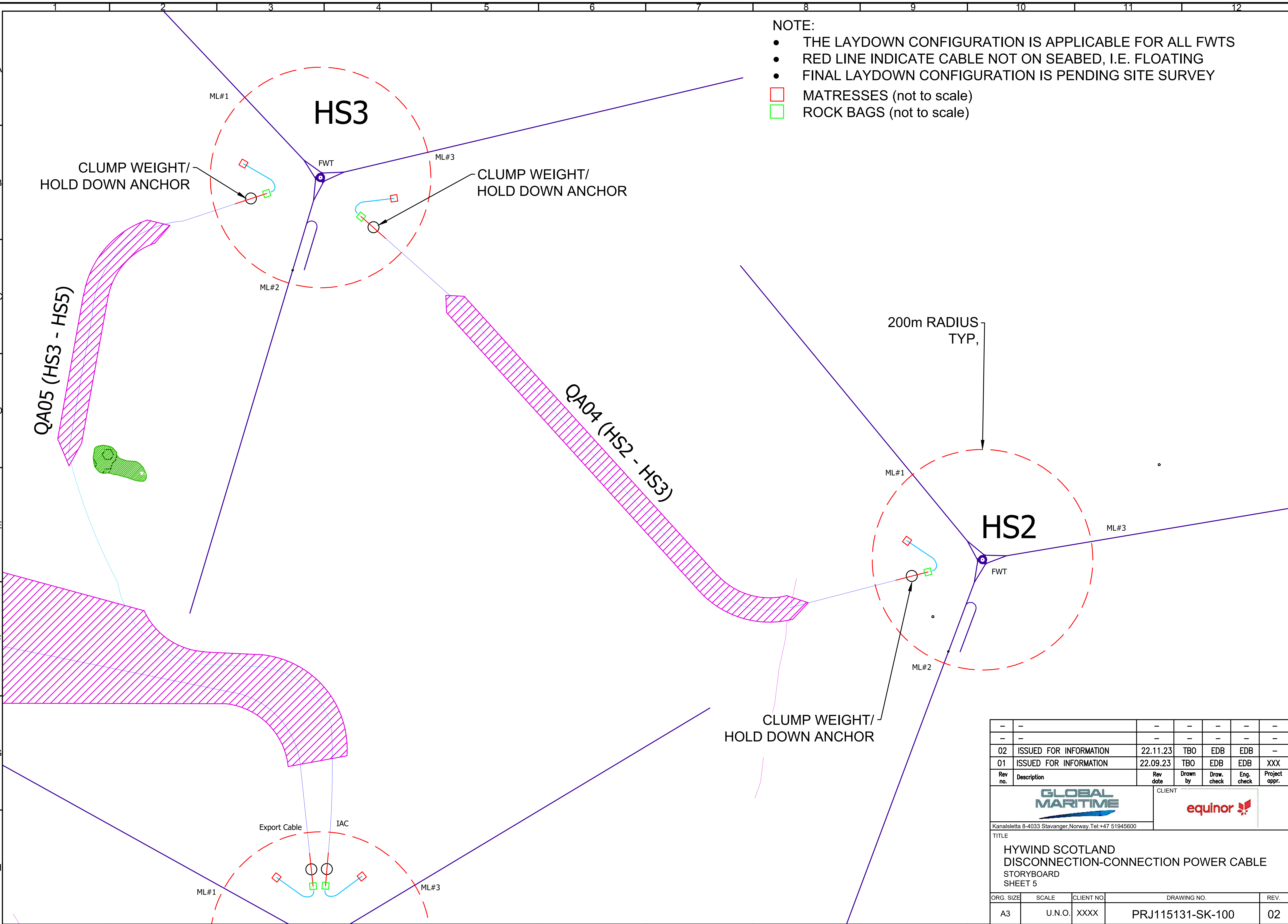
APPENDIX A FIELD LAYOUT

Projection in UTM Zone 30 N (Spheroid GRS 80)

		SA ID	Easting [m]	Northing [m]
HS1	FWT Center	HS1	599985.0	6372522.0
	Anchor As-installed	HS1_1	599504.6	6373079.7
		HS1_2	599739.6	6371822.7
		HS1_3	600847.2	6372685.2
HS2	FWT Center	HS2	598785.0	6373215.0
	Anchor As-installed	HS2_1	598345.6	6373748.6
		HS2_2	598524.5	6372518.7
		HS2_3	599551.9	6373344.3
HS3	FWT Center	HS3	597584.0	6373908.0
	Anchor As-installed	HS3_1	597047.4	6374477.8
		HS3_2	597346.3	6373118.3
		HS3_3	598351.6	6374089.0
HS4	FWT Center	HS4	598785.0	6371829.0
	Anchor As-installed	HS4_1	598116.1	6372217.3
		HS4_2	598784.5	6371019.4
		HS4_3	599467.8	6372223.9
HS5	FWT Center	HS5	597584.0	6372522.0
	Anchor As-installed	HS5_1	596904.9	6372898.9
		HS5_2	597598.0	6371689.6
		HS5_3	598289.4	6372945.4

APPENDIX B DYNAMIC CABLE LAYDOWN

[Drawings describing the cable laydown for all FWTs can be seen on the next page]



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01	ISSUED FOR INFORMATION	22.09.23	TBO	EDB	EDB	XXX
Rev no.	Description	Rev date	Drawn by	Draw. check	Eng. check	Project appr.

GLOBAL MARITIME

Kanalsletta 8-4033 Stavanger,Norway.Tel:+47 51945600

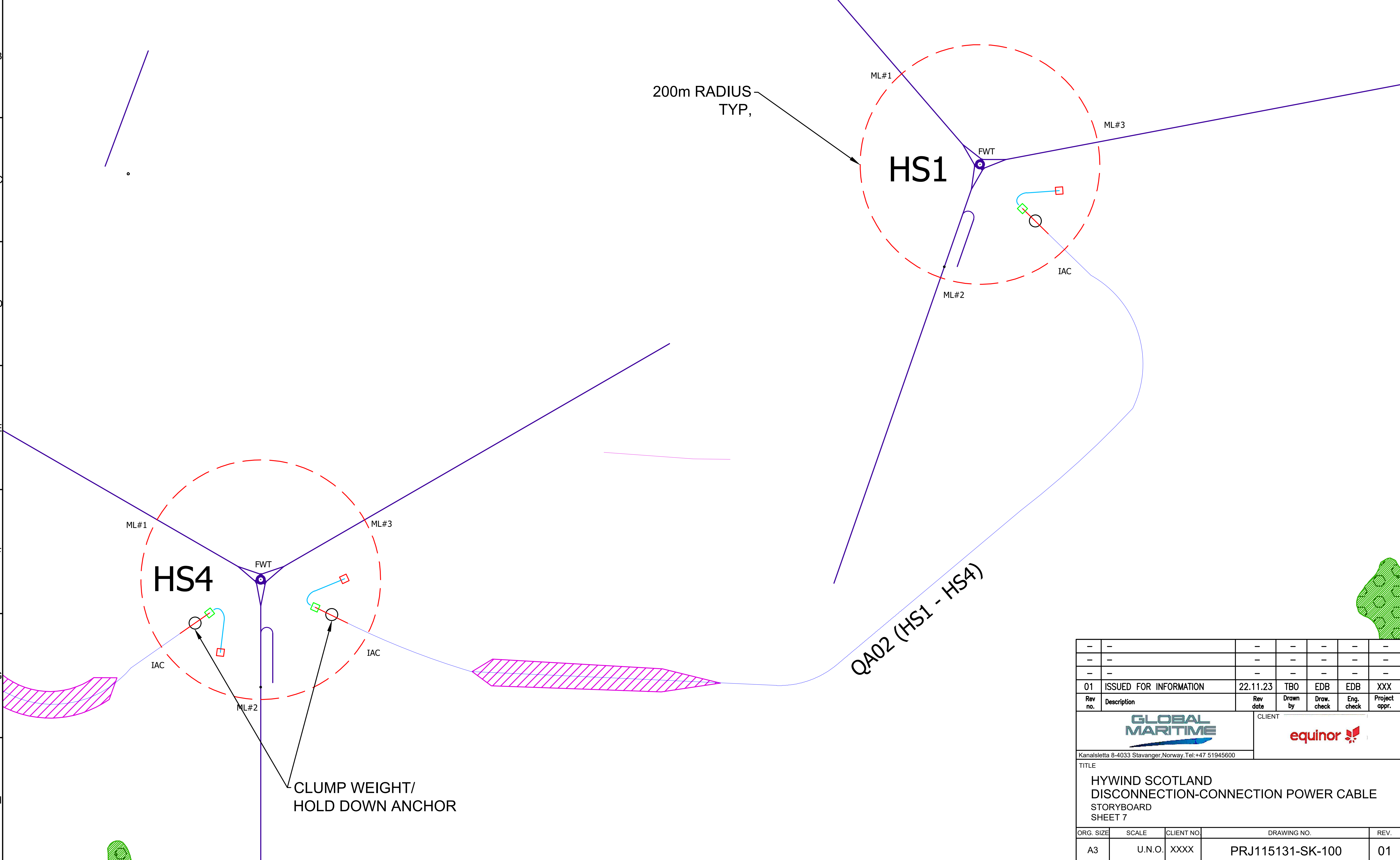
CLIENT
equinor

TITLE
HYWIND SCOTLAND
DISCONNECTION-CONNECTION POWER CABLE
STORYBOARD
SHEET 5

ORG. SIZE	SCALE	CLIENT NO	DRAWING NO.	REV.
A3	U.N.O.	XXXX	PRJ115131-SK-100	02

NOTE:
- THE LAYDOWN CONFIGURATION IS APPLICABLE FOR ALL FWTS
- RED LINE INDICATE CABLE NOT ON SEABED, I.E. FLOATING
- FINAL LAYDOWN CONFIGURATION IS PENDING SITE SURVEY

☐ MATRESSES (not to scale)
☐ ROCK BAGS (not to scale)



Rev no.	Description	Rev date	Drawn by	Draw. check	Eng. check	Project appr.
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01	ISSUED FOR INFORMATION	22.11.23	TBO	EDB	EDB	XXX

GLOBAL MARITIME
Kanalsletta 8-4033 Stavanger,Norway.Tel:+47 51945600

CLIENT
equinor

TITLE
HYWIND SCOTLAND
DISCONNECTION-CONNECTION POWER CABLE
STORYBOARD
SHEET 7

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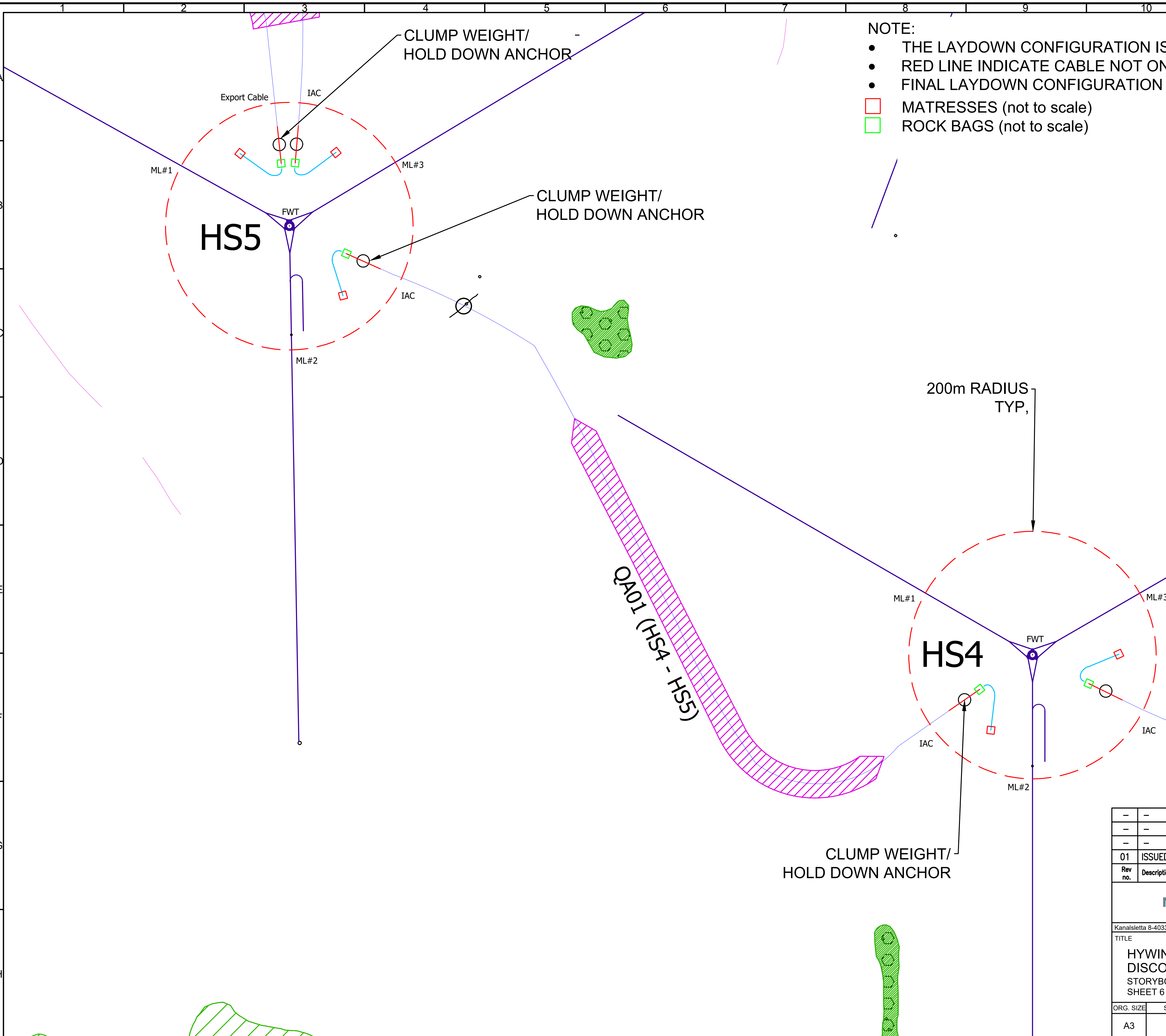

NOTE:

- THE LAYDOWN CONFIGURATION IS APPLICABLE FOR ALL FWTS
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- FINAL LAYDOWN CONFIGURATION IS PENDING SITE SURVEY

MATRESSES (not to scale)

ROCK BAGS (not to scale)

Rev no.	Description	Rev date	Drawn by	Draw. check	Eng. check	Project appr.
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01	ISSUED FOR INFORMATION	22.11.23	TBO	EDB	EDB	XXX

GLOBAL MARITIME

Kanalsletta 8-4033 Stavanger,Norway.Tel:+47 51945600

CLIENT

equinor

TITLE

HYWIND SCOTLAND
DISCONNECTION-CONNECTION POWER CABLE
STORYBOARD
SHEET 6

ORG. SIZE	SCALE	CLIENT NO.	DRAWING NO.	REV.
A3	U.N.O.	XXXX	PRJ115131-SK-100	01

APPENDIX C LOCATIONS OF MATTRESSES AND ROCK BAGS ON SEABED

Projection in UTM Zone 30 N (Spheroid GRS 80)

			Rock Bags		Mattresses		Subsea buoy	
	Unit	Number	Northing	Easting	Northing	Easting	Northing	Easting
HS2	IAC	QA04	6373193	598686	6373250	598648	-	-
	Mooring	1	-	-	-	-	6373272	598738
		2	-	-	-	-	6373051	598745
		3	-	-	-	-	6373227	598858
HS3	IAC	QA04	6373837	597658	6373870	597717	-	-
		QA05	6373879	597487	6373933	597445	-	-
	Mooring	1	-	-	-	-	6373962	597533
		2	-	-	-	-	6373741	597555
		3	-	-	-	-	6373925	597656
HS5	IAC	QA01	6372477	597676	6372409	597671	-	-
		QA05	6372624	597593	6372641	597659	-	-
		Export	6372623	597571	6372639	597504	-	-
	Mooring	1	-	-	-	-	6372558	597520
		2	-	-	-	-	6372355	597604
		3	-	-	-	-	6372560	597648
HS4	IAC	QA01	6371773	598699	6371708	598718	-	-
		QA02	6371783	598876	6371831	598925	-	-
	Mooring	1	-	-	-	-	6371866	598721
		2	-	-	-	-	6371657	598804
		3	-	-	-	-	6371866	598849
HS1	IAC	QA02	6372448	600056	6372478	600117	-	-
	Mooring	1	-	-	-	-	6372578	599937
		2	-	-	-	-	6372351	599948
		3	-	-	-	-	6372535	600058

APPENDIX D SIMPLIFIED ML#2 DISCONNECTION/RECONNECTION METHOD

General

The simplified methodology presented in section below utilises additional information not present when the original method statement was drawn up. The reason for opening for this option is access to an active heave compensated winch on field which this simplified methodology require.

The methodology *significantly reduces risk* to both personnel and asset during disconnect and reconnect by reducing the complexity of the operation and reducing duration. This method also reduces the additional seabed area impacted by disconnect and reconnect operations.

Additionally, this simplified methodology greatly reduces the amount of ROV work at shallow water depth close to FWT substructure both prior to and during the disconnect and reconnection phase.

Simplified Methodology

Preparatory work prior to disconnection:

Install marker buoy on ML#2 (Anchor side) from cut position.

Disconnection of FWT from ML#2:

<u>*Step 1:*</u>

- Hold Back Vessel (HBV) to deploy tension rigging for mooring cutting.
- Vessel with ROV to install tension rigging on ML#2 (FWT side from cut point)
- ROV to cut anchor approx. 100m from anchor (cut position may be moved closer to TDP if found beneficial) ref. Figure 6-1

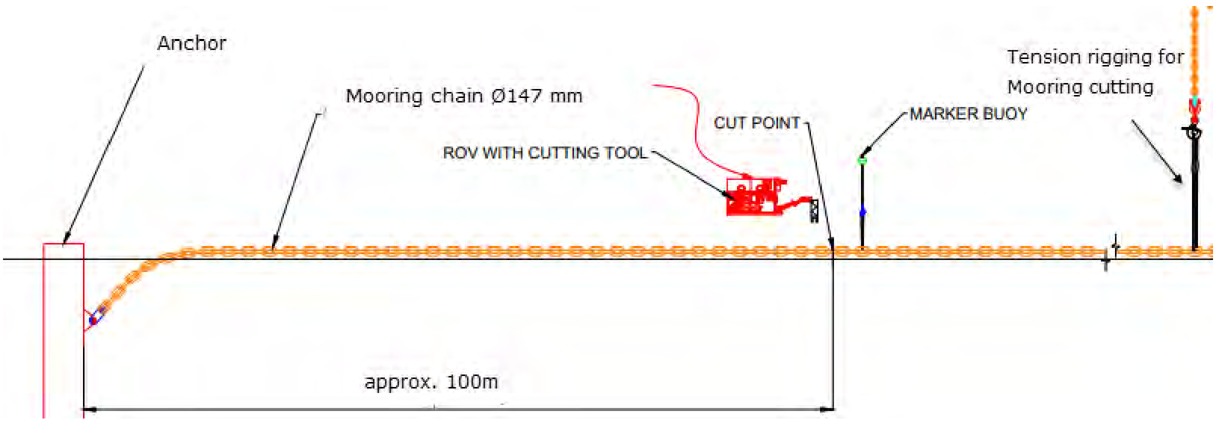


Figure 6-1: ML#2 cutting operation

Step 2:

- Recover ML#2 (Temporary removed chain) to vessel ref. Figure 6-2 and Figure 6-3

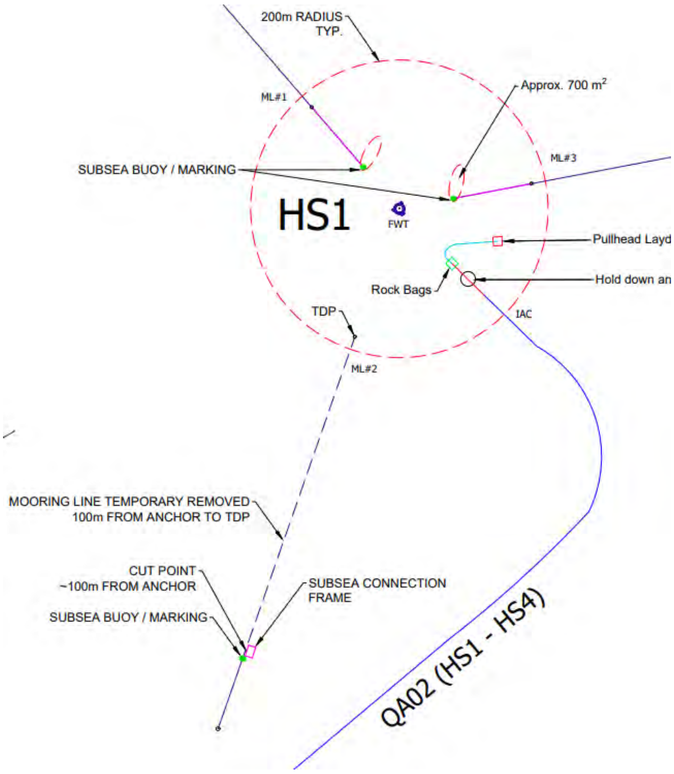


Figure 6-2: Impact area of temporary removed mooring line ML#2

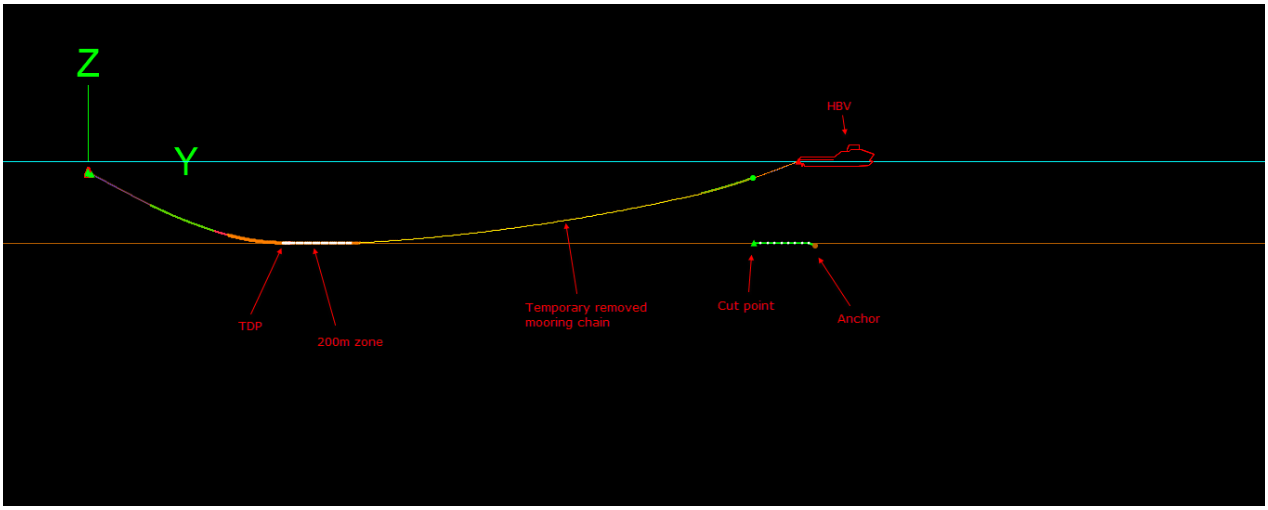


Figure 6-3: ML#2 Recovery operation

Preparatory work prior to reconnection:

- Install Subsea connection frame (SCF) on seabed mattress
- Connect ML#2 (Anchor side) to H-link in SCF ref. Figure 6-4

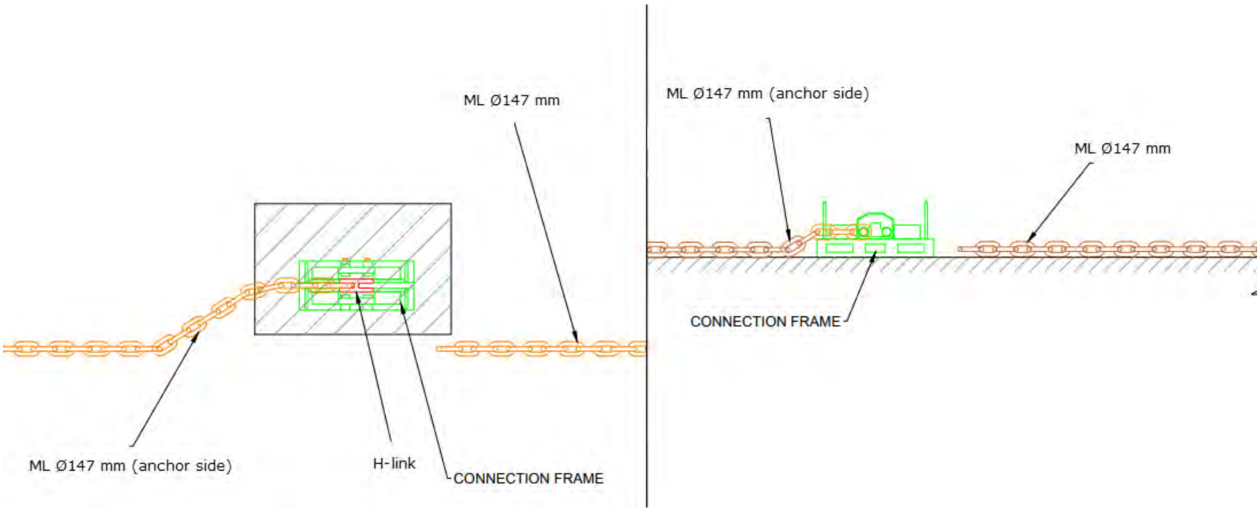


Figure 6-4: Installation of SCF and connection of ML#2 (anchor side from cut point)

Reconnection of FWT ML#2:

Step 1:

- HBV to deploy ML#2 (Temporary removed mooring line), create overlay and maintain tension for overlay ref. Figure 6-5
- ROV to cut soft sling ref. Figure 6-6

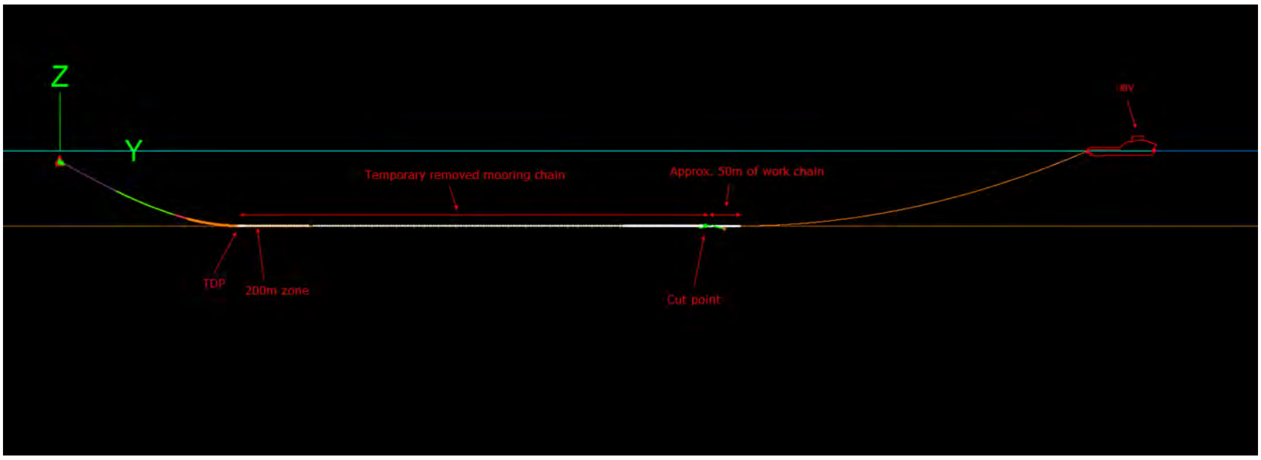


Figure 6-5: Deployment of ML#2

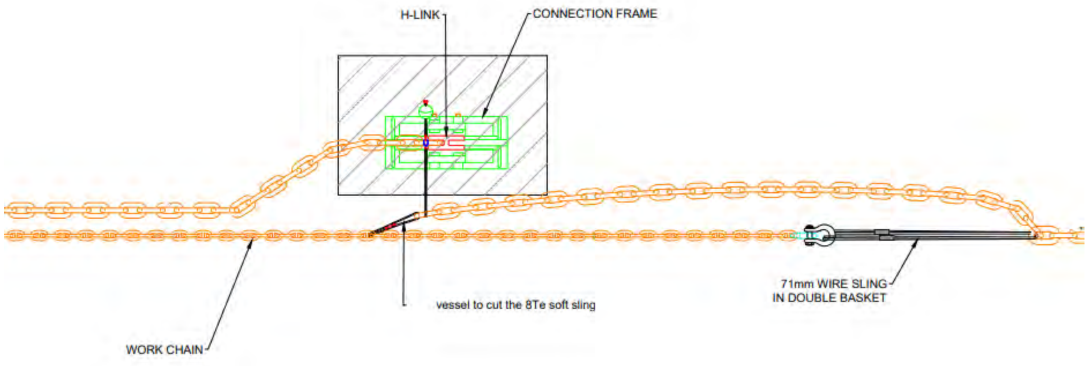


Figure 6-6: ML#2 overlay creation

Step 2:

- HBV to maintain tension while CSV lifts chain into SCF
- CSV to lift chain out of SCF and recover subsea mat and SCF to deck ref. Figure 6-7

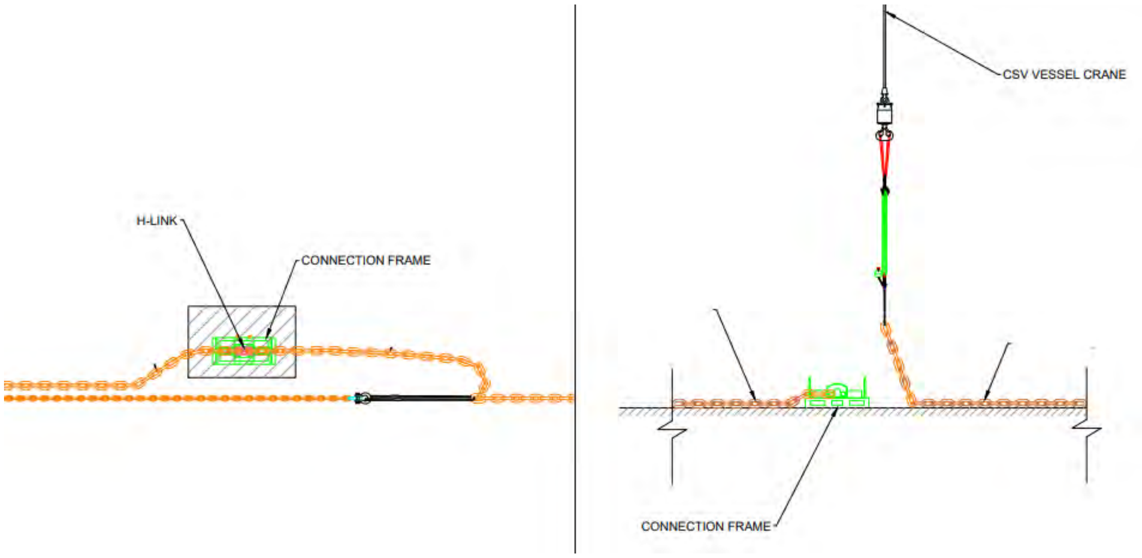


Figure 6-7: ML#2 reconnection

Comparison of Original Method and Simplified Method ML#2

Figure 6-8 and Figure 6-9 show the seabed impact areas for the original and simplified methods respectfully. Observe that this option only impact ML#2, methodology for ML#1 and ML#3 is unchanged. For detailed information on seabed impact for each turbine see Appendix E, for the original methodology see sheets 1 – 5, while for the *simplified methodology see sheets 6 – 10.*

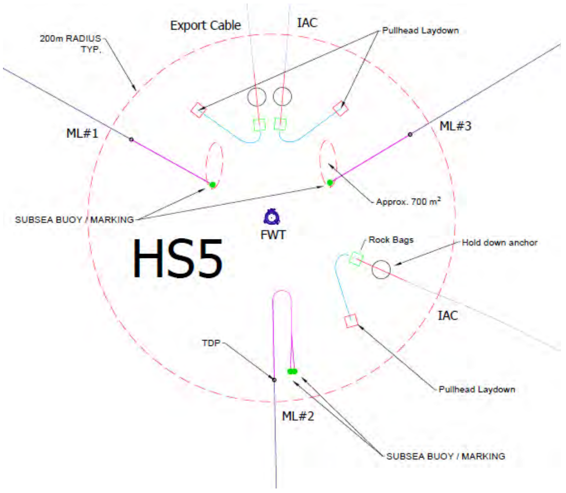


Figure 6-8: Original method seabed impact

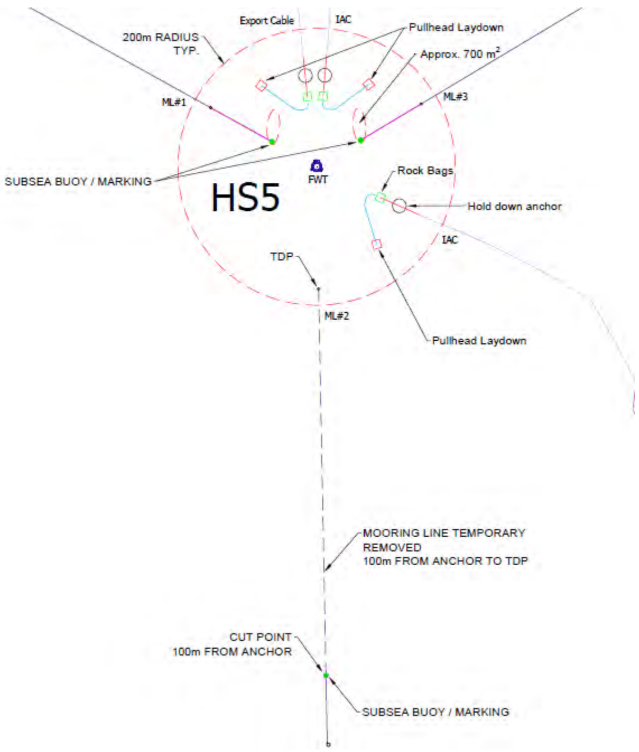


Figure 6-9: Simplified method seabed impact

Table below shows change in impact area of disconnection and reconnection on virgin seabed for the two methodologies for a single turbine.

Table 6-1: Impact area vs. methodology comparison for a single turbine

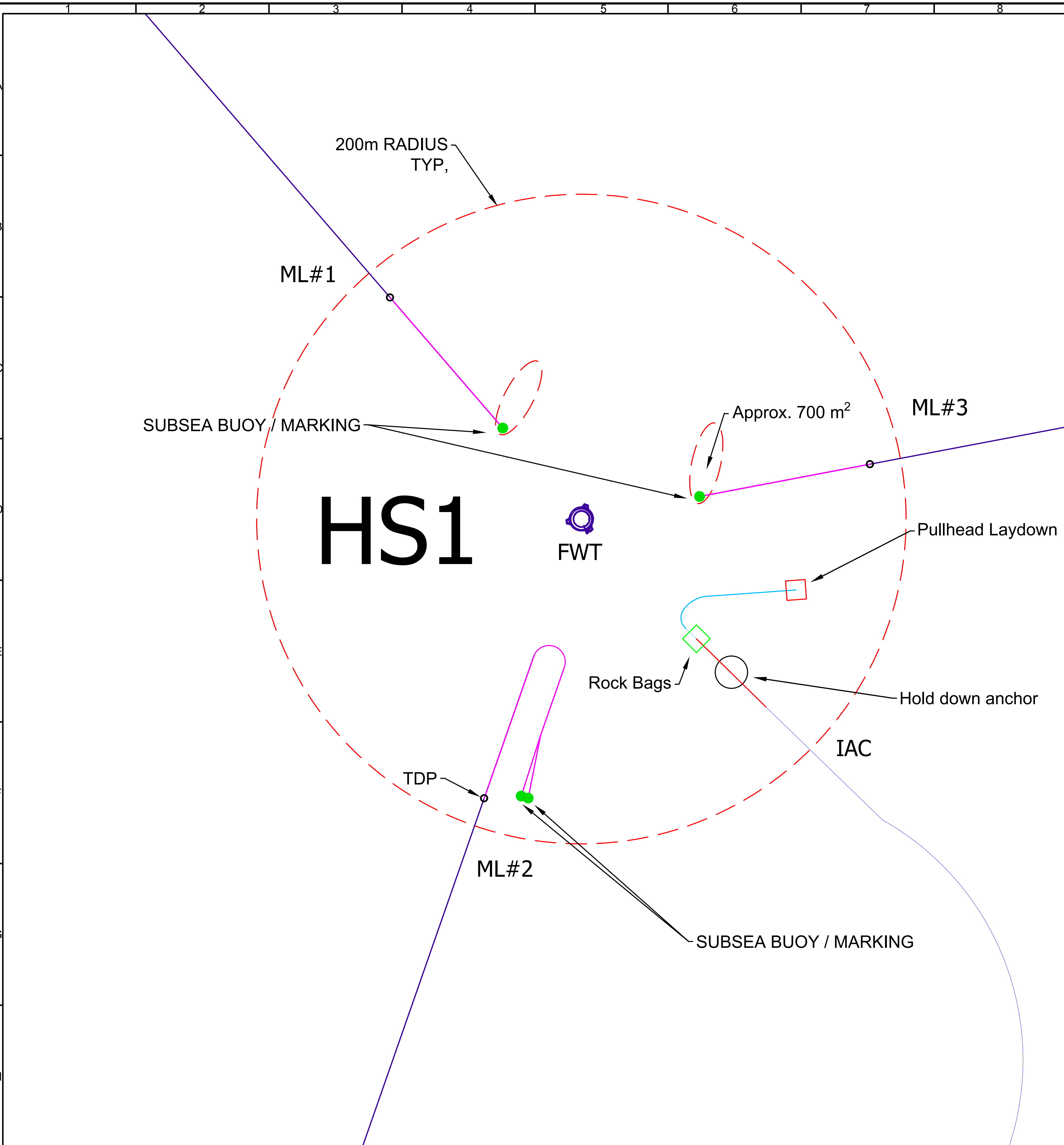
	Original methodology [m2]	Simplified methodology [m2]	Difference [m2]
Chain	115	42	-73
Subsea connection frame (SCF) including subsea mattress	0	16	16
Difference	-	-	-57

Table 6-2: Subsea connection frame wight and dimension

Equipment	Quantity	Dimension LxWxH [mm]	Weight (air/seawater) [kg]	Material
SCF	1	$3843 \cdot 1421 \cdot 1340$	3119	S355 EN 10025
Subsea mattress (Pipemat or mudmat)	1	$4000 \cdot 4000 \cdot 50$	323/55	High Density Polyethylene

APPENDIX E MOORING LAYDOWN

[Drawings describing the mooring laydown for all FWTs can be seen on the next page]



NOTE:

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- FINAL LAYDOWN CONFIGURATION IS PENDING SITE SURVEY
- LIGHT COLORS (Light pink and light blue) INDICATES LAID DOWN CHAIN/CABLE.
- 20m CORRIDOR TO BE SURVEYED AT EACH CHAIN/CABLE TO BE LAID DOWN.
- TDP IS APPLICABLE TO FWT IN OPERATING MODE

MATRESSES (not to scale)
ROCK BAGS (not to scale)
SUBSEA BUOY/MARKING (not to scale)
TDP of ML in operating mode

Rev no.	Description	Rev date	Drawn by	Draw. check	Eng. check	Project appr.
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–	–	–	–	–	–	–
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01	ISSUED FOR INFORMATION	24.11.23	AI	XXX	XXX	XXX

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CLIENT: equinor

TITLE
HYWIND SCOTLAND
MOORING DISCONNECTION & LAYDOWN
STORYBOARD SHEET 1 OF 10
HS1 - ORIGINAL METHOD

ORG. SIZE	SCALE	CLIENT NO.	DRAWING NO.	REV.
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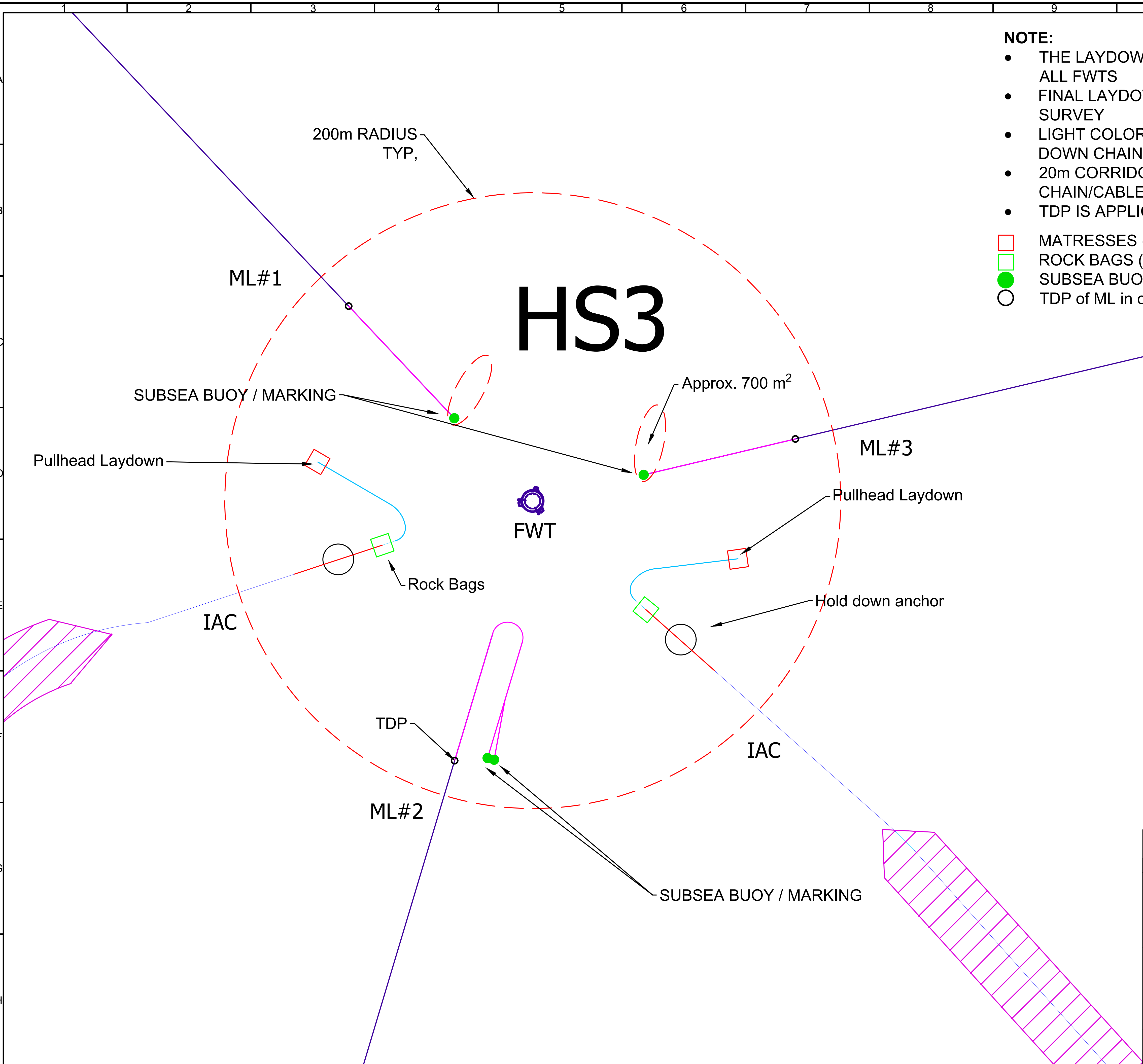

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ROCK BAGS (not to scale)
SUBSEA BUOY/MARKING (not to scale)
TDP of ML in operating mode

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TITLE
HYWIND SCOTLAND
MOORING DISCONNECTION & LAYDOWN
STORYBOARD SHEET 3 OF 10
HS3 - ORIGINAL METHOD

ORG. SIZE	SCALE	CLIENT NO	DRAWING NO.	REV.
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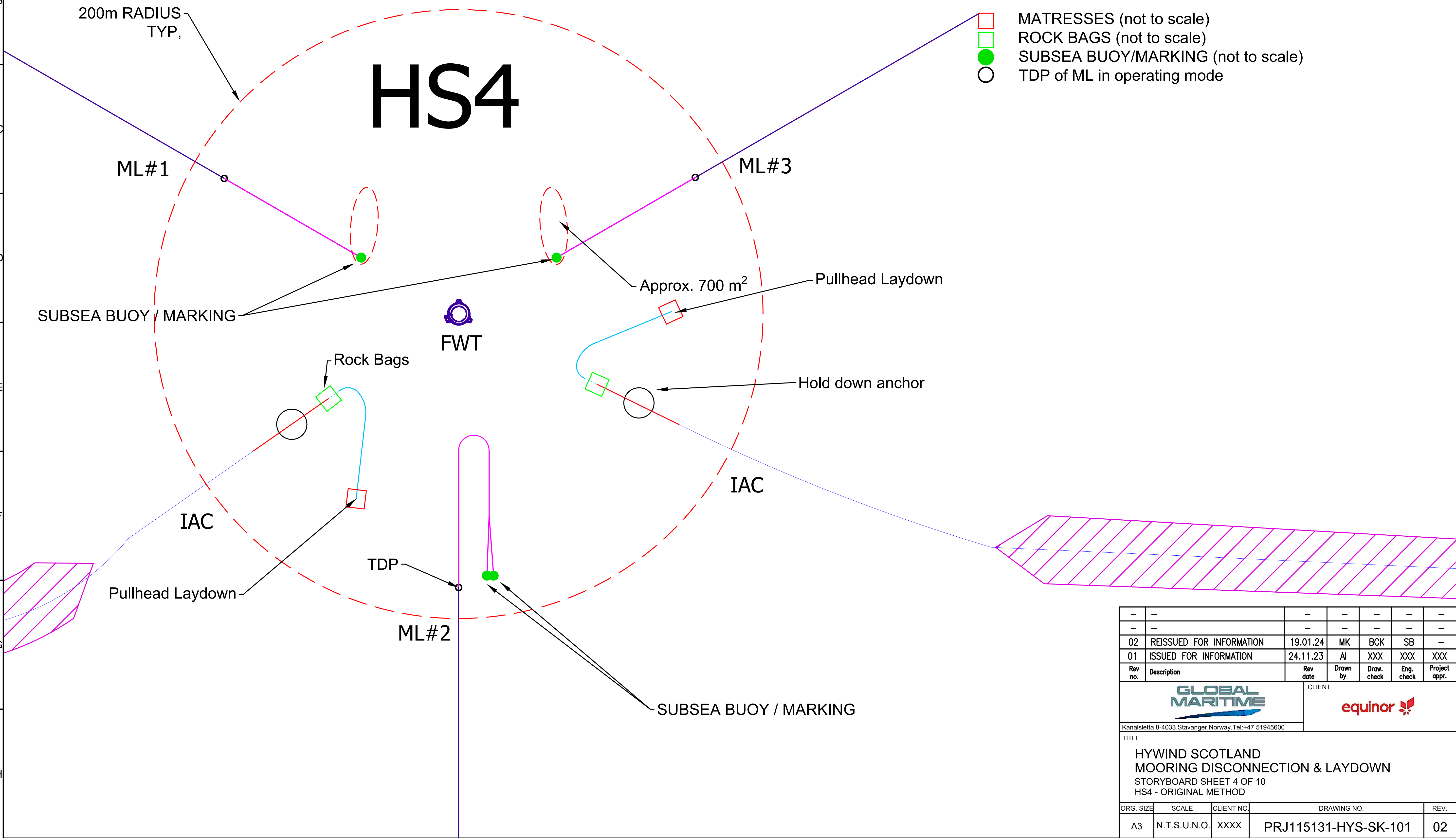
- TDP IS APPLICABLE TO FWT IN OPERATING MODE

MATRESSES (not to scale)
ROCK BAGS (not to scale)
SUBSEA BUOY/MARKING (not to scale)
TDP of ML in operating mode



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01	ISSUED FOR INFORMATION	24.11.23	AI	XXX	XXX	XXX

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TITLE
HYWIND SCOTLAND
MOORING DISCONNECTION & LAYDOWN
STORYBOARD SHEET 4 OF 10
HS4 - ORIGINAL METHOD

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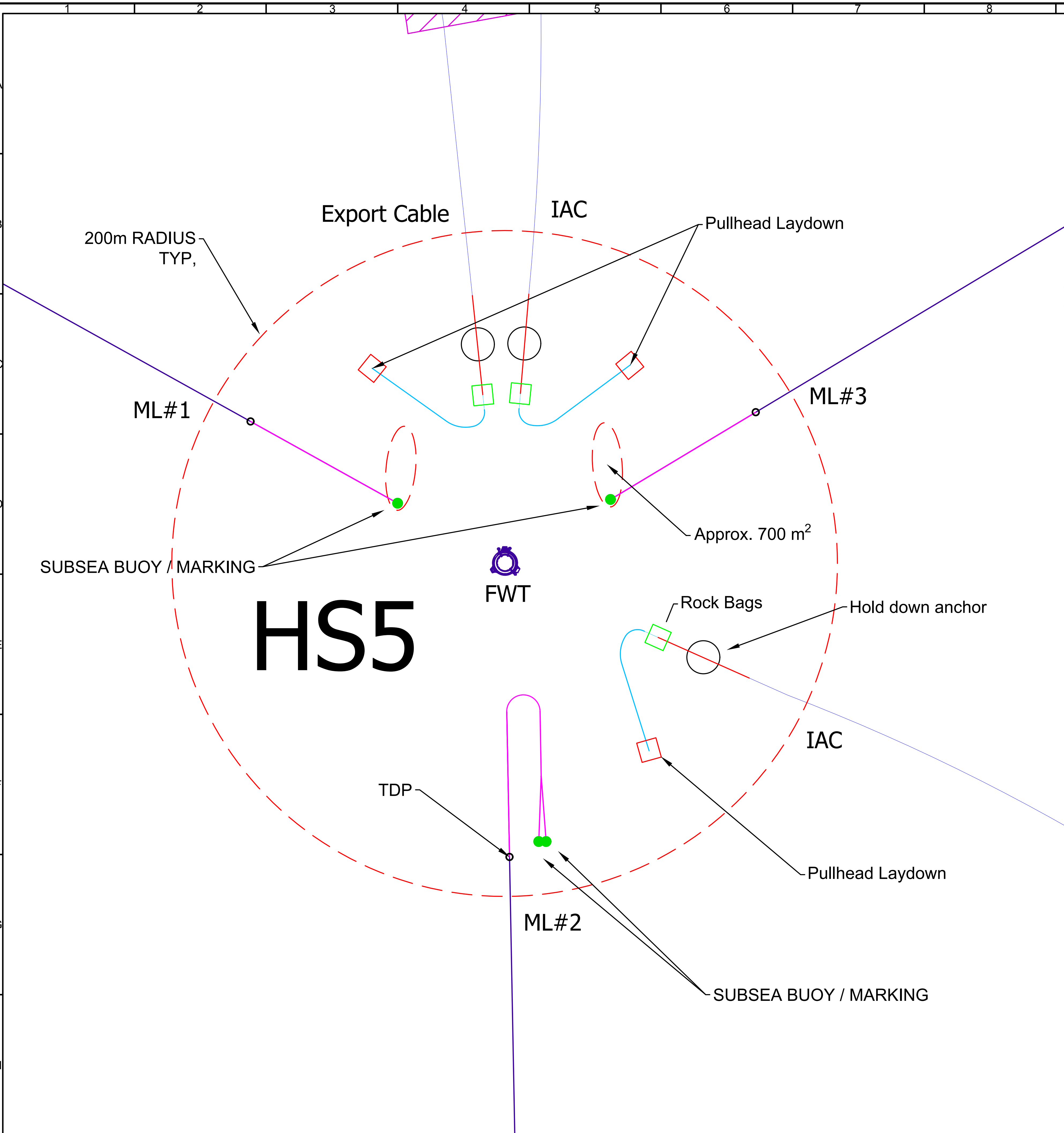

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MATRESSES (not to scale)
ROCK BAGS (not to scale)
SUBSEA BUOY/MARKING (not to scale)
TDP of ML in operating mode

Rev no.	Description	Rev date	Drawn by	Draw. check	Eng. check	Project appr.
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TITLE
HYWIND SCOTLAND
MOORING DISCONNECTION & LAYDOWN
STORYBOARD SHEET 5 OF 10
HS5 - ORIGINAL METHOD

ORG. SIZE	SCALE	CLIENT NO	DRAWING NO.	REV.
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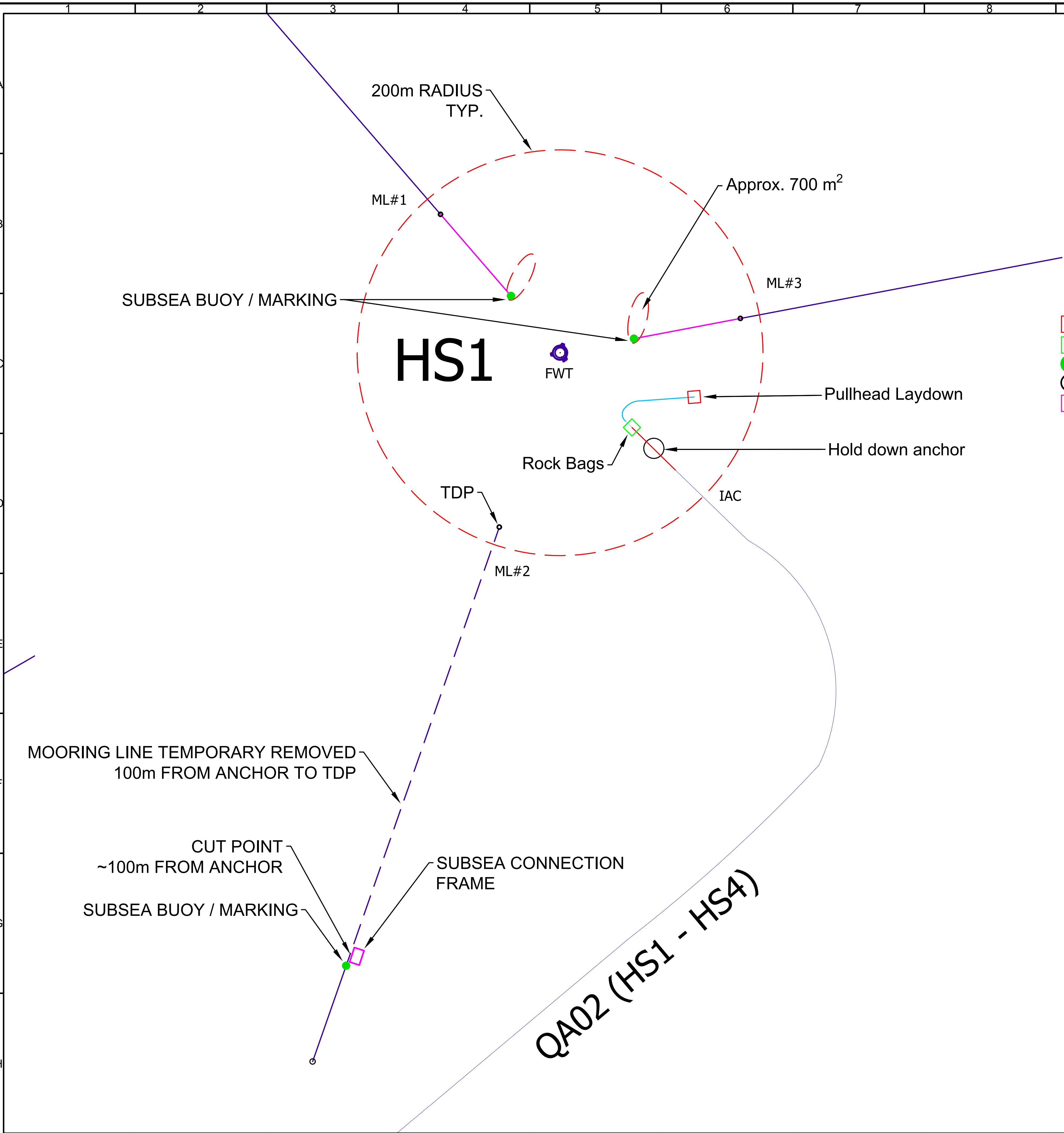

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- SUBSEA CONNECTION FRAME TO BE POSITIONED IN MOST OPTIMAL LOCATION ON SEABED WITHIN MOORING CHAIN CORRIDOR

MATRESSES (not to scale)
ROCK BAGS (not to scale)
SUBSEA BUOY/MARKING (not to scale)
TDP of ML in operating mode
SUBSEA CONNECTON FRAME (not to scale)

Rev no.	Description	Rev date	Drawn by	Draw. check	Eng. check	Project appr.
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–	–	–	–	–	–	–
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01	ISSUED FOR INFORMATION	24.11.23	AI	XXX	XXX	XXX

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TITLE
HYWIND SCOTLAND
MOORING DISCONNECTION & LAYDOWN
STORYBOARD SHEET 6 OF 10
HS1 - SIMPLIFIED METHOD

ORG. SIZE	SCALE	CLIENT NO	DRAWING NO.	REV.
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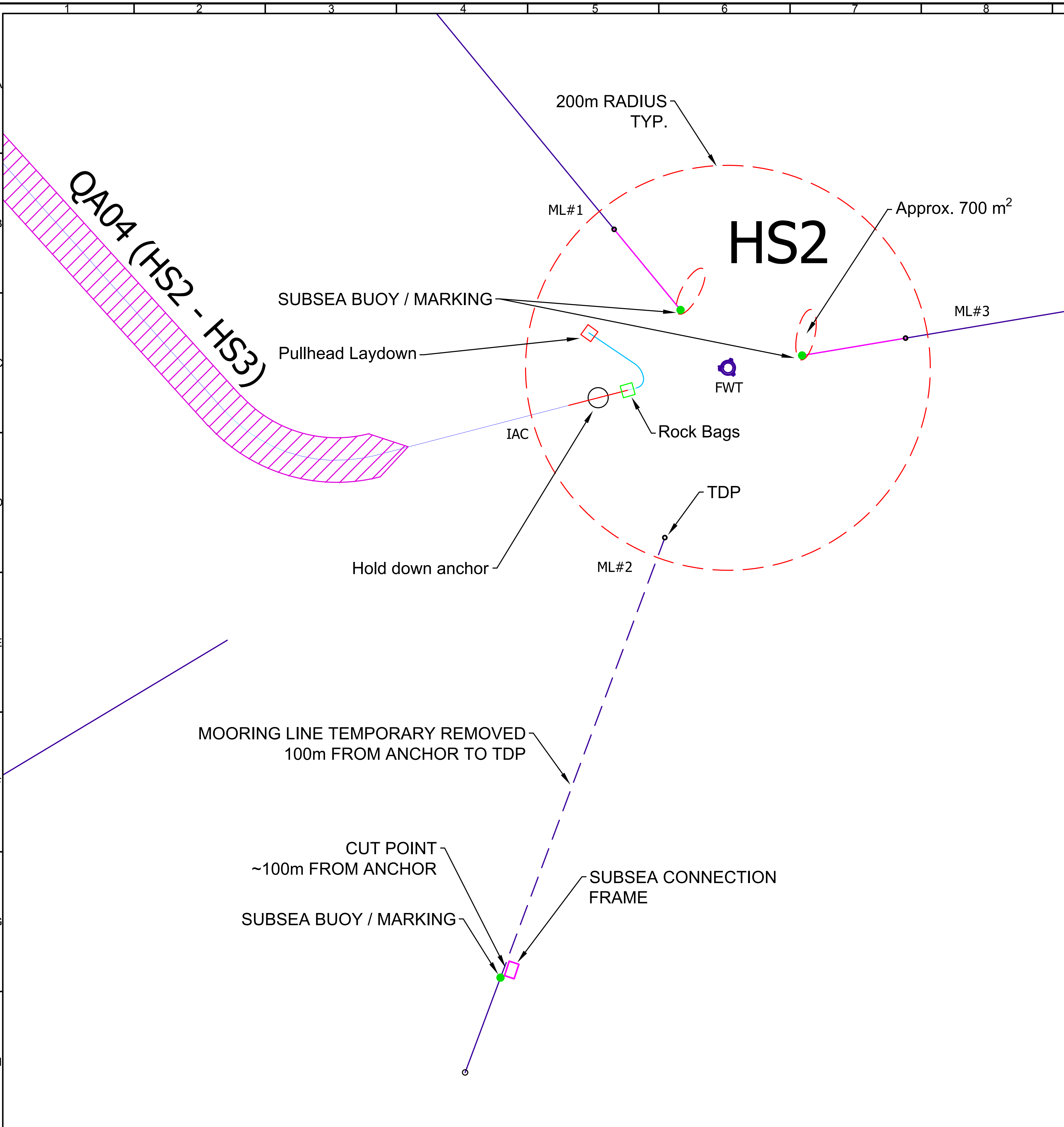

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MATRESSES (not to scale)
ROCK BAGS (not to scale)
SUBSEA BUOY/MARKING (not to scale)
TDP of ML in operating mode
SUBSEA CONNECTON FRAME (not to scale)

Rev no.	Description	Rev date	Drawn by	Draw. check	Eng. check	Project appr.
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–	–	–	–	–	–	–
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HYWIND SCOTLAND
MOORING DISCONNECTION & LAYDOWN
STORYBOARD SHEET 7 OF 10
HS2 - SIMPLIFIED METHOD

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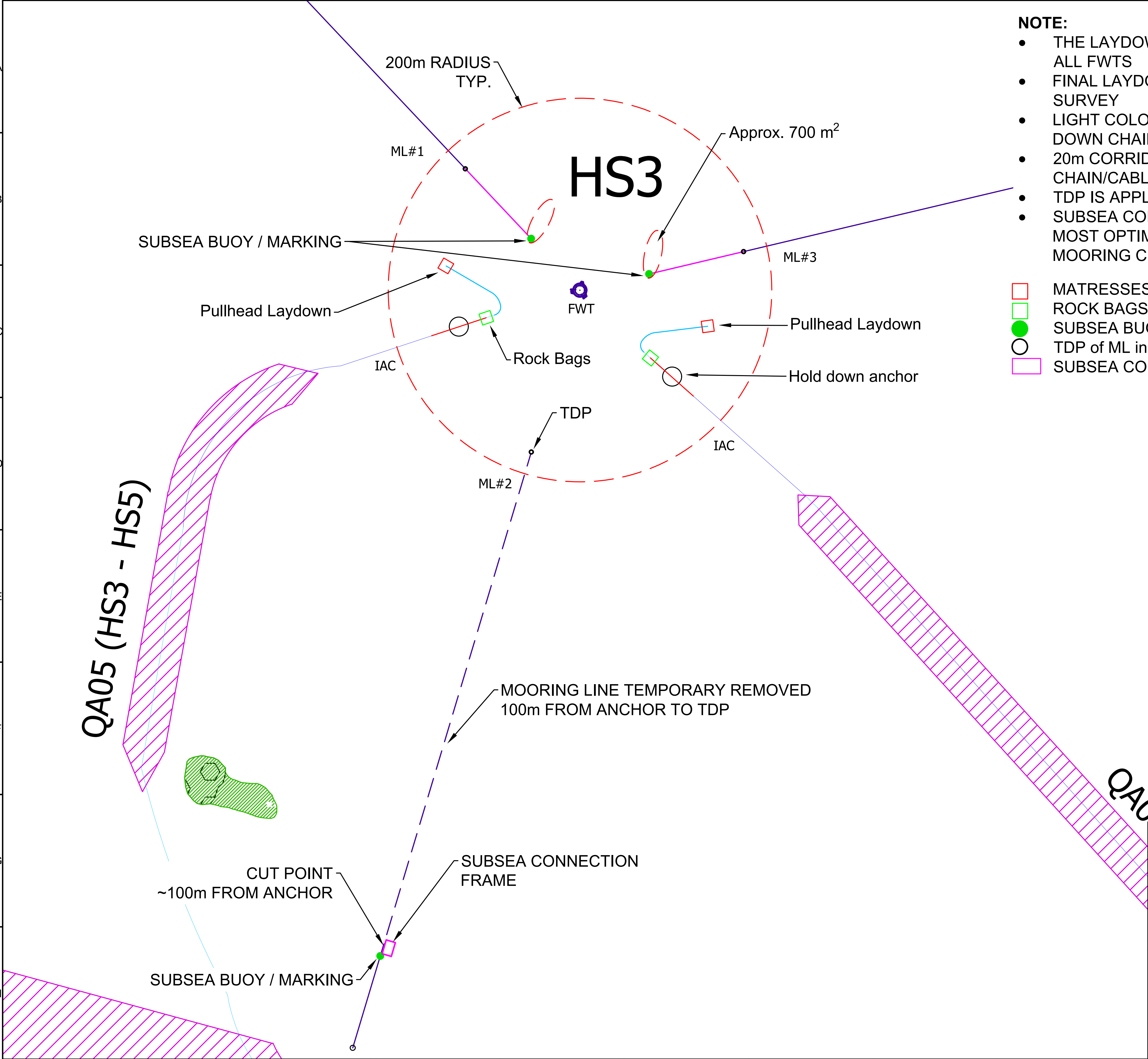

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ROCK BAGS (not to scale)
SUBSEA BUOY/MARKING (not to scale)
TDP of ML in operating mode
SUBSEA CONNECTON FRAME (not to scale)

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HYWIND SCOTLAND
MOORING DISCONNECTION & LAYDOWN
STORYBOARD SHEET 8 OF 10
HS3 - SIMPLIFIED METHOD

ORG. SIZE	SCALE	CLIENT NO.	DRAWING NO.	REV.
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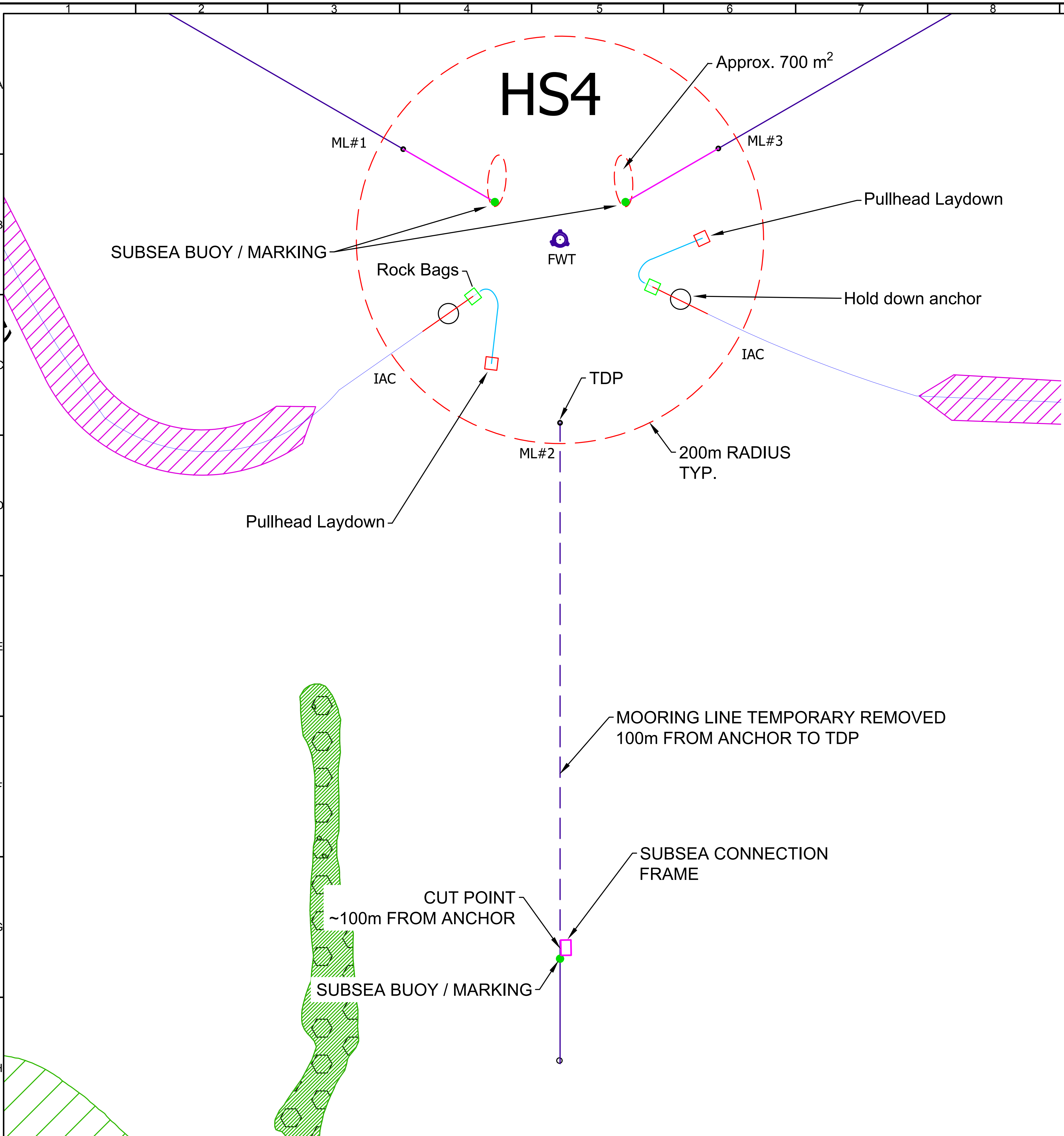

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MATRESSES (not to scale)
ROCK BAGS (not to scale)
SUBSEA BUOY/MARKING (not to scale)
TDP of ML in operating mode
SUBSEA CONNECTON FRAME (not to scale)

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TITLE
HYWIND SCOTLAND
MOORING DISCONNECTION & LAYDOWN
STORYBOARD SHEET 9 OF 10
HS4 - SIMPLIFIED METHOD

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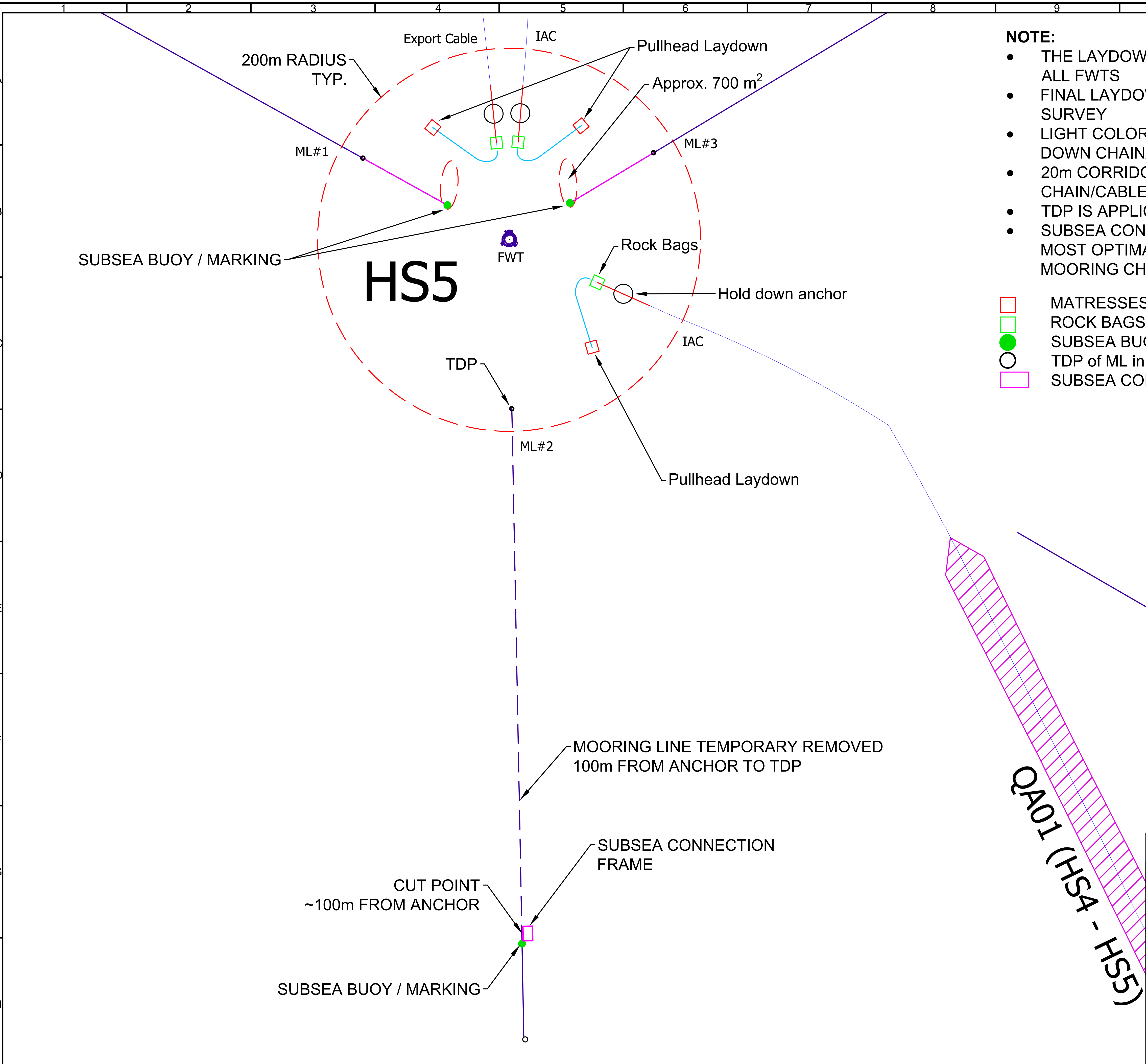

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MATRESSES (not to scale)
ROCK BAGS (not to scale)
SUBSEA BUOY/MARKING (not to scale)
TDP of ML in operating mode
SUBSEA CONNECTON FRAME (not to scale)

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HYWIND SCOTLAND
MOORING DISCONNECTION & LAYDOWN
STORYBOARD SHEET 10 OF 10
HS5 - SIMPLIFIED METHOD

ORG. SIZE	SCALE	CLIENT NO	DRAWING NO.	REV.
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APPENDIX F WEATHER BUOY INFORMATION

General

A weather buoy will be installed at the Hywind Scotland field prior to commencing the preparatory work at the FWTs and will be removed at the end of the project.

The following position for the weather buoy has been chosen, in agreement with the surveyed area from *GM-PRJ116276-MO-PRO-0001 Hywind Scotland Main Component Exchange - Survey Procedure.*

Latitude: 57º 28’ 26.706” N

Longitude: -1º 23’ 33.468” E

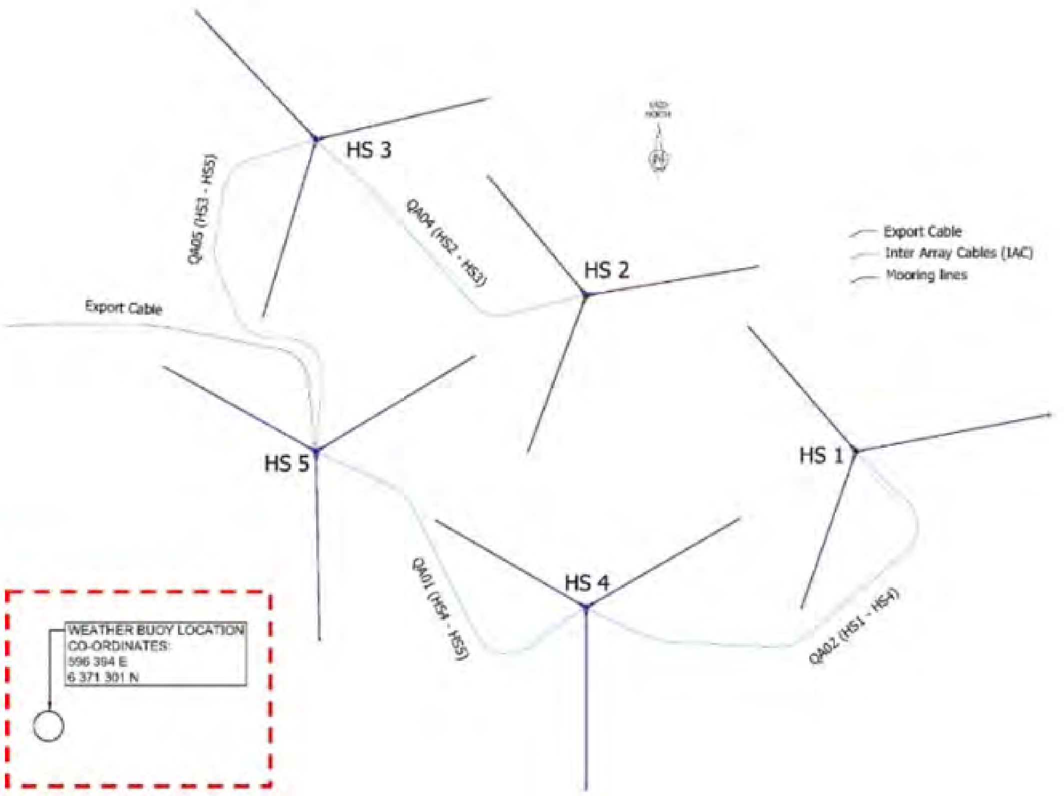

Figure 6-10: Weather buoy location at Hywind Scotland field

Installation (For illustration reasons only, the weather buoy will be similar to information given below)

The weather buoy will either be installed by an AHV or SOW and contain a Seawatch mid buoy (approx. weight: 550kg) with a clump weight of approximately 1000kg which will be laid at the seabed. See Figure 2-1Figure 6-11 - Figure 6-13 for illustration of weather buoy installation, ballast weight and dimensions.

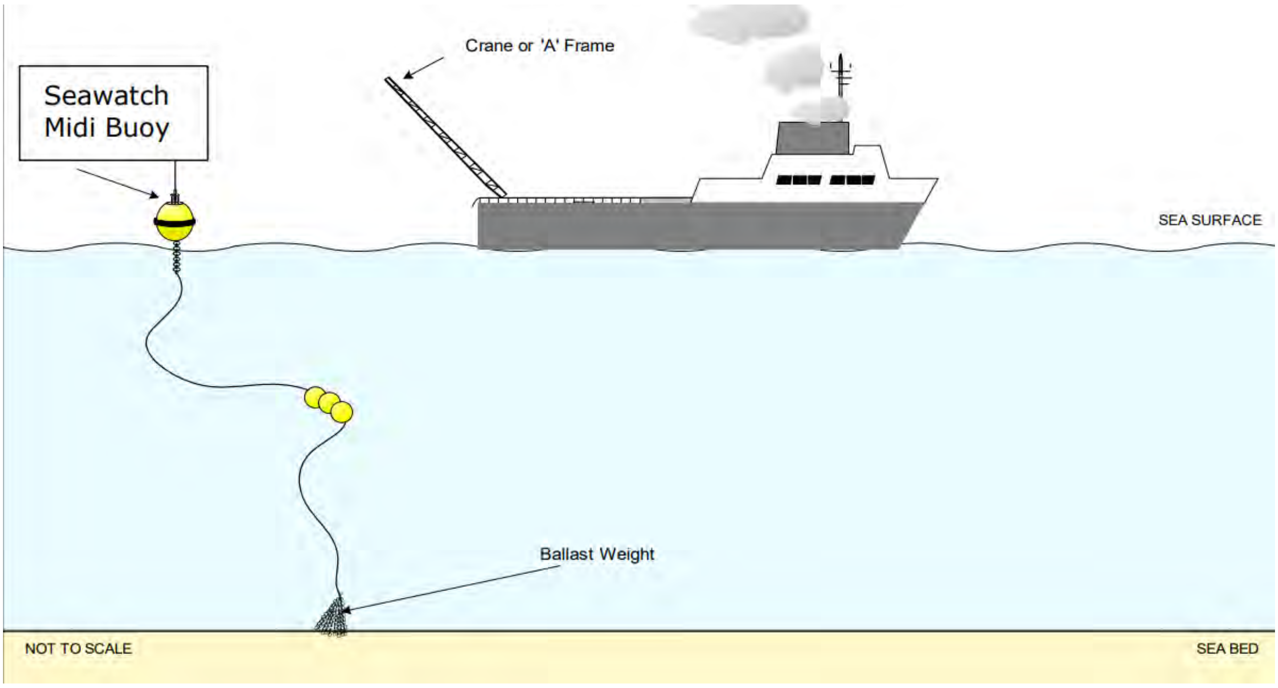

Figure 6-11: Illustration of weather buoy installation

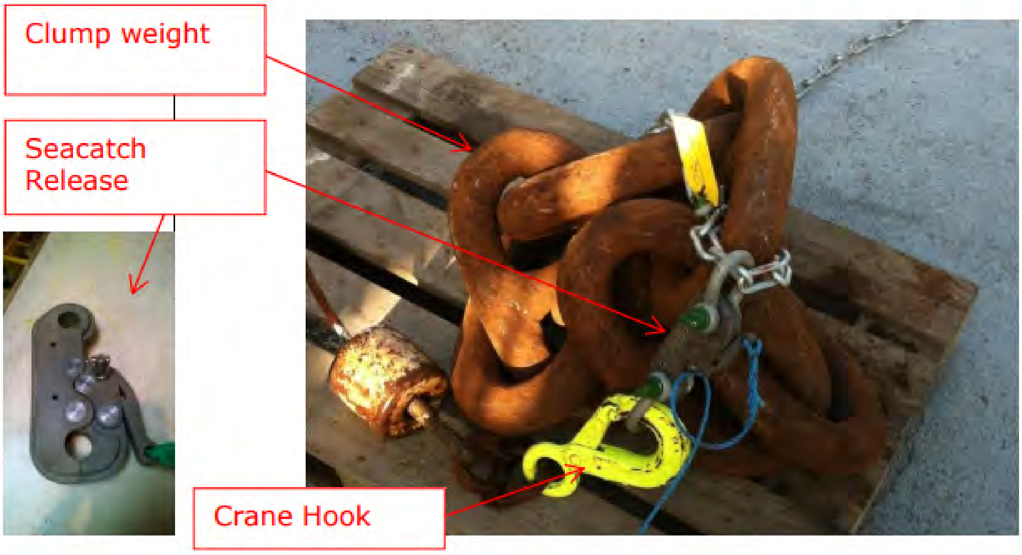

Figure 6-12: Example of clump weight (Typical weight approx. 1000kg)

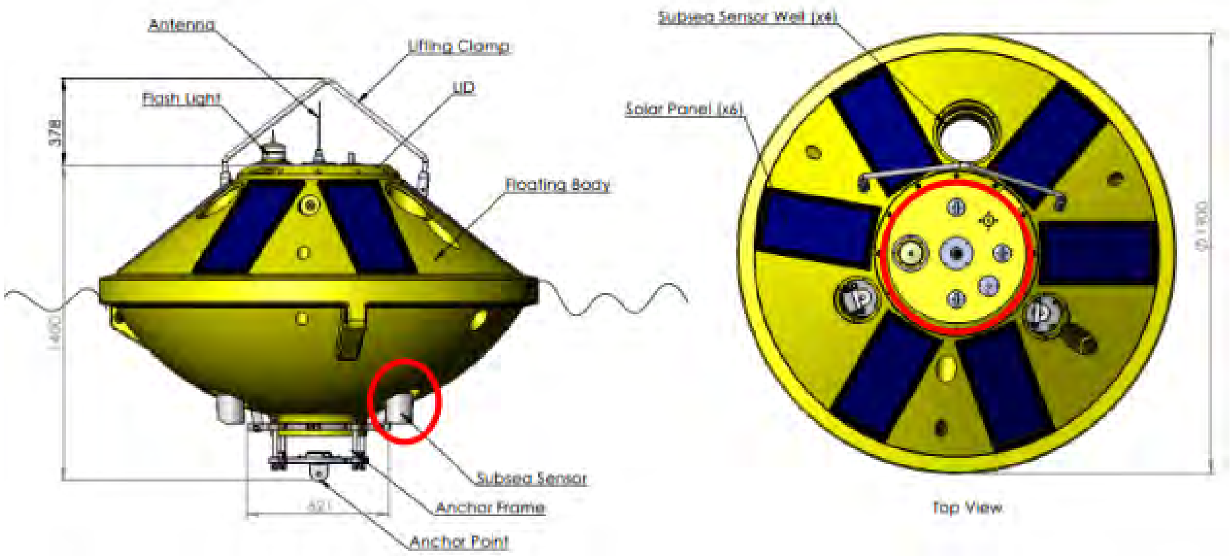

Figure 6-13: Typical dimensions of the weather buoy

Appendix 2 Hywind Scotland Pilot Park Visual Benthic Survey

HYWIND SCOTLAND

Visual benthic survey

EQUINOR ENERGY AS

Report no.: 2023-1273, Rev. 0
Document no.: 2083235
Date: 2024-01-08

Project name:	Hywind Scotland	DNV AS Energy Systems
Report title:	Visual benthic survey	Environmental Risk Nordics
Customer:	EQUINOR ENERGY AS, Forusbeen 50 4035 Stavanger Norway	Veritasveien 1, 1363 Høvik Norway
Customer contact:	Guillaume Vines-Gravey	
Date of issue:	2024-01-08	Tel: +47 67 57 99 00
Project no.:	10483568	945 748 931
Organization unit:	Environmental Risk Mgt Nordics-4100-NO	
Report no.:	2023-1273, Rev. 0	
Document no.:	2083235	

Applicable contract(s) governing the provision of this Report: Framework Agreement no. 4600022577

Objective:

Prepared by:	Verified by:	Approved by:
Amund Ulfsnes Marine biologist/Principal consultant	Thomas Møskeland Marine biologist/Senior principal consultant	Tor Jensen Vice President - Head of Section
Annecken Nøland Environmental consultant		
Emma Høgh Åslein Environmental consultant		

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Keywords Visual survey, Hywind, Sabellaria

Rev. no.	Date	Reason for issue	Prepared by	Verified by	Approved by
A	2023-12-21	Draft issue	ULAM	THM	TJEN
B	2023-12-22	2nd Draft	ULAM	THM	TJEN

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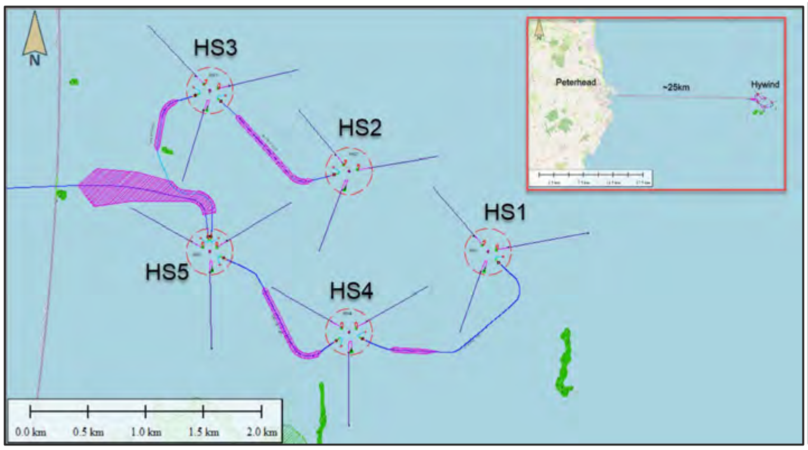
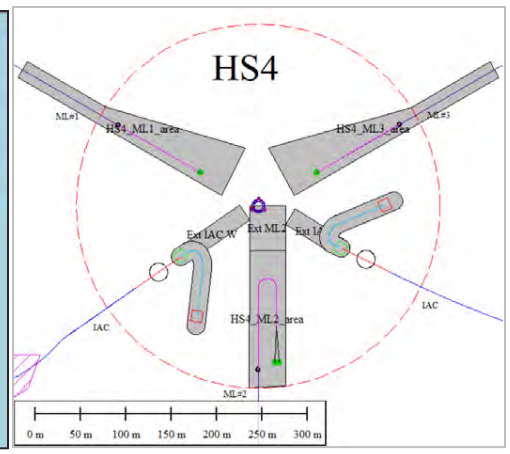
Table of contents

1 EXECUTIVE SUMMARY

On behalf of Equinor Energy ASA, DNV has performed a benthic visual survey at Hywind Scotland (HyS) in the period 6th - 16th of December 2023. The benthic visual survey was performed in the planned lay down areas where cables, mooring lines and other equipment are to be landed on the seabed as part of planned maintenance of the turbines in 2024. The result from the visual surveys is intended used in the planning of the disconnecting operations to minimize the influence on the benthic communities at HyS.

The wind park is located~25km east of Peterhead (Scotland) and consist of 5 wind turbines, each with 3 anchors and chain corridors, and 1-2 interconnecting cables and one export cable. The water depth within the wind park varies from 100-120m. Previous surveys east of Peterhead (Scotland) has revealed presence of *Sabellaria spinulosa* reefs. Sabellaria reefs are identified by OSPAR and is on a list of threatened and/or declining species and habitats.

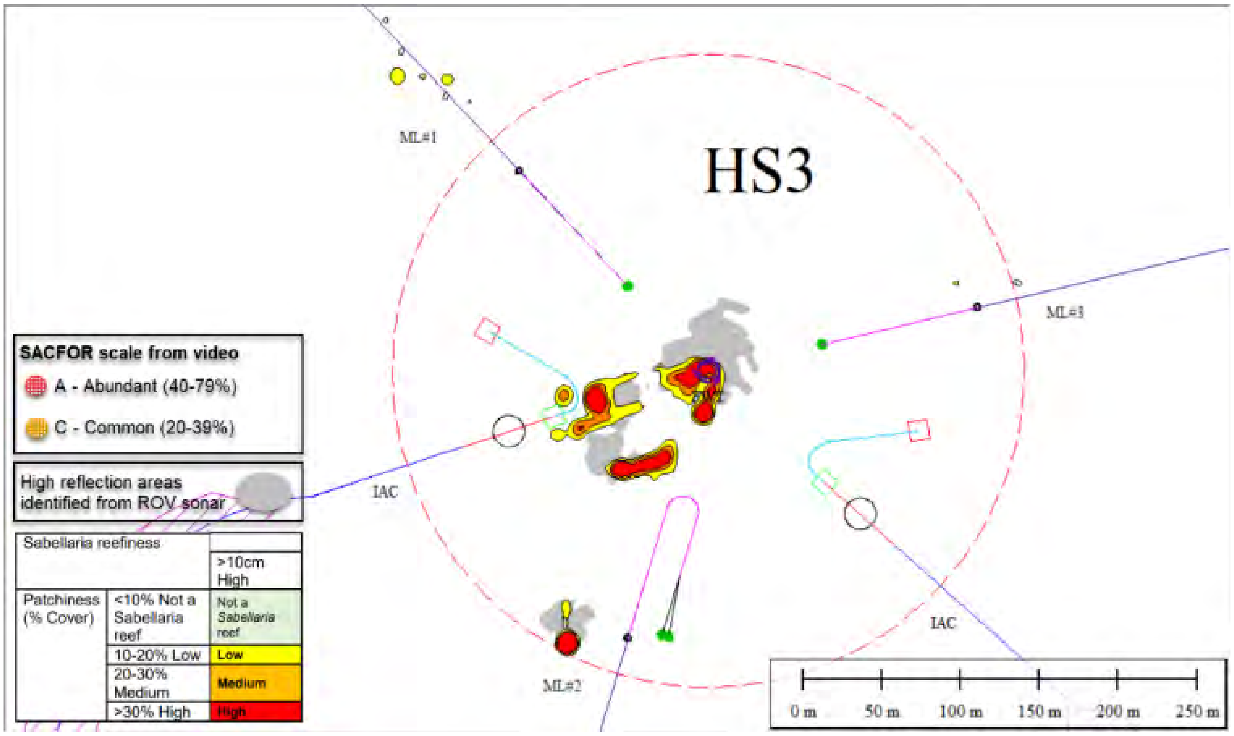


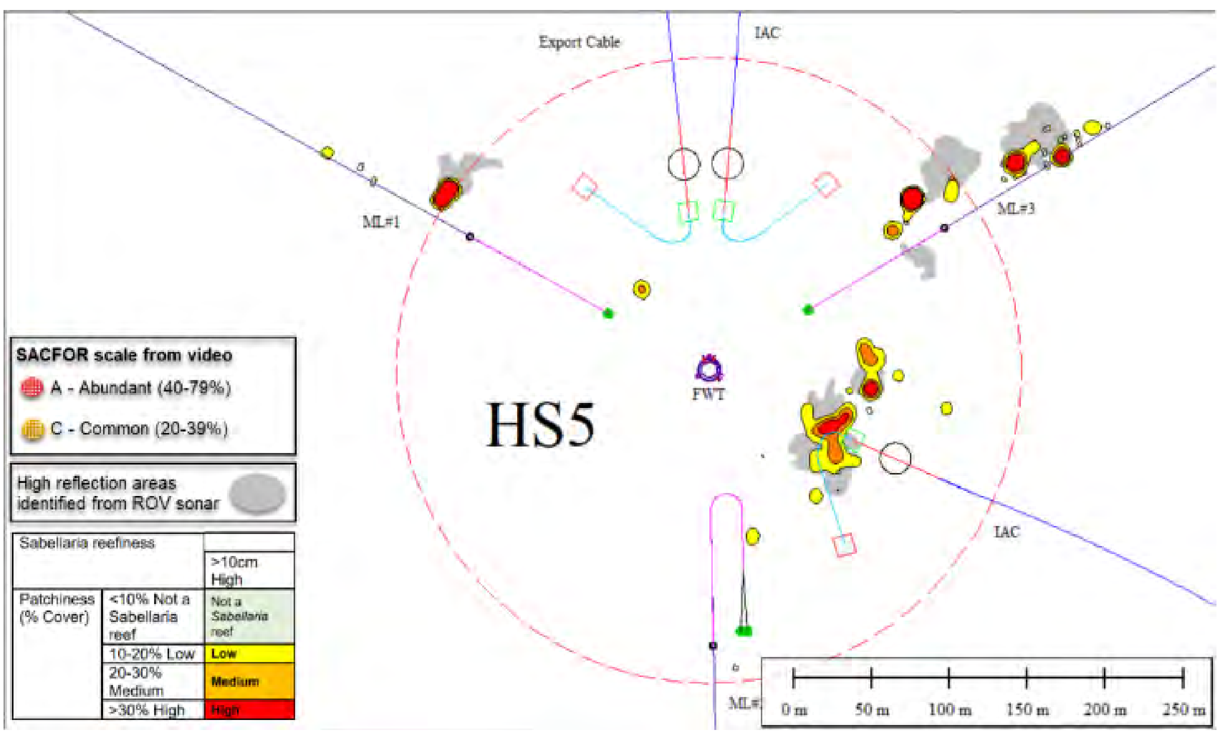


The Hywind Scotland wind farm with five wind turbines (HS1 to HS5), and potential lay-down areas (●) where the visual survey has been carried out (example from turbine HS4)

Within each lay-down area, the visual survey was performed with ~10m line spacing. Along with actively use of the ROV sonar during the survey for identification high-reflection areas, the lay-down areas are considered to have been thoroughly surveyed. The survey revealed presence of *Sabellaria spinulosa,* and a detailed analysis were performed which resulted in an environmental resource map to be used in the planning of the upcoming operations at the wind park.

Sabellaria observations are classified in accordance with SACFOR scale for image analysis (coverage in %), patchiness assessment for reef classification based on presence/absence observations and along with ROV sonar reflection assessment were the basis for the developed and proposed resource map. Of the five wind turbines, possible conflicting areas between the planned operation and *Sabellaria* communities have been identified at turbines 3 and 5 (see figures and table below).





Proposed environmental resource map to be used in the planning of the upcoming operations at Hywind Scotland for turbine HS3 and HS5.

Assessment of conflicting areas between planned operations and Sabellaria reef areas.

Possible conflicting area	Assessment	Recommendation
HS5 – IAC Southeast	The planned cable lay-down area may possibly conflict with identified Sabellaria communities.	Consider use of mitigating action (e.g use of buoyancy modules over the reef to reduce lay down area to minimize influence on the *Sabellaria* community or adjusting lay down route further south). High focus on operational accuracy during the lay down operations.
HS5 – ML3	The planned anchor lay-down area is not in direct conflict with the identified *Sabellaria* community. Touches parts of the ROV sonar reflection area, but there are few rare observations in category "rare". There are higher density areas north of the line which should be avoided	Use planned lay-down corridor to avoid higher density *Sabellaria* areas north of the line
HS3 – IAC Southwest	Planned cable is in between high density *Sabelleria* areas and not in direct conflict.	High focus on operational accuracy during the lay down operations to avoid high density *Sabellaria* areas on both sides of the planned cable corridor.
HS3 – Lay-down area nearby turbine	Temporarily cable/chain contact with seabed during the disconnecting operation could be in direct conflict with the identified *Sabellaria* communities	Consider the operational solution and touching areas to minimize influence on the *Sabellaria* community.
Existing chain corridors	Both along and on anchors chains there are observations of *Sabellaria*. There are already significant sideways movement of the chains, especially close to the touch down location.	Minimize alteration of the horizontal direction of the existing chain to limit the influence area.

Other findings

Fauna observations

- No other species or habitats identified are evaluated as threatened or have a protective status.
- Previously observation proposed as possible cold-water coral *Desmophyllum pertusum* is not a coral but a lacy tubeworm cf *Filograna implexa.*

Observed influence in the area from the wind park

- There is significant influence on the seabed within the anchor corridors from touch down out to approximately 50-100m. Apparently the chain movement cause depressions in the seabed up 2 m deep and up to 15m wide.
- There are moderate densities of shell debris underneath the turbines and the free span of the anchor chains.
- The garbage observed doesn't necessarily derives from the wind park.

2 INTRODUCTION

On behalf of Equinor Energy ASA, DNV has in collaboration with Global Maritime (GM) and DOF at the vessel Skandi Vega performed a benthic visual survey at Hywind Scotland (HyS) n the period 6th -16th of December 2023. The benthic visual survey was performed in the planned lay down areas where cables, mooring lines and other equipment are to be landed on the seabed as part of maintenance of the turbines in 2024. The result from the visual surveys is intended used in the planning of the disconnecting operations to minimize the influence on the benthic communities at HyS.

The wind park is located~25km east of Peterhead (Scotland) and consist of 5 wind turbines, each with 3 anchors and chain corridors, and 1-2 interconnecting cables and one export cable (Figure 2-1). The water depth within the wind park varies from 100-120m.

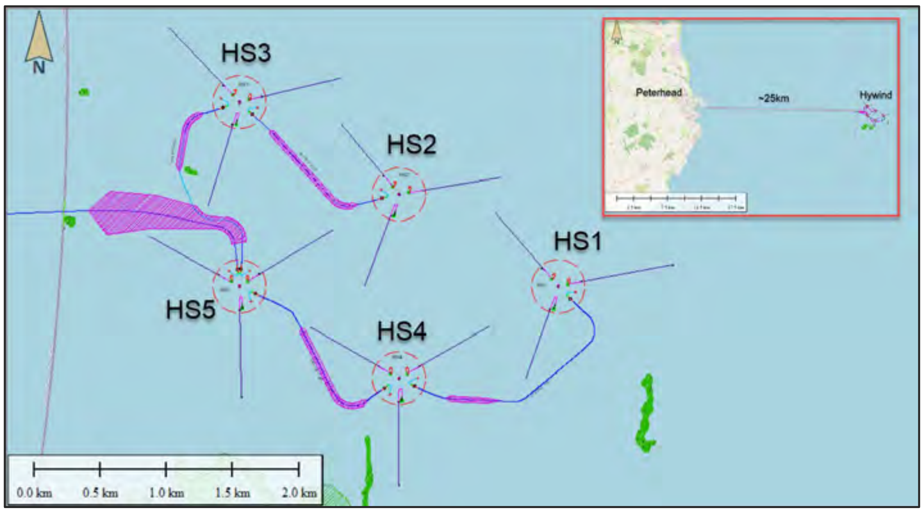


Figure 2-1 The Hywind Scotland wind farm with five wind turbines (HS1 to HS5).

Previous surveys east of Peterhead (Scotland) has revealed presence of *Sabellaria spinulosa* reefs. *Sabellaria* reefs are identified by OSPAR on list for threatened and/or declining species and habitats[1]. When conditions are favourable dense aggregations may be found, forming reefs up to about 60 cm high and extending over several hectares; these are often raised above the surrounding seabed. Reefs may persist in an area for many years although individual clumps may regularly form and disintegrate. A survey performed in 2013 indicated reef areas are found in the vicinity of the wind park especially towards south, but also ~200m off some of the anchor corridors (Figure 2-1). No reef areas are identified within a 200m radius from any of the wind turbines. DNV performed a visual survey at HyS from 200m towards centre in 2022, and no reef complexes where observed.

The objectives of this study are:

- Visually survey all potential lay down areas for benthic communities and habitats.
- In case of any *Sabellaria* findings, visually survey of alternative lay down areas.

[1]Microsoft Word - CH10_04_Sabellaria_spinulosa.doc (ospar.org)

documents (ospar.org)

3 Background

3.1 Previous surveys

Hywind Scotland is the world's first floating offshore wind farm, which came into operation in October 2017. Multiple surveys have been done since then, to investigate how the presence of floating windfarms and their substructures impact the local marine habitat (Table 3-1).

Table 3-1 A summary of previous surveys at the offshore wind park, Hywind Scotland.

Article	Purpose	Main findings
Environmental Survey Report Hywind Offshore Windfarm, Statoil (MMT, 2013).	Complete a geophysical and benthic survey, more specifically a seabed and sub-seabed mapping of the development site and export cable corridor.	Found three different habitats within the survey area: stony reefs, bedrock reefs and *Sabellaria spinulosa* reefs. The latter was observed in both scattered patches and more dense aggregations at 19 out of 34 grab sites. No habitat listed among the Scottish Priority Marine Features (PMFs) was found, but three species were encountered: two sand eel species (*Ammondytes marinus* and *Ammodytes tobianus*) and the ocean quahog (*Arctica islandica*). The seabed was mainly characterized as sand with occasional shell fragments.
Environmental Survey Report, Hywind Offshore Windfarm, Equinor Energy AS. (MMT, 2020).	The purpose was to investigate how the zonation and succession of marine growth had taken place on the substructures and anchor chains, and the interaction between anchor chains and the seabed.	The same zonation patterns were observed on all five substructures, and they resembled the patterns found in other European offshore wind farms. The mooring lines housed the most diversified fauna. The fauna was dominated by sea anemones (*M. senile*), and *S. spinulosa* (polychaeta) and *Ectopleura larynx* (cnidarian) dominated the chain structure. They found a young colony, possibly a species of the deep-water coral *Desmophyllum pertusum*. The seabed was classified as mixed sediment (sand, gravel and occasional boulders).
Artificial hard-substrate colonisation in the offshore Hywind Scotland Pilot Park (Karlsson et al., 2022).	The study aimed to investigate colonisation and zonation, quantify diversity and abundance, and identify any non-indigenous species present within the wind farm area, as well as to describe changes in the epifouling growth between 2018 and 2020.	Identified epifauna and flora were all species indigenous to Scottish waters and the North Sea. The faunal community was dominated by M. senile, and the composition of epifaunal colonisation was similar to colonisation of other artificial structures in the North Sea. Four species featured on the PMFs was found close to the structures: Atlantic cod (*Gadus morhua*), ling (*M. molva*), sand eel (*Ammodytes spp*.) and whiting (*Merlangius merlangus*). The seabed was characterised predominately by sand and gravel.
Environmental benthos survey, Hywind Scotland. Equinor Energy AS (DNV, 2023).	The purpose of the environmental benthos survey in 2022 was to investigate the possible impacts on marine life from the floating offshore wind park. Their survey included three main activities: sediment characterization, biological analysis of macrofauna, and visual assessment of habitats.	The macrofauna at Hywind Scotland has a high diversity, and all stations were evaluated as undisturbed and representing natural macrofauna in the area. No species listed on the PMFs or OSPAR type habitats were registered at the two locations investigated. No observations of S. spinulosa was made. The sediment at Hywind Scotland can in general be classified as fine sand with moderate amounts of shell debris. The seabed closest to the turbines was covered in "low" and "moderate" densities of blue mussel shells originating from the wind turbine and associated anchor chains, the amount of shell debris was not particularly high.

3.2 *Sabellaria spinulosa*

Biology and reef structure complex

Sabellaria spinulosa is a sedentary, tube-building polychaeta that forms aggregations or biogenic reefs on the seabed. These reefs are habitats of special conservation interest under the EC Habitats Directive Annex I (OSPAR, 2010). They are found mostly solitary and in small groups, but also less frequently in dense aggregations on mixed and rocky substrata. EUNIS (2019) classify *S. spinulosa* reefs into two categories: encrusting on the upper faces of wave-exposed rocky habitats bedrock in the subtidal and lower intertidal fringe and at high abundances on mixed sediment (sand, gravel, pebble, and cobble). The latter consists of a characteristic cluster of tubes that form a matrix of sand, gravel, mud, and tubes (EUNIS, 2019), and if it covers >30 % of the substrate and is sufficiently thick and persistent, it can support a distinct associated epibiota (OSPAR, 2010). The dense aggregations can form up to 60 cm high reef structures in favourable conditions, providing topographically complex structures that make up a three-dimensional biogenic microhabitat for other marine species (OSPAR, 2010; Natural Resources Wales, 2022). Subsequently, their reef structures are considered ecologically significant as they stabilize mixed strata habitats and increase benthic biodiversity (Natural Resources Wales, 2022). Their structure consists of crevices and attachment surfaces for other organisms (Natural Resources Wales, 2022). Twice as many species have been observed in their reef structures compared to nearby areas without *S. spinulosa* reefs (NRA, 1994), and *S. spinulosa* inhabiting mixed sediments increases the abundance of sedentary epifauna needing hard substratum (OSPAR, 2010). Sabellaria reefs provide ecosystem services such as food provisioning for other species and filtering water and nutrients from the surrounding water (Natural Resources Wales, 2022).

Distribution:

S. spinulosa reefs inhabit all European coasts, except the Baltic and the waters of Kattegat and Skagerrak (OSPAR, 2010), favouring turbid waters with a good supply of sand-sized particles which they glue together to build their tubes. It is usually found all around UK in the sublittoral zone, but significant aggregations have been found at intertidal depths in Harwich, the Wash and parts of Scotland (Natural Resources Wales, 2022).

Conservation status

The *S. spinulosa* habitat was considered threatened and/or declining in OPSAR regions II and III (Greater North Sea and Celtic Sea) due to physical disturbance including dredging, fishing, coastal engineering, and other human activities that is destructive to the reefs. Moreover, this habitat is of conservation importance considering its topographically complex structure and high associated biodiversity. Thus, this explains why it was nominated for protection under the OPSAR convention, the EU Habitats Directive, the Wadden Sea Red List, and the UK Biodiversity Action Plan (OSPAR, 2010; Pearce and Kimber, 2020). More specifically it has been identified as a priority habitat for conservation in European waters and nationally, and the reef structures are protected through their inclusion as features of Marine Protected Areas (MPAs) (Pearce and Kimber, 2020). Conservation management should include the protection of both living and dead reefs, as both tube structures support the settlement and metamorphosis of *S. spinulosa* larvae (OSPAR, 2010).

Until recently, there were few records of *S. spinulosa* habitats occurring in Scottish waters. However, seabed imagery collected from the east coast of Scotland recently revealed S. spinulosa aggregations with reef-like characteristics. Video surveys of five sites in Scottish waters revealed that these areas support significant areas of *S. spinulosa* reefs, where they occur on isolated cobbles and boulders in an otherwise featureless soft-bottom habitat (Pearce and Kimber, 2020). Moreover, previous surveys east of Peterhead (Scotland) at the Hywind offshore windfarm have revealed the presence of *Sabellaria spinulosa* reefs (MMT, 2013; MTM 2022; Karlsson et al, 2022). These reefs in Scottish waters tend to occur in turbid waters with good sand supplies, and they are often near areas suited to renewable energy development. Previous studies have shown that the facilitated establishment created for *S. spinulosa* by the wind park structures should not have a negative impact on the habitat. *S. spinulosa* habitats are often associated with high faunal biodiversity (Pearce et al., 2014), and it has key functions in creating feeding grounds for different species of fish.

To conserve this habitat in the future, the current reefs must be continuously monitored and assessed with specific reference to Scottish waters. Despite their high conservation status on a European level, Sabellaria spinulosa reefs are not currently listed as PMFs in Scotland (Tyler-Walters et al, 2016). Based on the evidence presented in this study and additional records from the east coast (MMT, 2013; Moore 2019; Pearce and Kimber 2020) reefs are indeed present in Scottish waters, and additional reefs will likely be discovered as survey activity associated with offshore renewable energy increases.

Assessment criteria

Management considerations include site safeguarding, zoning, monitoring and research. To assess *S. spinulosa* habitat, surveys should include a description of the *S. spinulosa* habitats present within the survey area and the identification of other habitats and/or species of conservation concern (Natural Resources Wales, 2022). It is not yet fully agreed upon how to define and assess the reefiness (whether aggregations can be characterised as a reef or not) of *S. spinulosa*, different scoring systems have been developed and the most acknowledged are given in Table 3-2. More details are given in Section 4.4.

Table 3-2 Characteristics for assessing *S. spinulosa* reefs (Gubbay, 2007; OSPAR, 2010).

Assessment criteria	Explanation
Elevation (cm)	The height of the reef above the surrounding seabed, indicating the degree of biogenic structure and complexity. Reefs are typically classified as not a reef (< 2 cm), low (2-5 cm), medium (5-10 cm) or high (>10 cm) elevation (Gubbay, 2007).
Extent (m^2)	The area covered by the reef, which reflects the spatial distribution and connectivity of the habitat. Reefs are typically classified as not a reef (< 25), small (25 – 10 000), medium (10 000 – 1 000 000) or large (>1 000 000) extent (Gubbay, 2007).
Coverage / Patchiness (% cover)	The percentage of the seabed covered by the reef, which indicates the density and patchiness of the habitat. Reefs are typically classified as not a reef (< 10 %), low (10 – 20 %), medium (20 – 30 %) or high (> 30 %) coverage (Gubbay, 2007). OPSAR has a List of Threatened and/or Declining Species (OSPAR 2010), which states that 30 % of the cover is considered a reef in mixed sedimentary habitats and 50 % on rock substrate.

4 Methodology

4.1 Data collection

4.1.1 Data logging system

An electronic registration form (video log) was used for each ROV dive. The log included date, time, type of seabed substratum, mega-fauna, and any special observations (e.g. debris, fish). In parallel, ROV position was recorded every second in a navigation log. By merging these two logs all registrations from the video material were given a coordinate to be used in mapping.

4.2 ROV sonar assessment

The ROV sonar identifies changes in seabed reflectivity and was used mainly to identify potential *S. spinulosa* reef structures. These areas were to a large extent surveyed. The sonar data was not recorded, but snapshots of the sonar screen were taken, geo-referenced and plotted in maps. If the shapes were overlapping, they were combined to represent a larger area (Figure 4-1).

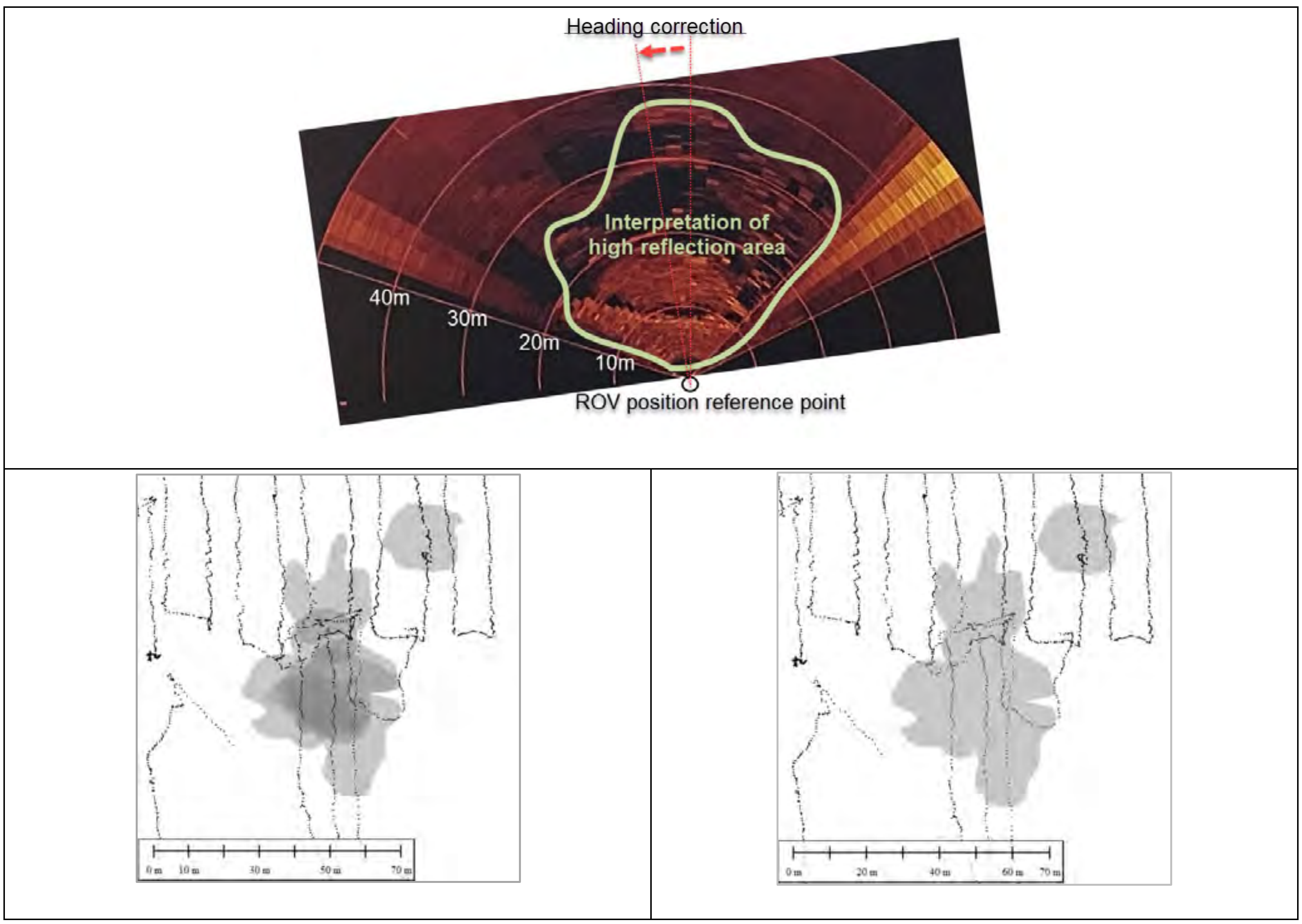


Figure 4-1 Example of how high reflectivity areas from the ROV sonar data were delineated, georeferenced and plotted in maps.

4.3 Visual mapping

4.3.1 Survey strategy

The visual survey was carried out in accordance with "*Environmental visual survey program for Hywind*" (Figure 4-2) (DNV, 2023). There are a total of 24 lay-down areas (15 anchor and 9 cable areas) distributed within the five turbines area, all within a radius 200m from the turbine. In addition, a 20m corridor along anchor chains at mooring lines #1 and #3 for all turbines at distance between 200 to 300m has been identified as potential influence area in case of sideway movements of chains during the operation. A location for placement of a weather buoy located southwest was also surveyed.

Within each lay-down area a comprehensive visual survey has been performed. There are relative strong tidal currents at the location, so the survey lines were planned and surveyed to follow this direction (N-S or S-N). The distance between the lines was set to 10m width ~3m observation width (depending on visibility, camera angel and height above seabed). This gives roughly 35-40% visual coverage of the seabed within the lay-down areas. In addition, the ROV sonar was used actively during the survey. Identified changes in seabed reflectivity from the sonar was to a large extent explored and surveyed. By use of sonar there was 100% coverage for each lay-down area.

The ROV survey was performed following NS-EN16260-12. This implies that the ROV should be 1-3m above seabed (depending on the visibility) and not exceeding a speed of 1kn. The image resolution should be that objects down to 1cm will be identified.

In case of any *Sabellaria* findings, alternative lay-down area was outlined and visually surveyed. This was the case at HS5 and lay-down area IAC southeast.

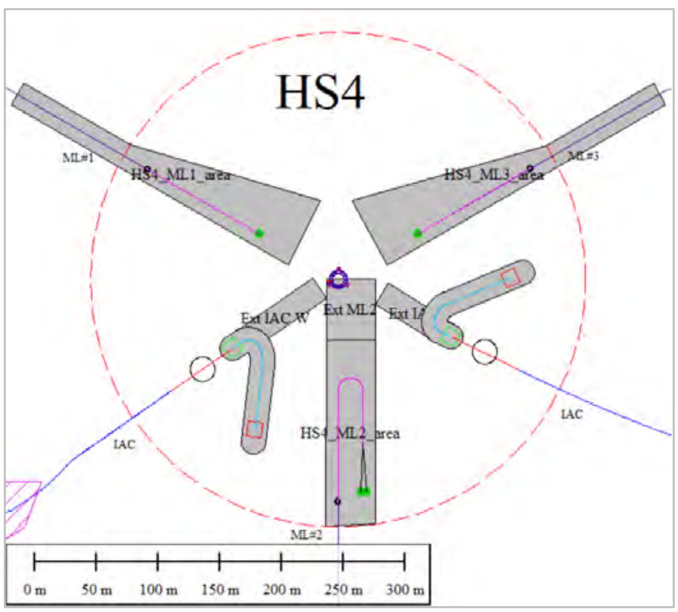


Figure 4-2 Grey areas are potential lay-down areas where the visual survey has been carried out (eg. HS4)

Table 4-1 Lay-down areas visually surveyed at Hywind Scotland.

Turbine	Area	Survey	Origin
HS1	Mooring line	HS1_ML1	Program
		HS1_ML2	Program
		HS1_ML2_Extension	**MOC**
		HS1_ML3	Program
	Cable	HS1_IAC	Program
		HS1_IAC_Extension	**MOC**
HS2	Mooring line	HS2_ML1	Program
		HS2_ML2	Program
		HS2_ML2_Extension	**MOC**
		HS2_ML3	Program
	Cable	HS2_IAC	Program
		HS2_IAC_Extension	**MOC**
HS3	Mooring line	HS3_ML1	Program
		HS3_ML2	Program
		HS3_ML2_Extension	**MOC**
		HS3_ML3	Program
	Cable	HS3_IAC_W	Program
		HS3_IAC_W_Extension	**MOC**
		HS3_IAC_E	Program
		HS3_IAC_E_Extension	**MOC**
HS4	Mooring line	HS4_ML1	Program
		HS4_ML2	Program
		HS4_ML2_Extension	**MOC**
		HS4_ML3	Program
	Cable	HS4_IAC_W	Program
		HS4_IAC_W_Extension	**MOC**
		HS4_IAC_E	Program
		HS4_IAC_E_Extension	**MOC**
HS5	Mooring line	HS5_ML1	Program
		HS5_ML2	Program
		HS5_ML2_Extension	**MOC**
		HS5_ML3	Program
	Cable	HS5_Export	Program
		HS5_Export_Extension	**MOC**
		HS5_IAC_NE	Program
		HS5_IAC_NE_Extension	**MOC**
		HS5_IAC_SE	Program
		HS5_IAC_SE_Extension	**MOC**
		HS5_IAC_SE_Extension_Contigency area	**MOC**
Weather buoy			**MOC**

4.3.2 Substrate and fauna registrations

A modified Udden Wentworth scale (according to NS-EN 16260) was used in the continuous categorization of the substrate along the seabed (Table). Grain sizes less than 0.5 cm can be difficult to categorize from video. Substrate categorization in the survey followed categories according to "Mapping/Trend" in Table 4-2.

Table 4-2 Sediment characterization according to the Udden-Wentworth scale, and categories utilized during the visual survey (NS-EN16260).

Udden-Wentworth scale		Type of survey and main category	
Grain size	**Bottom substrate**	**Screening**	**Mapping/trend**
0,6 µm – 3,9 µm	Clay	Mud/sand	Mud
3,9 µm – 63 µm	Silt		
0,063 mm – 2 mm	Sand		Sand
2 mm – 4 mm	Granules		
4 mm – 64 mm	Gravel	Boulder	Gravel
6,4 cm – 25,6 cm	Pebbles		Pebbles
25,6 cm – 410 cm	Boulder		Boulder
> 4 m	Bedrock	Bedrock	Bedrock

Shell debris originating from floating structures or e.g., anchor chains can be of interest to map when surveying floating wind turbines, particularly in the light of long-term effects on the seabed. The occurrence of blue mussel- and other debris was mapped according to categories in Figure 4-3.

Figure 4-3 Categories used for assessing surface-associated mussel shell debris.

All megafauna species and habitat types encountered during the surveys were registered. Individual fauna was identified to the lowest taxonomic level possible and colonial species (e.g., *S. spinulosa*) were both recorded using the SACFOR scale (see section 4.1.3); a semi-quantitative method for estimating the abundance of marine organisms based on visual observations (JNCC).

4.3.3 Assessment of *Sabellaria spinulosa*

Aggregations of the threatened, reef-building *S. spinulosa* have previously been observed within the Hywind Scotland Pilot Park (MTM, 2013); thus, this report has a key focus on the habitat mapping of this species. Video footage of all surveyed areas was analysed to the highest level of detail possible to estimate *S. spinulosa* abundance (% coverage). The abundance was quantified according to the Marine Nature Conservation Review (MNCR) SACFOR abundance scale (Table 4-3)). The scale has six categories each representing a percentage cover interval, depending on the growth form or size of the individual. The crust/meadow growth form was used when evaluating ross worm abundance, which was chosen based on growth form and under recommendations by Pearce & Kimber (2020).

Table 4-3 The SACFOR scale used for logging species abundances. A size relative six graded scale with densities classified as; **S**uperabundant–**A**bundant–**C**ommon–**F**requent–**O**ccasional-**R**are. The red rectangle shows the % coverage for each category used in mapping of *Sabellaria spinulosa.*

% cover scale	Growth form		Size of individuals/colonies				Density scale	
	Crust/meadow	Massive/Turf	<1cm	1-3 cm	3-15 cm	>15 cm		
>80%	S		S				>1/0.001 m^2 (1x1 cm)	>10,000 / m^2
40-79%	A	S	A	S			1-9/0.001 m^2	1000-9999 / m^2
20-39%	C	A	C	A	S		1-9 / 0.01 m^2 (10 x 10 cm)	100-999 / m^2
10-19%	F	C	F	C	A	S	1-9 / 0.1 m^2	10-99 / m^2
5-9%	O	F	O	F	C	A	1-9 / m^2	
1-5% or density	R	O	R	O	F	C	1-9 / 10m^2 (3.16 x 3.16 m)	
<1% or density		R		R	O	F	1-9 / 100 m^2 (10 x 10 m)	
					R	O	1-9 / 1000 m^2 (31.6 x 31.6 m)	
						R	<1/1000 m^2	

S	A	C	F	O	R	P
super-abundant	abundant	common	frequent	occasional	rare	present

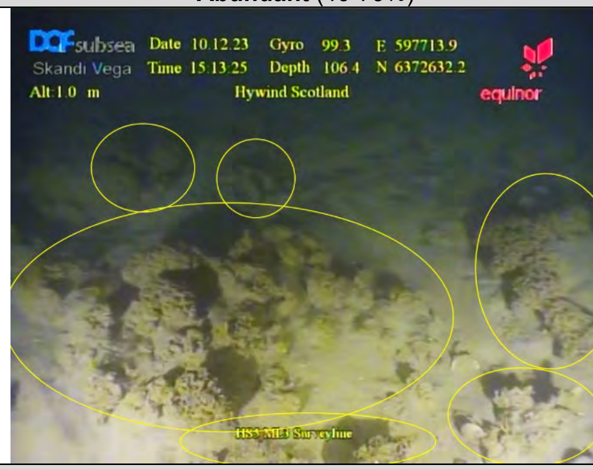
The percentage cover of *S. spinulosa* was estimated by analysing every picture segment in the visual surveys as a separate sample, each segment representing an area of approximately 10 m^2. The video was paused, rewound, and looped, if necessary, to ensure that all *S. spinulosa* observations were included. The estimated percentage cover was based on the count of *S. spinulosa* bommies within one picture frame (Table 4-3) and logged alongside time and surveyed area. If a picture segment had an *S. spinulosa "*bommies" count that covered 30 % of the picture frame, the letter C was logged next to the corresponding time. These data were used to generate a % cover maps of *S. spinulosa* presence in the survey area.

Table 4-4 Examples of *Sabellaria spinulosa* percentage (%) cover estimations according to the SACFOR scale. Pictures are taken from the visual survey conducted on Hywind Scotland in 2023 and the yellow circles indicate presence of *S. spinulosa*. The category for superabundant (S) was not found in the visual dataset and has not been visualized.

Superabundant (>80%)

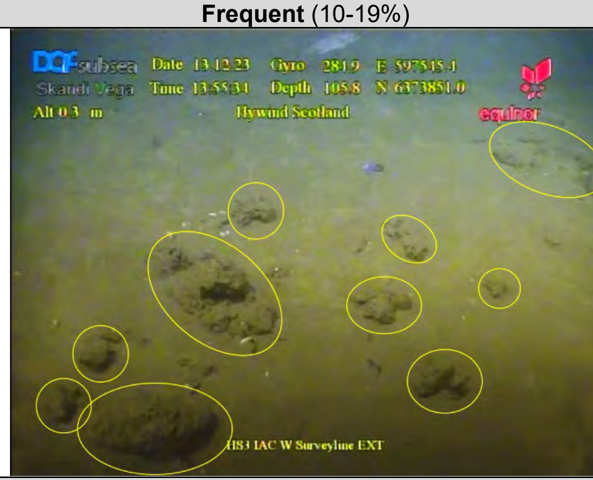
No observations

Abundant (40-79%)

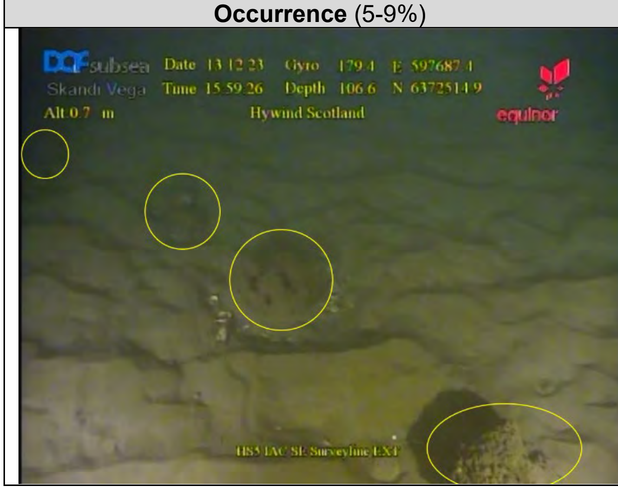


Common (20-39%)

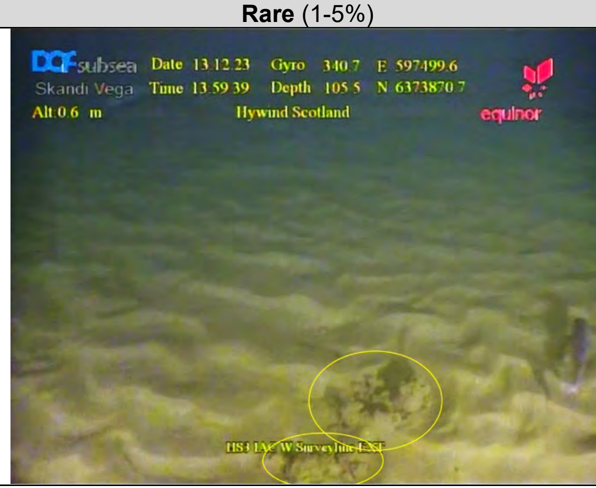
Frequent (10-19%)



Occurrence (5-9%)



Rare (1-5%)



4.4 Reefiness assessment

The presence/absence of *S. spinulosa* was logged simultaneously as % coverage and can be used to assess the reefiness. A widely applied criteria proposed by Gubbay (2007) has been used to assess the reefiness of *S. spinulosa.* The criteria combine percentage cover and tube height to assign reef status for each segment (Table 4-5). However, height was not included in the assessment of this species, as it was difficult to determine whether an *S. spinulosa* clump grew over a boulder or a flat seabed based on seabed imagery alone. Moreover, estimating the elevation has proven difficult and inaccurate (Pearce and Kimber, 2020), and studies have shown a lack of relationship between reef height and ecological function (Pearce et al, 2011; Pearce and Kimber, 2020). Nevertheless, a coarse comparison of ROV depth measurement (transponder depth + ROV altimeter data) has been carried out indicating elevations within “reef area” at HS5 IAC SE (Figure 4-4).

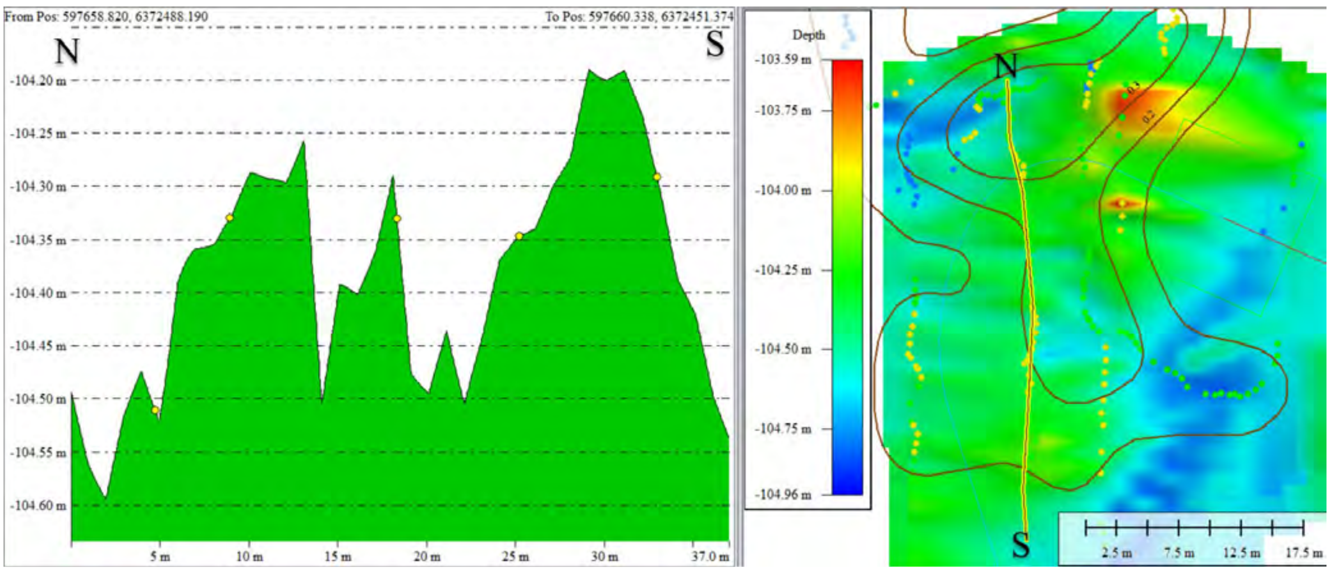


Figure 4-4 Coarse comparisons between interpolated depth measurements (ROV transponder depth + ROV altimeter measurement) and isolines for “reefiness” (see chapter 5.1.4) at HS5 IAC SE. A vertical cross section from N to S along a transect with “Occasional” and “Frequent” Sabellaria registrations indicate depth variations up to 50cm (natural variations + possible bommies height).

Thus, it was assumed that all *S. spinulosa* bommies observed had a height > 10 cm when assessing reefiness in this study (conservative approach). This assumption was based on:

- The protruding structures observed in the video (Table 4-4)
- There was a reflection on the ROV sonar (Figure 4-1)
- Depth measurements from the ROV (Figure 4-4)

The reefiness assessment was used to generate a Sabellaria heat map to illustrate the species distribution and density at the survey area (see Section 4.5).

Table 4-5 The *Sabellaria spinulosa* reefiness assessment, developed by Gubbay (2007) and modified by Jenkins et al (2018).

Sabellaria reefiness		Elevation (cm)			
		<2cm Not a Reef	2-5cm Low	5-10cm Medium	>10cm High
Patchiness (% Cover)	<10% Not a Sabellaria reef	Not a *Sabellaria* reef	Not a *Sabellaria* reef	Not a *Sabellaria* reef	Not a *Sabellaria* reef
	10-20% Low	Not a Reef	**Low**	**Low**	**Low**
	20-30% Medium	Not a Reef	**Low**	**Medium**	**Medium**
	>30% High	Not a Reef	**Low**	**Medium**	**High**

4.5 Generation of density/heat maps

Heat maps (kernel density map) has been generated for shell debris and Sabellaria registrations based on presence-absence data using kernel density estimation (KDE) techniques. KDE is a non-parametric way to estimate the probability density function of a random variable. In the context of spatial data, KDE is often used to visualize the distribution of points in a continuous space. The heat map represent where *S. spinulosa* reef "cluster together rather than grow uniformly and randomely everywhere" (Jenkins et al, 2018). The survey area was divided into patches (3m in radius), and the heat map was generated based on the number of 'presence' registrations within this patch. If the adjacent patches have no presence registrations of *S. spinulosa* the denisty is registered as low, and the opposite if there are registrations of *S. spinulosa* in the adjacent sites (> 30 % cover, OSPAR, 2010; Gubbay, 2007) the density is registered as high.

5 Results

5.1 Distribution of *Sabellaria spinulosa*

Presence of *Sabellaria spinulosa* has been assessed and presented using four different approaches:

- Continuous classification of video along ROV transects in accordance with SACFOR (chapter 5.1.1).
- ROV sonar high reflectivity areas identified as potential *Sabellaria* reef areas (chapter 5.1.2).
- Generation of density/heat maps based on presence/absence of *Sabellaria* along ROV transects (chapter 5.1.3).
- Reef-classification in accordance to reef structure matrix (Gubbay 2007, Jenkins et al. 2018) (chapter 5.1.4).

5.1.1 Visual observations

Field lay-out is presented in Figure 5-1 to Figure 5-5 for HS1 to HS5.

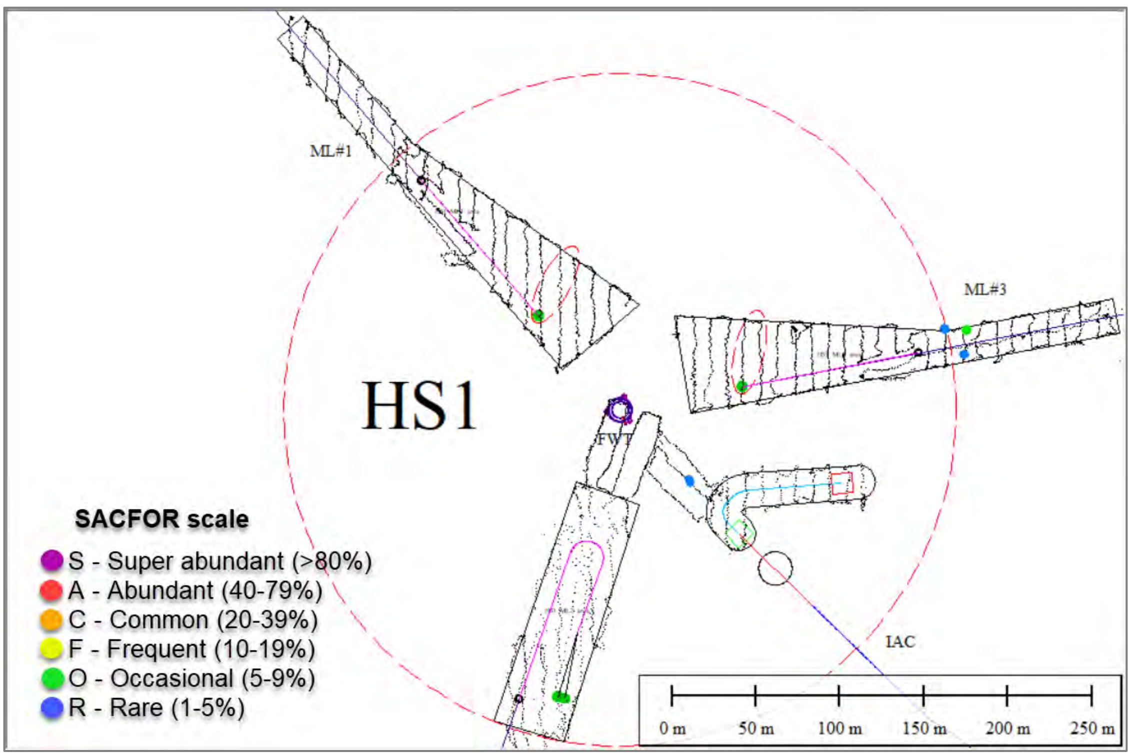


Figure 5-1 Field lay-out, ROV track and *Sabellaria spinulosa* registrations at HS1.

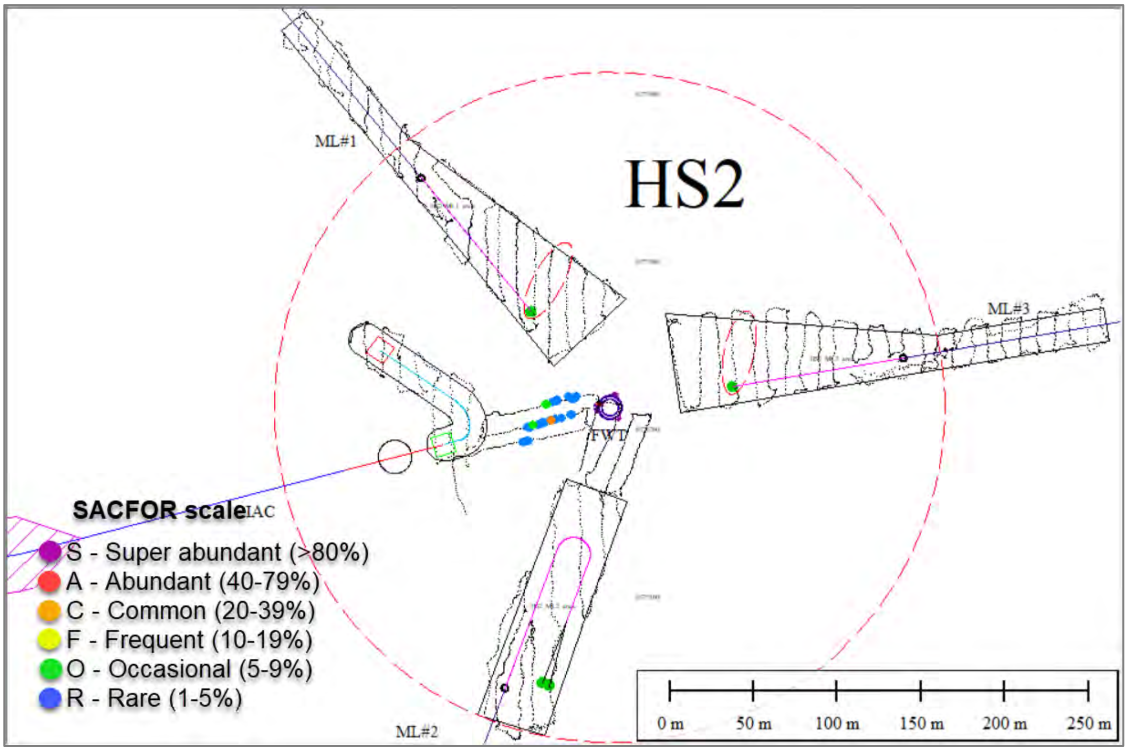


Figure 5-2 Field lay-out, ROV track and *Sabellaria spinulosa* registrations at HS2.

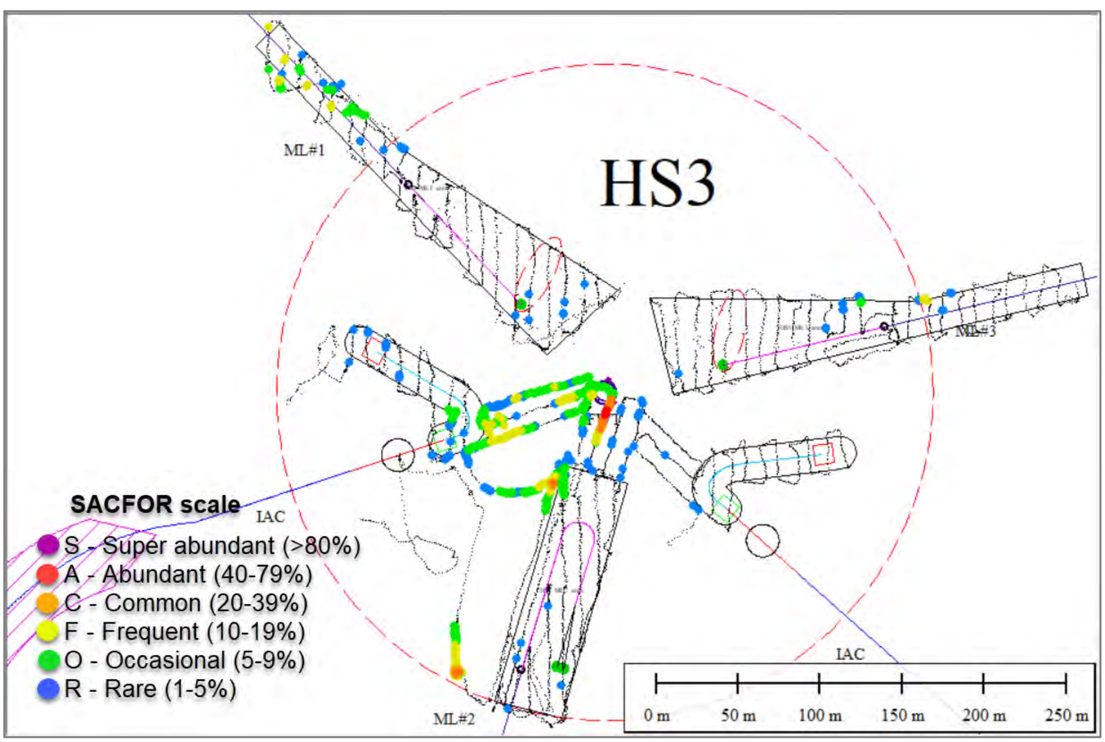


Figure 5-3 Field lay-out, ROV track and *Sabellaria spinulosa* registrations at HS3.

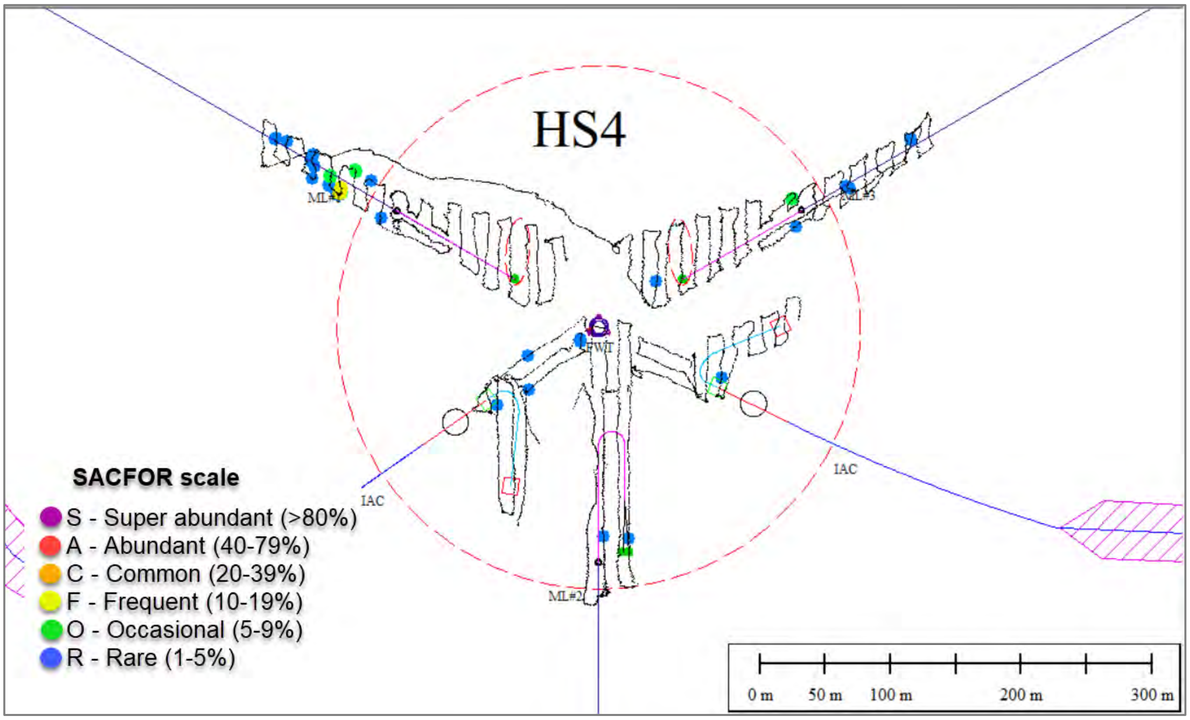


Figure 5-4 Field lay-out, ROV track and *Sabellaria spinulosa* registrations at HS4.

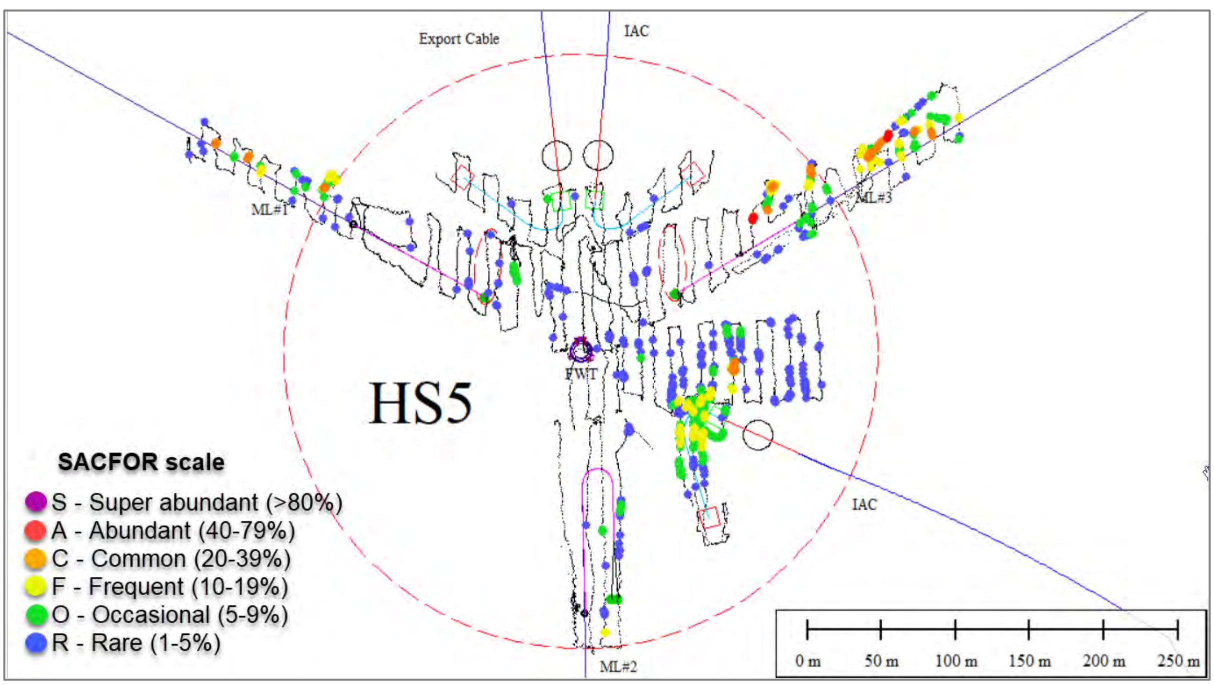


Figure 5-5 Field lay-out, ROV track and *Sabellaria spinulosa* registrations at HS5.

5.1.2 High reflection areas and possible Sabellaria aggregations

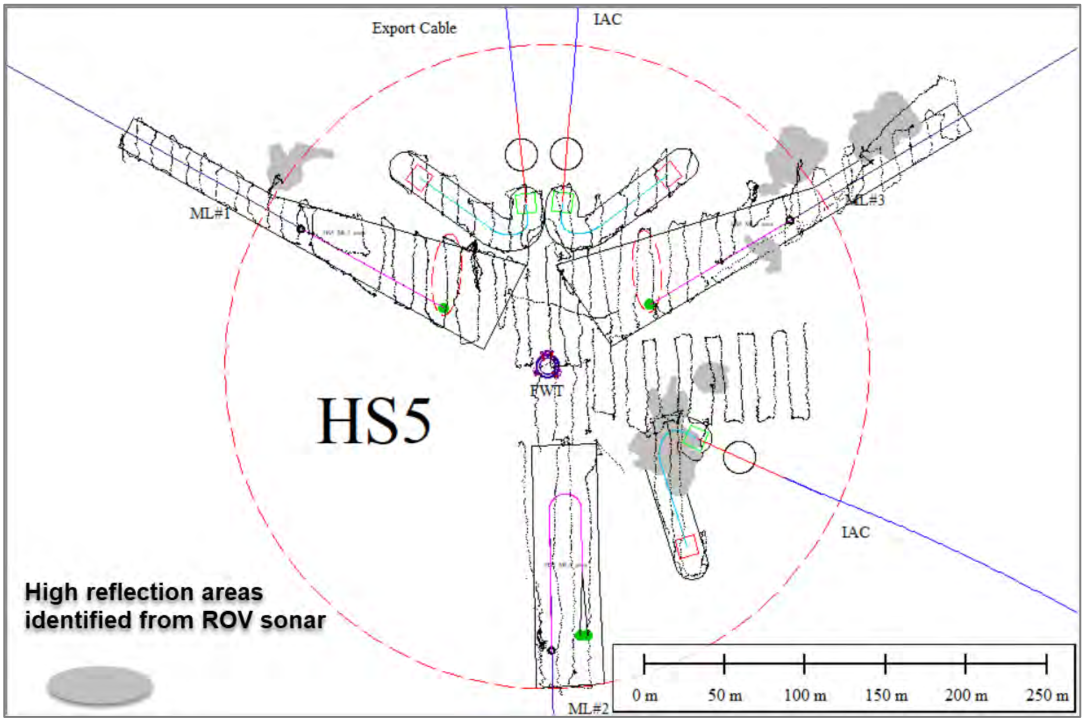


Figure 5-6 Field lay-out, ROV track and high reflection areas from the ROV sonar at HS5.

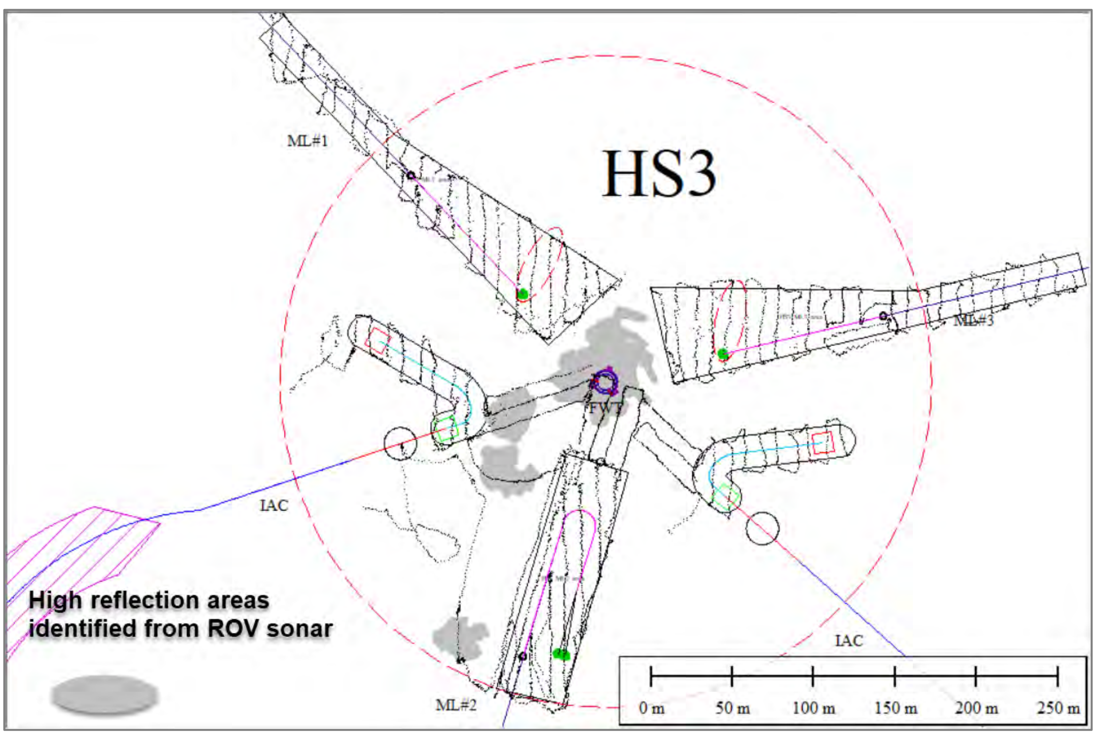


Figure 5-7 Field lay-out, ROV track and high reflection areas from the ROV sonar at HS3.

5.1.3 Density assessment

Density calculations are shown in Figure 5-8 to 5-12

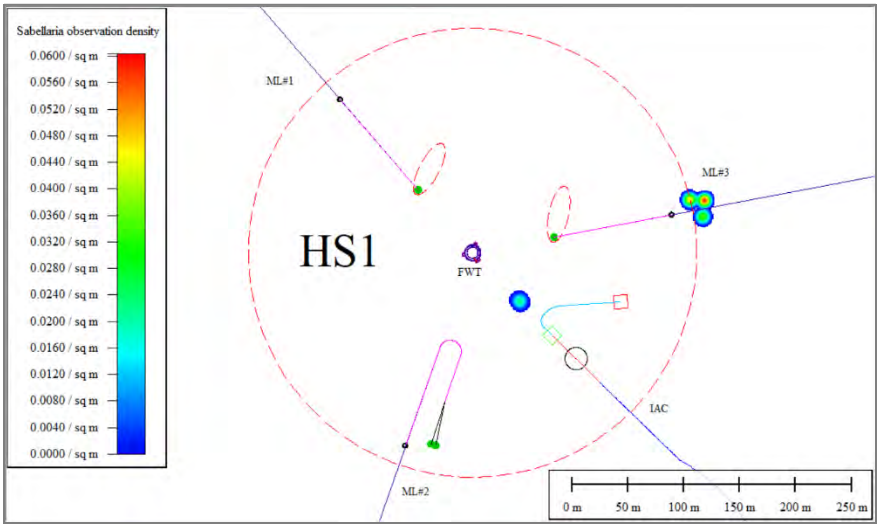


Figure 5-8 Field lay-out, density calculations based on presence/absence data of *Sabellaria observations* at HS1.

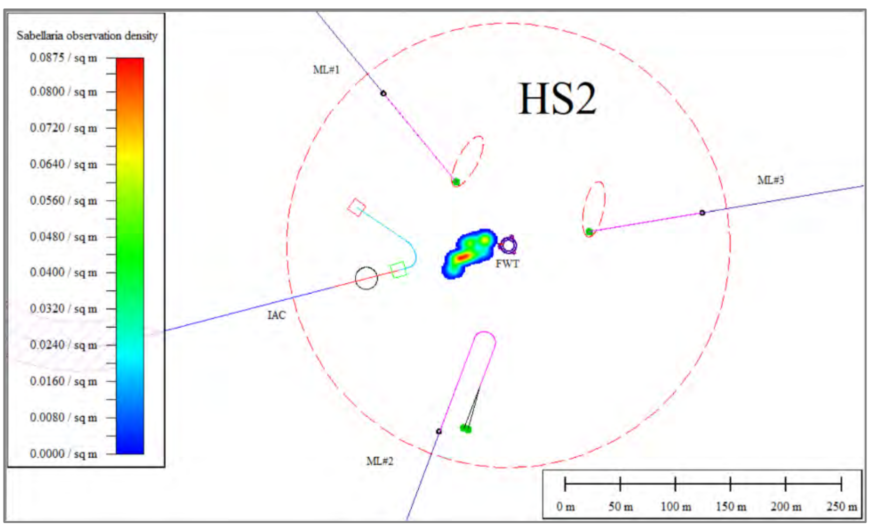


Figure 5-9 Field lay-out, density calculations based on presence/absence data of *Sabellaria observations* at HS2.

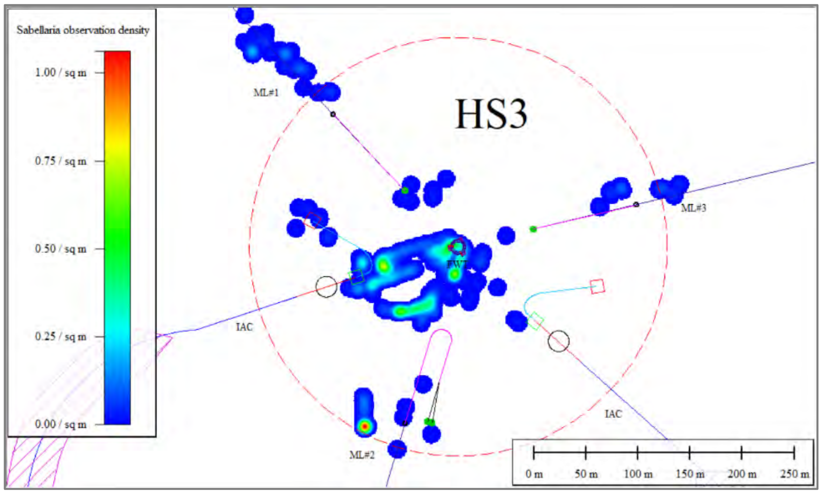


Figure 5-10 Field lay-out, density calculations based on presence/absence data of Sabellaria observations at HS3.

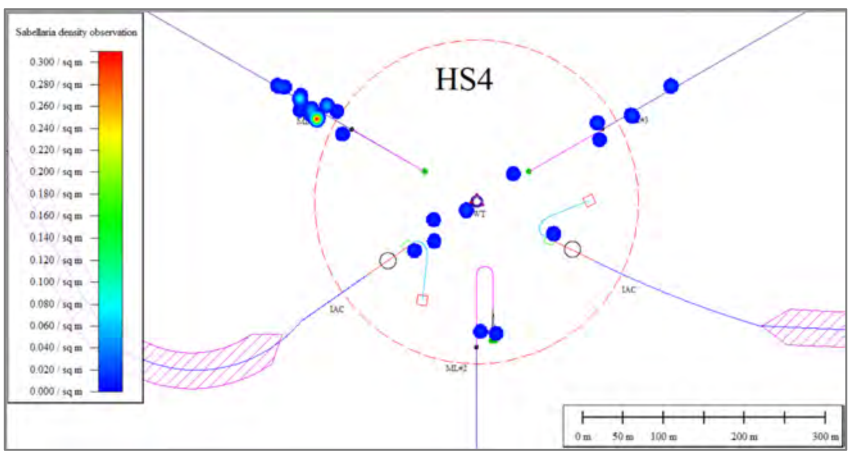


Figure 5-11 Field lay-out, density calculations based on presence/absence data of Sabellaria observations at HS4.

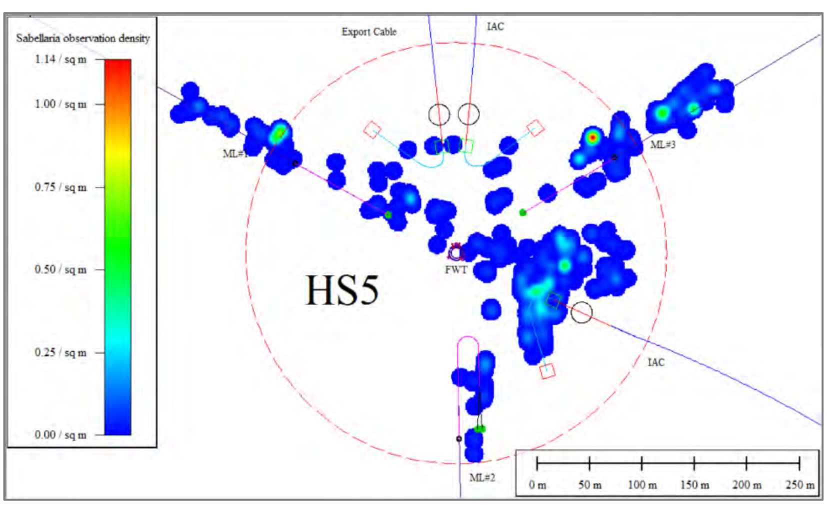


Figure 5-12 Field lay-out, density calculations based on presence/absence data of Sabellaria observations at HS5.

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5.1.4 Reef patchiness assessment

Sabellaria reefiness areas are shown in Figure 5-13 to 5-15 for HS3, HS4 and HS5

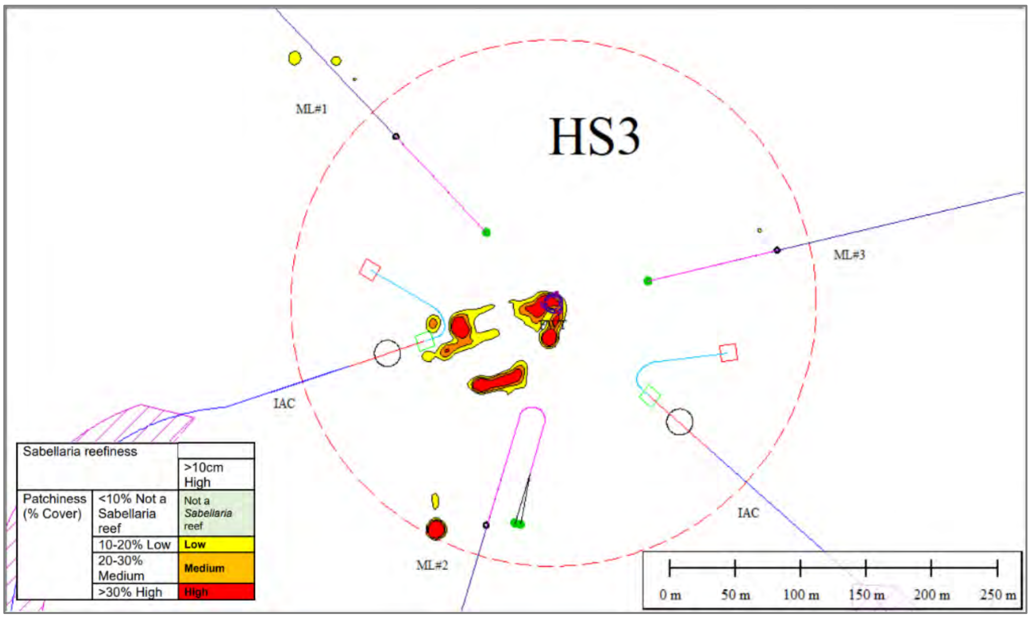

Figure 5-13 *Sabellaria* reefiness areas from density calculations based on presence/absence data of *Sabellaria* observations at HS3.

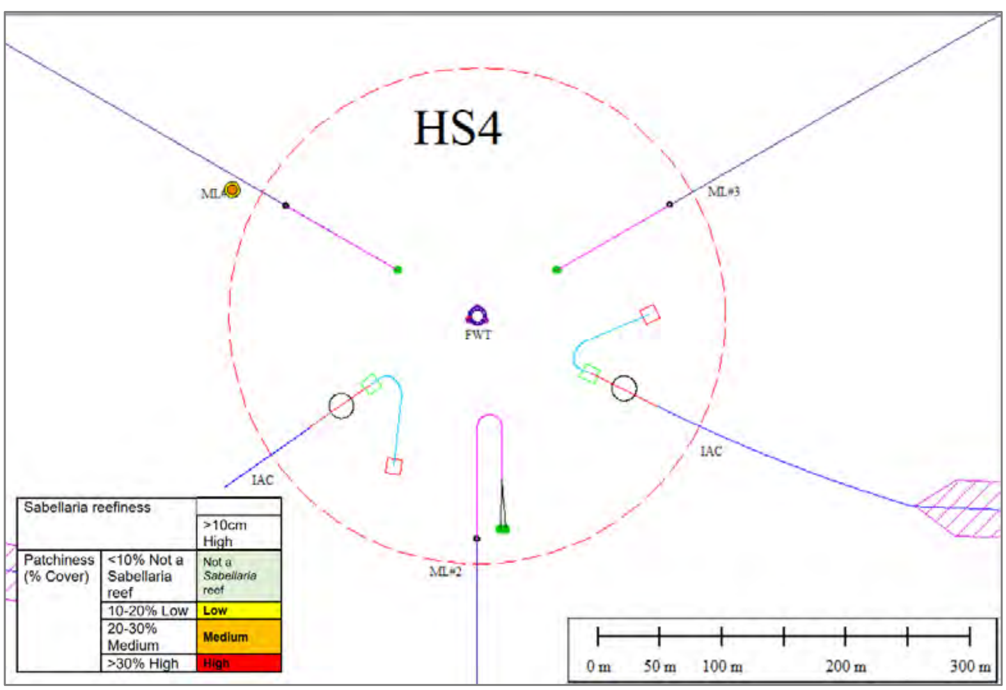

Figure 5-14 *Sabellaria* reefiness areas from density calculations based on presence/absence data of *Sabellaria* observations at HS4.

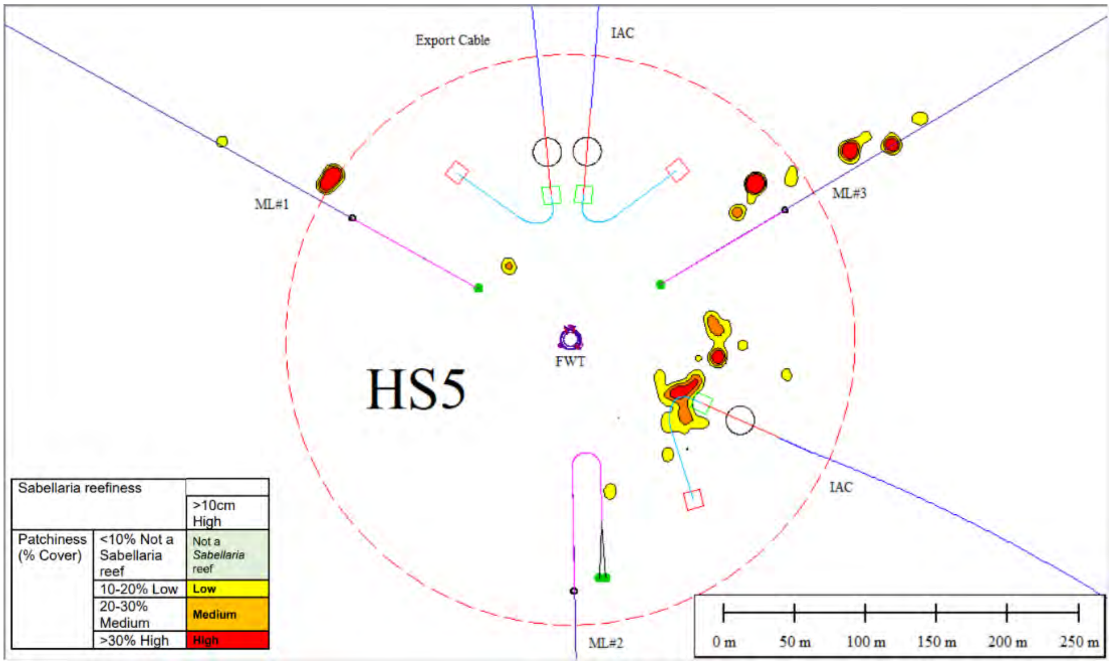

Figure 5-15 *Sabellaria* reefiness areas from density calculations based on presence/absence data of *Sabellaria* observations at HS5.

5.2 Anthropogenic influence

5.2.1 Anchor chains

Depth measurements from the ROV were used to assess the impact movement of anchor chain has on the seabed at different distances from the touch down point. Data has been extracted from mooring line #1 for turbine HS2, HS4 and HS5. Nearest the touch-down point had the highest effects when it comes to "trenching" (up to 2 m difference) and sideways (10-15 m) movement. The impact gradually becomes less significant as the distance from the touch down location increases (Figure 5-16 and Figure 5-17).

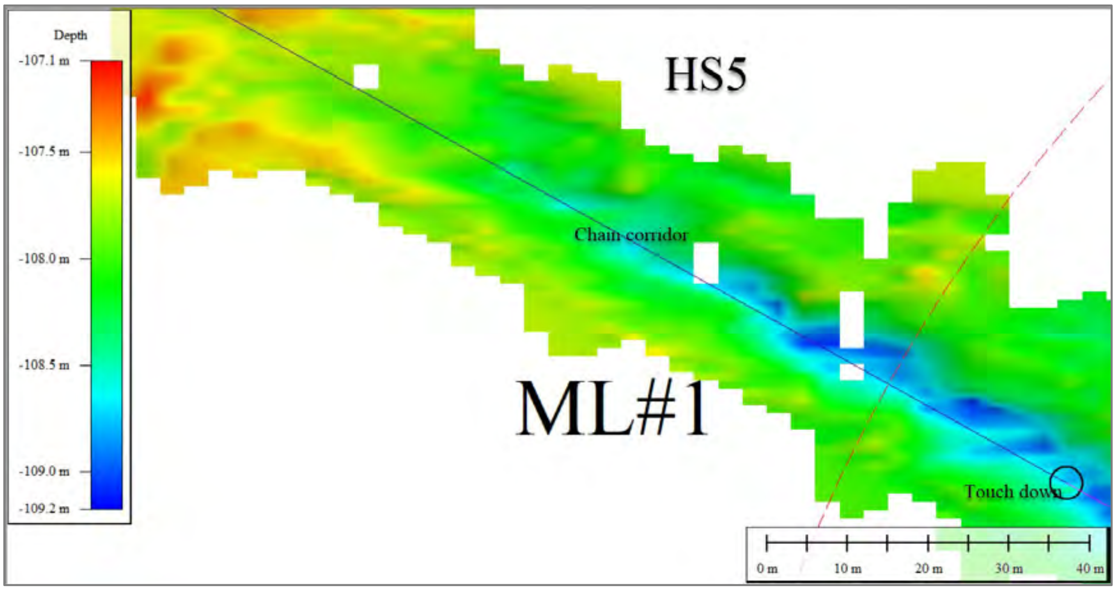

Figure 5-16 Effects from anchor chain movement seen as changes in bathymetry (example from HS5).

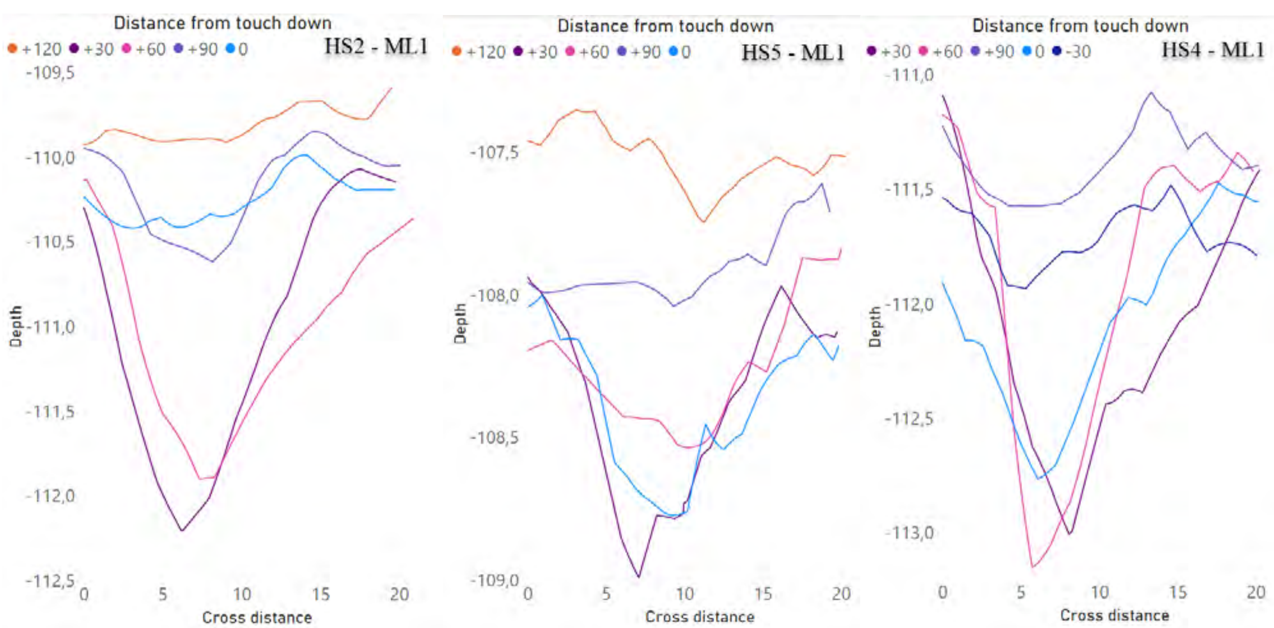

Figure 5-17 Assessment of anchor chain effects on the seabed.

5.2.2 Shell debris

The surface shell debris observed on the seabed comprised a mixture of shells and was not dominated by blue mussels. Where observed, the coverage ranged from low to moderate, as shown in Figure 5-18. Most observations were registered I proximity to the base of the wind turbine and adjacent to the seabed chains, with a diminishing frequency of observations at greater distances from the turbine base (Figure 5-19).

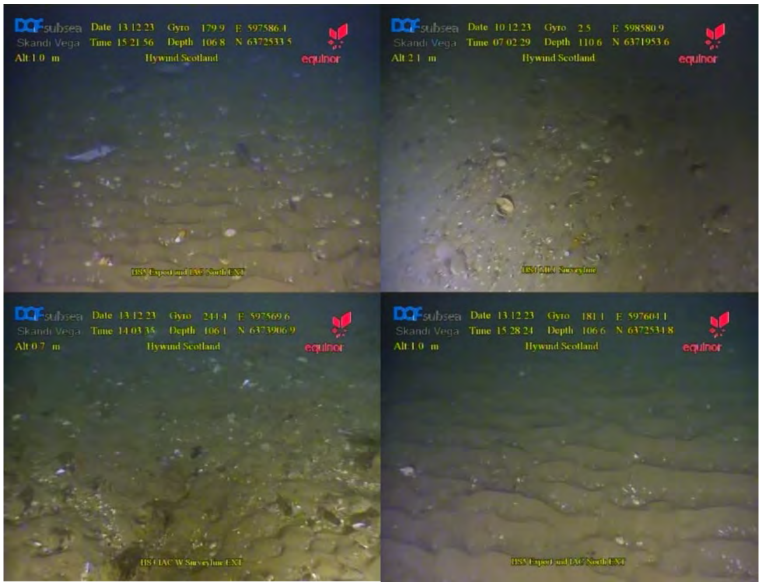

Figure 5-18 Shell debris observed along the transects.

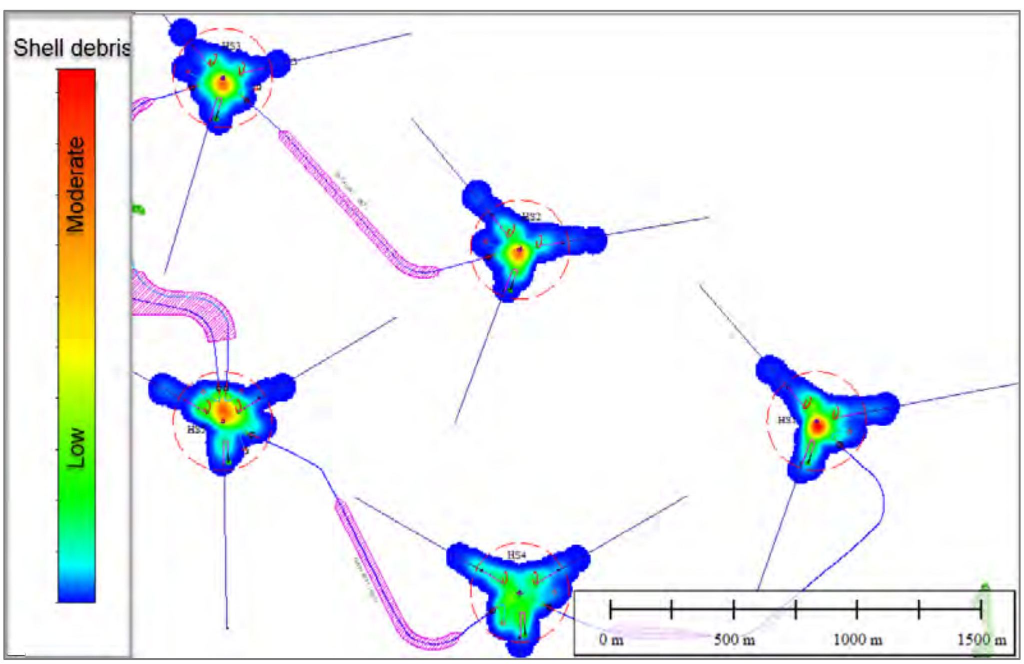

Figure 5-19 Shell debris presented as heat-map based on registrations of present/absent along the survey lines.

5.2.3 Garbage

Miscellaneous garbage was observed during the survey (Figure 5-20 and Figure 5-21).

Figure 5-20 Garbage found during the transects, ranging from soda cans, plastic bags, tires to larger metallic pieces.

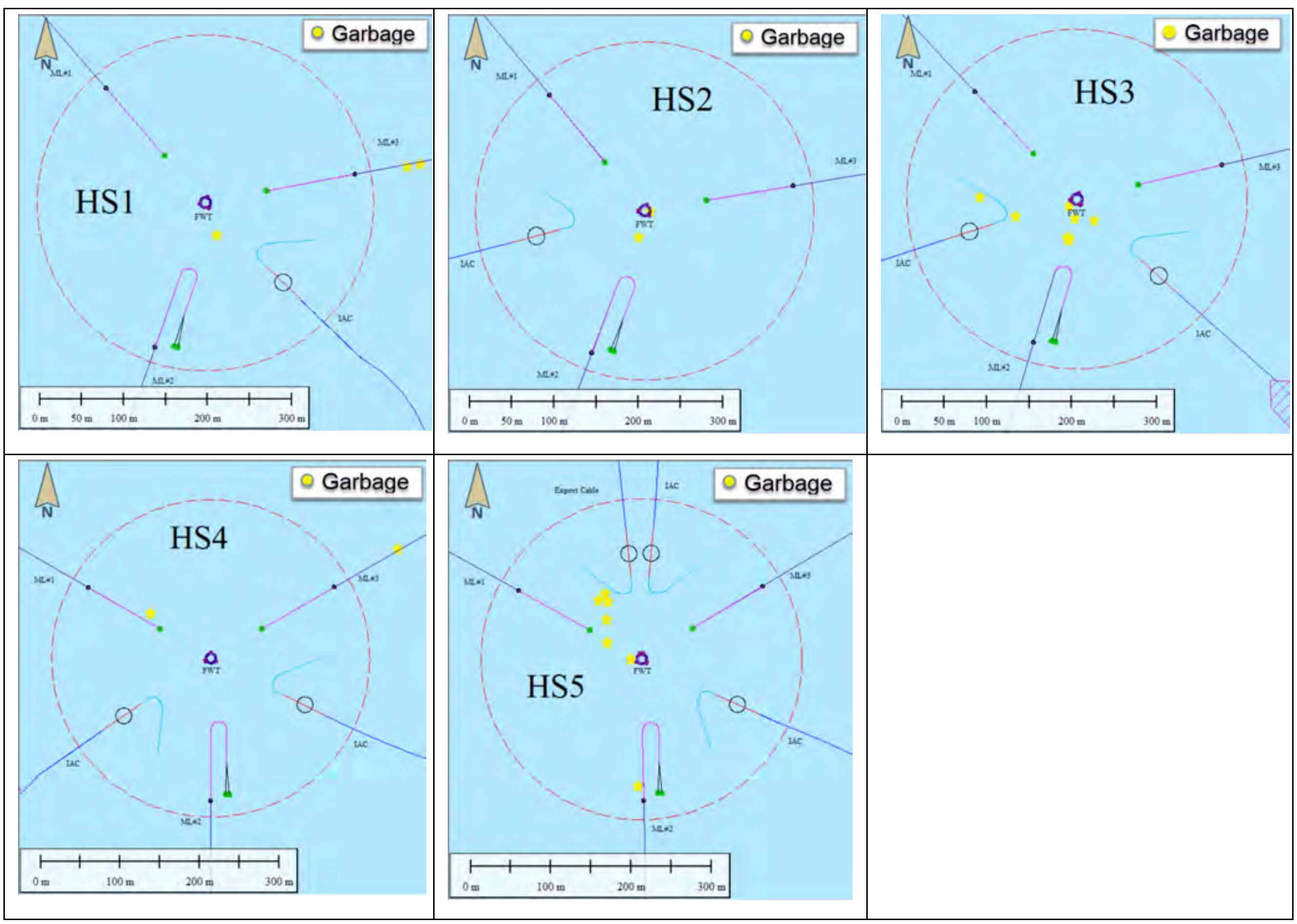

Figure 5-21 Observed garbage during the visual survey at HyS December 2023.

5.3 Sediment and megafauna observations

5.3.1 Sediment characteristics

There was a dominance of muddy/sandy substrate along the transects, with wave patterns formed by the currents above the seafloor (Figure 5-22). The sediment's wave-like pattern made it challenging to spot *Sabellaria* at times, particularly given its similar colour to the sediment. Some occurrences of macroalgae and boulders were observed along the transects in the otherwise seemingly homogeneous landscape. Anchor chains were encountered at multiple instances, with some of them resting atop the sediment while others were partially buried within the sediment (Figure 5-22).

Figure 5-22 Sediment characteristics along the transects. From top left: boulder with hard-bottom species, and wave pattern in the sandy sediment. From bottom left: macroalgae (*Laminaria hyperborea*), and anchor chain.

5.3.2 Megafauna observations

Observations of megafauna were generally limited. The various megafauna noted included hermit crabs (Paguridae), sea stars such as *Luidia ciliaris*, , brown crabs (*Cancer pagurus*) and a variety of fish species such as haddock (*Melanogrammus aeglefinus*), flounders, *Raja* sp. and European angler (*Lophius piscatorius*). Some of the observations are presented in Figure 5-23. Hard-bottom species, such as sea anemones and sea urchins, were found on the boulders and anchor chains (Figure 5-22). Moreover, a number of unidentified species were observed, but the resolution of video footage did not allow for a higher taxonomic classification. See Appendix B for a comprehensive list of species identified during the survey.

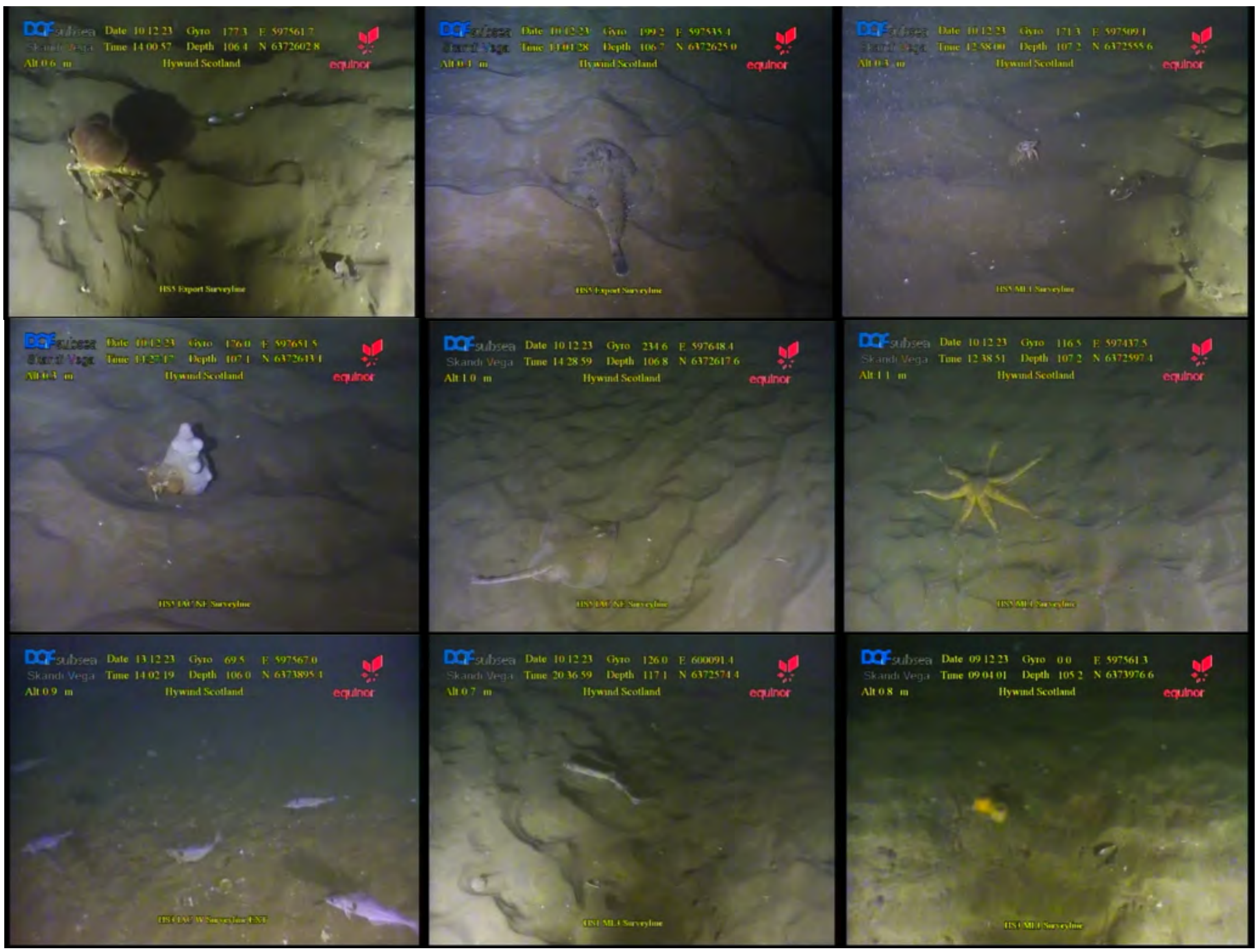

Figure 5-23 From top left: *Cancer pagurus*, *Lophius piscatorius*, Paguridae indet.. From middle left: *Porifera* indet., *Raja* sp *Luidia ciliaris,* From middle left: *Melanogrammus aeglefinus, Scyliorhinus canicular, Actiniaria* indet.

A globular colony was observed on the seabed. It resembled the colony presented in a MMT report from 2020 (MMT, 2020). It is there identified as a “possible young colony of *Desmophyllum pertusum*”. The video quality in this survey did not allow for proper identification, so the specimen was collected for a closer inspection. Figure 5-24 shows the level of details available from the video footage versus the close-up images captured at deck. The close-up images allowed for a higher identification and revealed that it is most likely a colony of lacy tubeworm (*Filograna implexa*) (Richards, S. 2008). The globular form may indicate that it initially has been growing on a smaller area, potentially on an anchor chain, before detaching.

Figure 5-24 Images of the colony of *Filograna implexa* (cf.) from video footage (top left) and close-up images taken on deck.

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6 Environmental resource map and assessment

Sabellaria observations classified in accordance with SACFOR for image analysis, patchiness assessment for reef classification based on presence/absence observations, along with ROV sonar reflection assessment, are the basis for the developed and proposed resource map to be used in the planning of the upcoming operations at Hywind Scotland. Of the five wind turbines, possible conflicting areas between the planned operation and Sabellaria communities have been identified at turbines 3 and 5 (Table 6-1,Figure 6-1, Figure 6-2, Figure 6-3 and Figure 6-4).

Table 6-1 Assessment of conflicting areas between planned operations and Sabellaria reef areas.

Identified possible conflicting area	Assessment	Recommendation
HS5 – IAC Southeast	The planned cable lay-down area may possibly conflict with identified Sabellaria communities.	Consider use of mitigating action (e.g use of buoyancy modules over the reef to reduce lay down area to minimize influence on the Sabellaria community or adjusting lay down route further south). High focus on operational accuracy during the lay down operations.
HS5 – ML3	The planned anchor lay-down area is not in direct conflict with the identified Sabellaria community. Touches parts of the ROV sonar reflection area, but there are few rare observations in category “rare”. There are higher density areas north of the line which should be avoided	Use planned lay-down corridor to avoid higher density Sabellaria areas north of the line
HS3 – IAC Southwest	Planned cable is in between high density Sabelleria areas and not in direct conflict.	High focus on operational accuracy during the lay down operations to avoid high density Sabellaria areas on both sides of the planned cable corridor.
HS3 – Lay-down area nearby turbine	Temporarily cable/chain contact with seabed during the disconnecting operation could be in direct conflict with the identified Sabellaria communities	Consider the operational solution and touching areas to minimize influence on the Sabellaria community.
Existing chain corridors	Both along and on anchors chains there are observations of Sabellaria. There are already significant sideways movement of the chains, especially close to the touch down location.	Minimize alteration of the horizontal direction of the existing chain to limit the influence area.

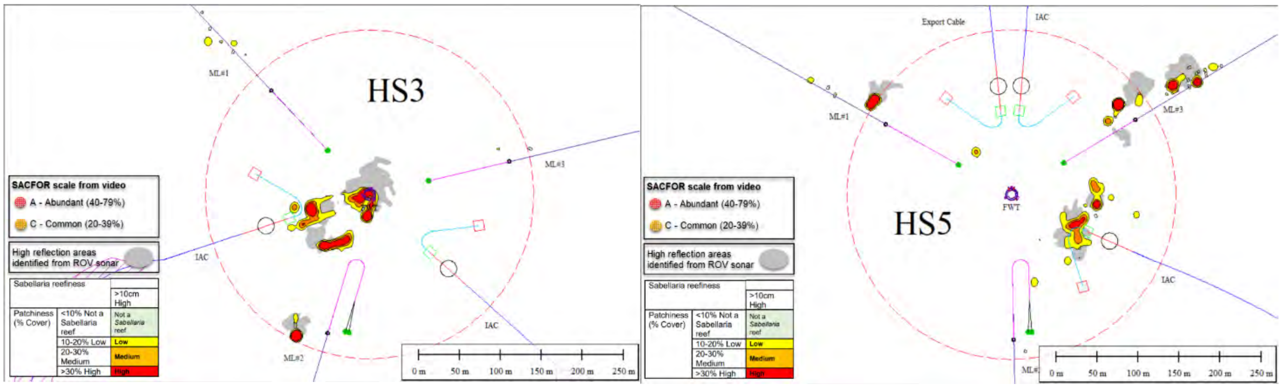

Figure 6-1 Overview of proposed resource map to be used in the planning of the upcoming operations at Hywind Scotland for turbine HS3 and HS5**.**

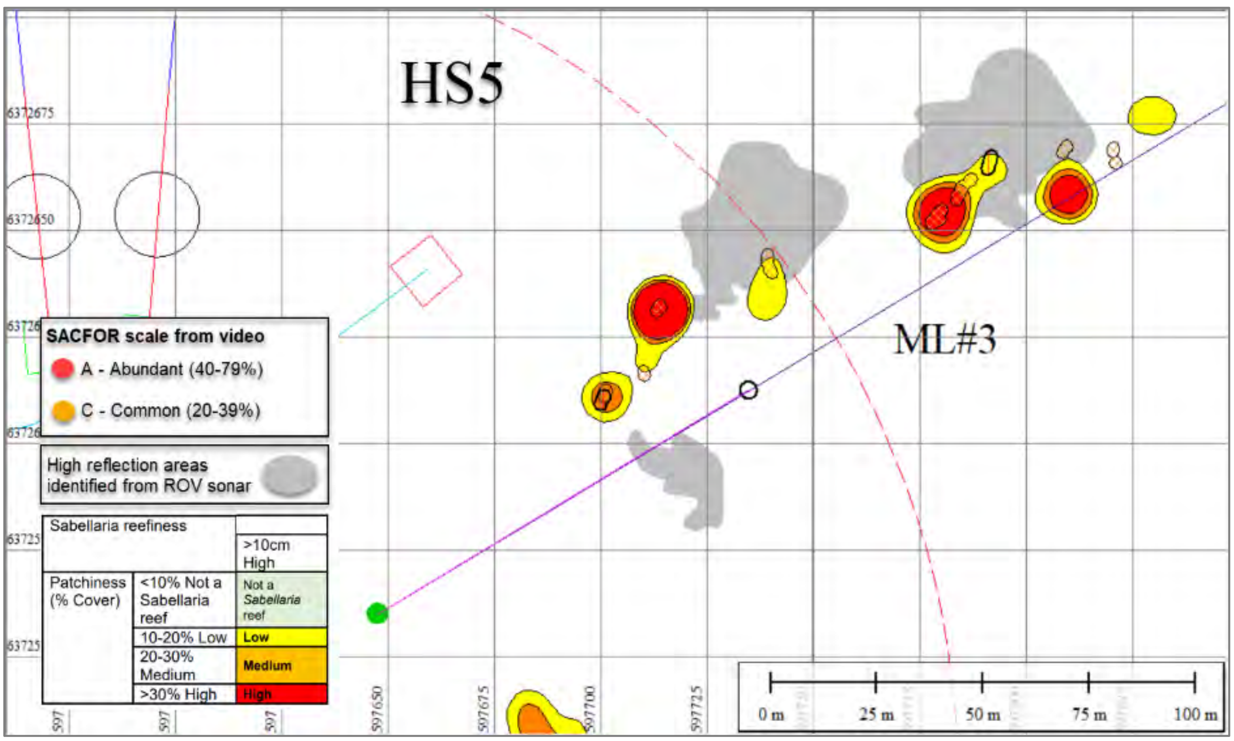

Figure 6-2 Proposed resource map to be used in the planning of the upcoming operations at turbine HS5

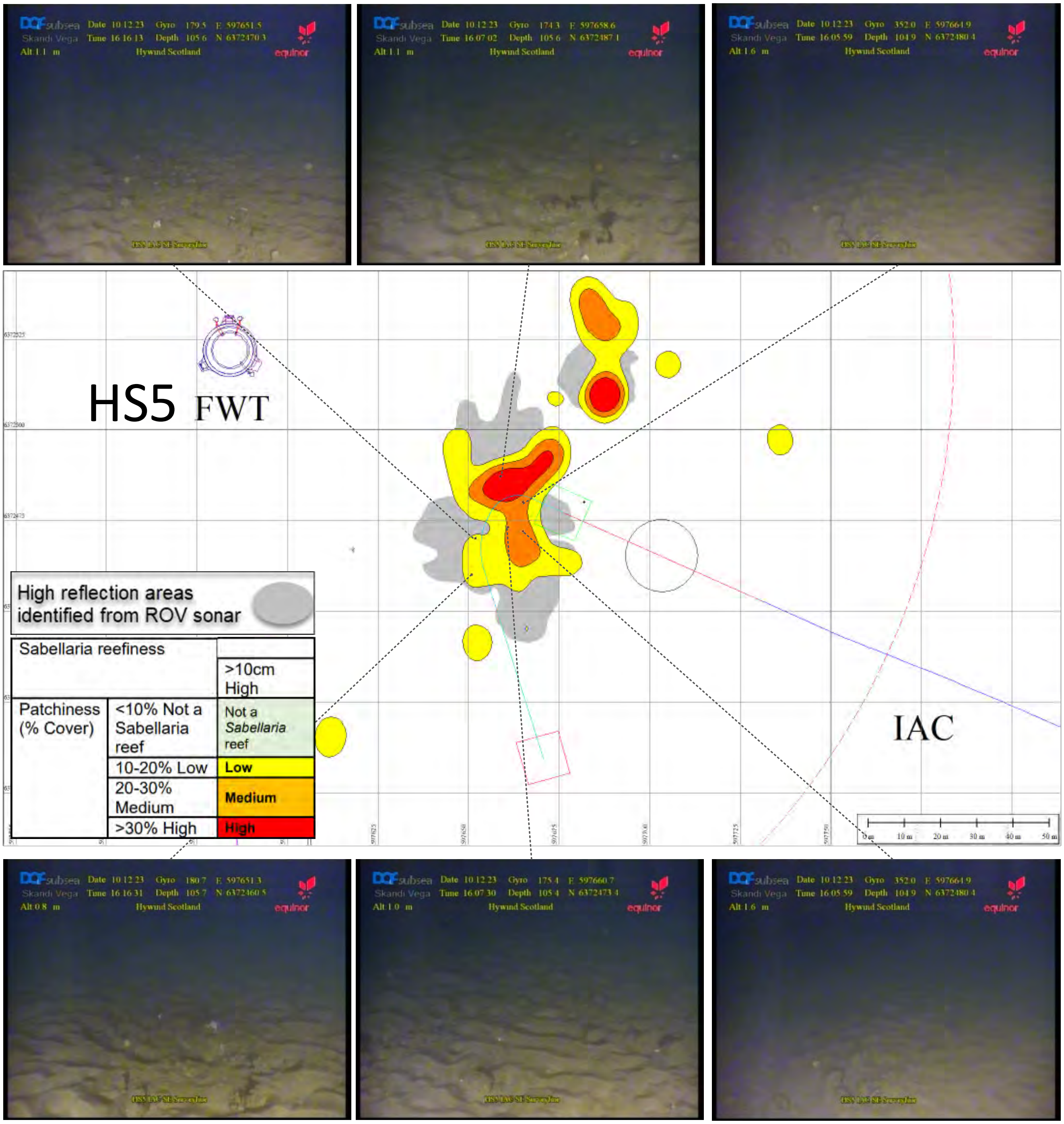

Figure 6-3 Proposed resource map to be used in the planning of the upcoming operations at turbine HS5

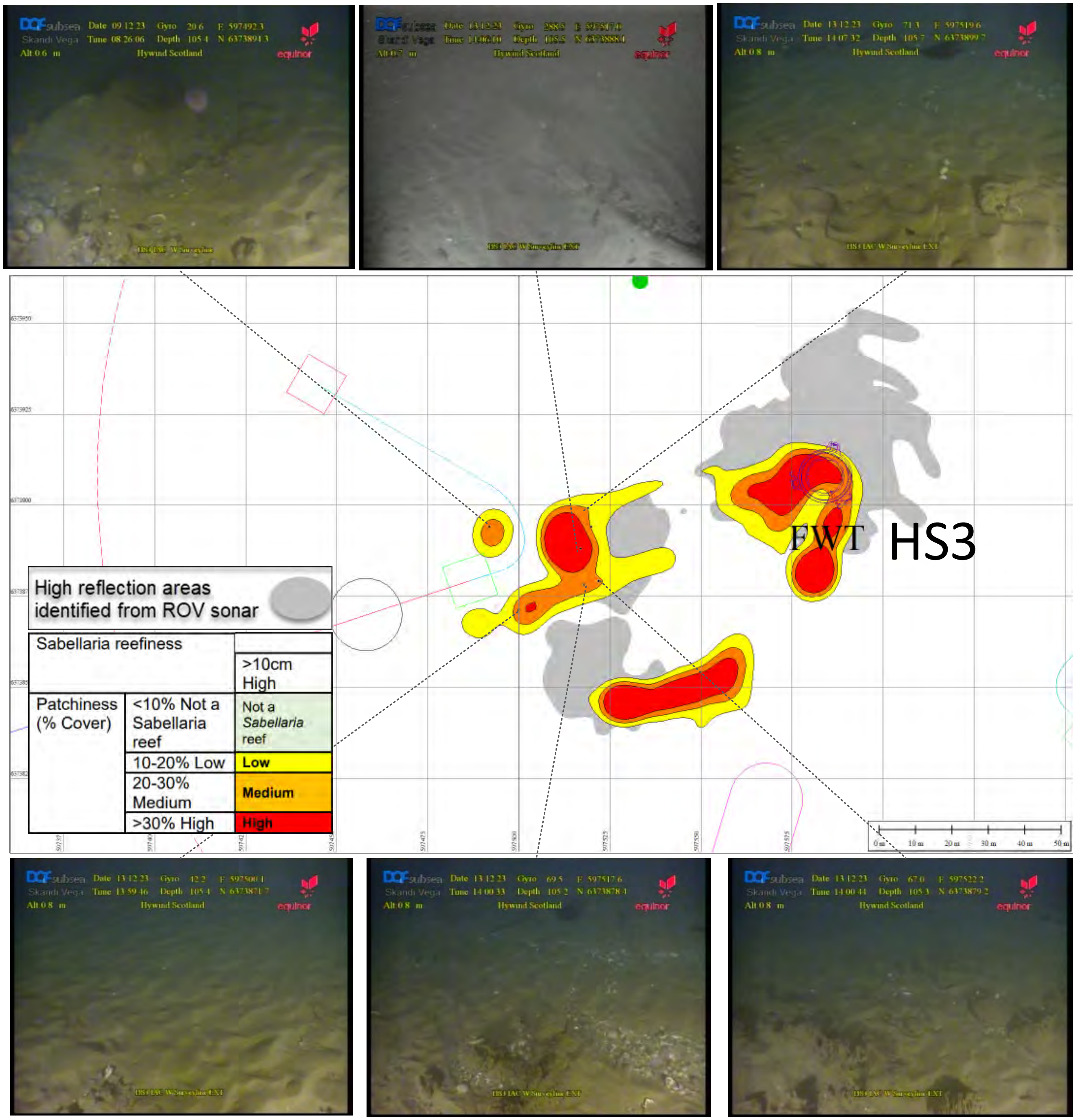

Figure 6-4 Proposed resource map to be used in the planning of the upcoming operations at turbine HS3

7 Conclusions

An extensive benthic visual survey was performed in the planned lay down areas where cables, mooring lines and other equipment are to be landed on the seabed as part of maintenance of the turbines in 2024. The result from the visual surveys is intended used in the planning of the disconnecting operations to minimize the influence on the benthic communities at HyS. The conclusions from the survey are:

Sabellaria communities

- There are Sabellaria findings proposed classified as reefs which could be in conflict with the planned operation in the wind park:
  - **HS5 – IAC Southeast**. The planned cable lay-down area may possibly conflict with identified Sabellaria community. Consider use of mitigating action (e.g use of buoyancy modules over the reef to reduce lay down area to minimize influence on the Sabellaria community or adjusting lay down route further south). High focus on operational accuracy during the lay down operations.
  - **HS5 – ML3**. The planned anchor lay-down area is not in direct conflict with the identified Sabellaria community. Touches parts of the ROV sonar reflection area, but there are few rare observations in category “rare”. There are higher density areas north of the line which should be avoided Use planned lay-down corridor to avoid higher density Sabellaria areas north of the line.
  - **HS3 – IAC Southwest**. Planned cable is in between high density Sabellaria areas and not in direct conflict. High focus on operational accuracy during the lay down operations to avoid high density Sabellaria areas on both sides of the planned cable corridor.
  - **HS3 – Lay-down area nearby turbine.** Temporarily cable/chain contact with seabed during the disconnecting operation could be in direct conflict with the identified Sabellaria communities Consider the operational solution and touching areas to minimize influence on the Sabellaria community.
  - **Existing chain corridors.** Both along and on anchors chains there are observations of Sabellaria. There are already significant sideways movement of the chains, especially close to the touch down location. Minimize alteration of the horizontal direction of the existing chain to limit the influence area.

Other fauna observations

- No other species or habitats identified are evaluated as threatened or have a protective status.
- Previously observation proposed as possible cold-water coral *Desmophyllum pertusum* is not a coral but a lacy tubeworm cf *Filograna implexa*

Observed influence in the area from the wind park

- There is significant influence on the seabed within the anchor corridors from touch down out to approximately 50-100m. Apparently the chain movement cause depressions in the seabed up 2m deep and up to 15m wide.
- There are moderate densities of shell debris underneath the turbines and the free span of the anchor chains.
- The garbage observed doesn’t necessarily derives from the wind park.

APPENDIX A

Surveyline	Start		Stop	
HS1 IAC	10.12.2023	21:43:00	10.12.2023	22:10:00
HS1 IAC ext	13.12.2023	12:32:20	13.12.2023	12:39:10
HS1 ML1	10.12.2023	18:58:00	10.12.2023	20:10:00
HS1 ML2	10.12.2023	22:48:00	10.12.2023	23:32:00
HS1 ML2 ext	11.12.2023	16:44:00	11.12.2023	16:57:59
HS1 ML3	10.12.2023	20:17:00	10.12.2023	21:34:00
HS2 IAC	09.12.2023	16:36:00	09.12.2023	16:55:00
HS2 IAC ext	13.12.2023	13:13:58	13.12.2023	13:21:58
HS2 ML1	09.12.2023	13:12:00	09.12.2023	14:05:00
HS2 ML2	09.12.2023	15:49:00	09.12.2023	16:24:00
HS2 ML2 ext	11.12.2023	15:57:00	11.12.2023	16:08:00
HS2 ML3	09.12.2023	14:28:00	09.12.2023	15:30:00
HS3 IAC E	09.12.2023	12:03:00	09.12.2023	12:20:00
HS3 IAC E ext	13.12.2023	14:17:50	13.12.2023	14:26:31
HS3 IAC W	09.12.2023	07:30:02	09.12.2023	08:35:00
HS3 IAC W ext	13.12.2023	13:54:54	13.12.2023	14:09:33
HS3 ML1	09.12.2023	08:49:00	09.12.2023	10:11:00
HS3 ML2	09.12.2023	06:13:00	09.12.2023	07:30:01
HS3 ML2 ext	11.12.2023	15:07:00	11.12.2023	15:23:00
HS3 ML3	09.12.2023	10:27:00	09.12.2023	11:35:00
HS4 IAC E	10.12.2023	08:50:00	10.12.2023	09:08:00
HS4 IAC E ext	13.12.2023	11:18:37	13.12.2023	11:27:11
HS4 IAC W	10.12.2023	10:37:00	10.12.2023	10:58:00
HS4 IAC W ext	13.12.2023	11:38:07	13.12.2023	11:47:14
HS4 ML1	10.12.2023	06:08:00	10.12.2023	07:12:00
HS4 ML1-3-Transit	10.12.2023	07:13:18	10.12.2023	07:26:17
HS4 ML2	10.12.2023	09:42:00	10.12.2023	10:22:00
HS4 ML2 ext	11.12.2023	14:08:00	11.12.2023	14:16:00
HS4 ML3	10.12.2023	07:26:18	10.12.2023	08:35:00
HS5 Export	10.12.2023	13:54:00	10.12.2023	14:15:00
HS5 Export and IAC North ext	13.12.2023	15:07:41	13.12.2023	15:28:54
HS5 IAC NE	10.12.2023	14:23:00	10.12.2023	14:40:00
HS5 IAC SE	10.12.2023	16:04:00	10.12.2023	16:18:00
HS5 IAC SE ext	13.12.2023	15:28:55	13.12.2023	16:21:22
HS5 ML1	10.12.2023	12:05:00	10.12.2023	13:33:00
HS5 ML2	10.12.2023	16:20:00	10.12.2023	16:45:00
HS5 ML2 ext	11.12.2023	17:37:00	11.12.2023	17:46:00
HS5 ML3	10.12.2023	14:42:00	10.12.2023	15:53:00
Weather buoy	11.12.2023	13:17:00	11.12.2023	13:26:00

APPENDIX B

Species list

PHYLUM	TAXA	SACFOR scale
Annelida	Sabellaria spinulosa	A-R
Annelida	Filograna implexa	R
Arthropoda	Paguridae	F
Arthropoda	Galatheoidea	O
Arthropoda	Cancer pagurus	R
Arthropoda	Hyas sp.	R
Chordata	Melanogrammus aeglefinus	C
Chordata	Merlangius merlangus	O
Chordata	Pleuronectiformes	O
Chordata	Rajiformes	O
Chordata	Lophius piscatorius	R
Chordata	Pollachius virens	R
Chordata	Sebastes sp.	R
Chordata	Solea sp.	R
Chordata	Scyliorhinus canicula	R
Cnidaria	Actiniaria	O
Cnidaria	Alcyonium digitatum	R
Cnidaria	Tubularia sp.	R
Echinodermata	Asterias rubens	R
Echinodermata	Poraniomorpha	R
Echinodermata	Echinus sp.	R
Echinodermata	Henricia sp.	R
Echinodermata	Hippasteria phrygiana	R
Porifera	Porifera	F
Echinodermata	Luidia ciliari	F

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