

SCOPE OF SERVICES

Project	Energy islands						
Assignment	Geophysical survey for offshore wind farms and energy island						
Document Title	Scope of Services – Baltic Sea OWF Bornholm I & II (Lot 3)						
Document No.	20/08794-2						
Audience	GeoXYZ						
Version	Document status	Prepared by		Reviewed by		Approved by	
		Name	Date	Name	Date	Name	Date
1	Template	JCO	2021-01-18				
2	For tender	JCO	2021-01-22	NHW	2021-01-23	JRA	2021-01-28
3	For tender	JCO	2021-02-12	JRA	2021-02-12	JRA	2021-02-12
4	For rev tender	JCO	2021-03-12	XMBHA	2021-03-12	MZA	2021-03-12
5	For review contractor	XTVSO	2021-03-06	JCO	2021-04-07	XMBHA	2021-04-07
6	Final	XTVSO	2021-04-14	JCO	2021-04-14	XMBHA	2021-04-14

TABLE OF CONTENTS

1. Introduction.....	2
2. Scope or Services.....	5
3. Time Schedule	7
4. Requirements	9
5. Areas of investigation.....	12
Annex 1 - Part 4 – Baltic Sea – Bornholm I.....	16
Annex 2 - Part 5 – Baltic Sea – Bornholm II.....	17

Enclosure

No.

Technical Requirements	1
Standards of Deliverables	2
HSE requirements	3
Quality requirements	4

1. Introduction

1.1 Political background

Following a decision in the Danish Parliament June 2020 Denmark is on the path to establish offshore energy infrastructure in the Danish North Sea and in the Danish Baltic Sea to connect respectively 3 GW and 2 GW offshore wind energy to the Danish mainland and to neighbouring countries via offshore energy hubs.

Figure 1-1 illustrate the regional locations of the project.

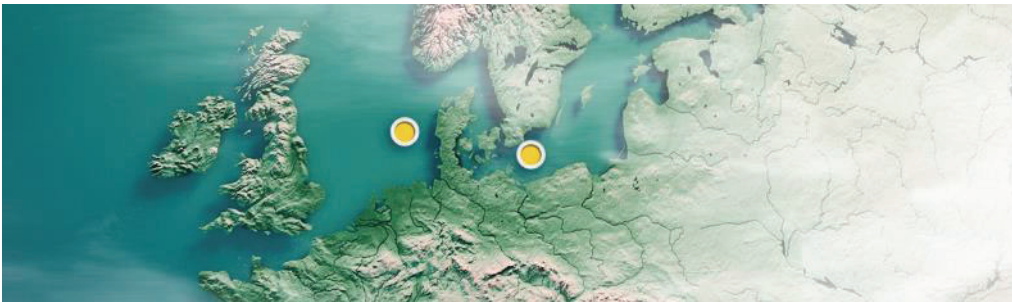


Figure 1-1. Project locations for the North Sea and the Baltic Sea.

1.2 The project

The offshore part of the project include the following main parts:

North Sea:

- 1 offshore wind farm area, of 3 GW.
- 1 energy island (platform or caisson structure or “artificial island”) to host substation functionality and potentially PtX and maintenance facilities.
- Subsea cables from energy island to offshore wind farms.
- Subsea cables from energy island to Denmark (Jutland).
- Subsea cables from energy island to a neighbouring country.

Baltic Sea:

- 2 offshore wind farms, each of 1 GW.
- Subsea cables from energy island (Bornholm) to offshore wind farms.
- Subsea cables from energy island (Bornholm) to Denmark (Jutland).
- Subsea cables from energy island (Bornholm) to a neighbouring country.

The project site parts are illustrated in Figure 1-2 and Figure 1-3 below.

Preliminary feasibility studies indicate that the energy island in the North Sea will require a construction site area in the order of 500m x 500m.

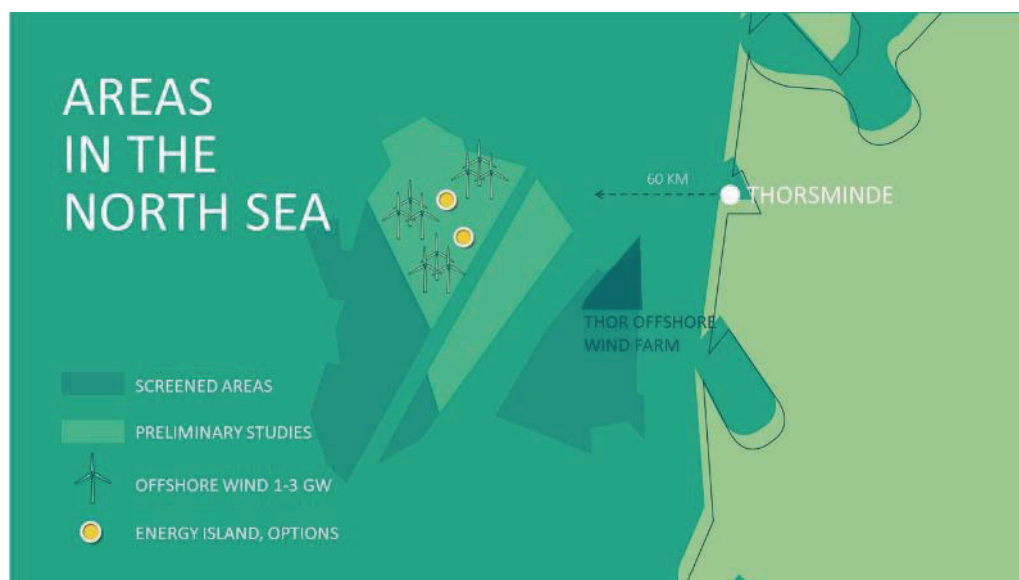


Figure 1-2. Conceptual illustration of the project site parts in the North Sea.



Figure 1-3. Conceptual illustration of the project site parts in the Baltic Sea.

1.3 Site investigations

Following the political decision the Danish Energy Agency has instructed the Client to initiate site investigations, environmental and metocean studies for the abovementioned main project elements.

On the basis of the instruction from the Danish Energy Agency the Client requests the Consultant to commence geophysical survey activities in 2021 for project parts listed in Table 1-1.

For the project parts, Table 1-1 shows the work packages required for each part (more details in section 2.2).

Surveys for the subsea cables are not included in the present scope of services.

Table 1-1. Overview of project parts included in the scope of services, the associated work packages (see section 2.2) and contract lot.

Part	Site	Region	Work package	Contract Lot
4	Bornholm I	Baltic Sea	A, B	3
5	Bornholm II	Baltic Sea	A, B	3

2. Scope or Services

To support the development of the project the Consultant must provide geophysical surveys covering the area of investigation described in Chapter 5.

2.1 Purpose of assignment

The results of the survey should be able to be used as basis for

- Initial marine archaeological site assessment.
- Planning of environmental investigations.
- Planning of initial geotechnical investigations.
- Decision of foundation concept and preliminary foundation design.
- Assessment of subsea inter-array cable burial design.
- Assessment of installation conditions for foundations and subsea cables.
- Site information enclosed the tender for the offshore wind farm concession.

2.2 Scope of assignment

To accommodate the abovementioned purposes the assignment includes the following work packages for part 4 and 5:

- **Work Package A – Geophysical site survey**
A geophysical site survey including 2D UHR seismic survey is performed with commencement in 2021 and completion as soon as possible. The survey has full coverage in the area of investigation. The survey must map the bathymetry, the static and dynamic elements of the seabed surface and the sub-surface geological soil layers to at least 100m below seabed.
- **Work Package B – Magnetometry box survey**
A high-resolution magnetometry box survey is performed at rectangular areas subject to future geotechnical drilling work following the geophysical survey. In addition to magnetometry the scope also include high-resolution acoustic survey (multibeam echo-sounding and dual frequency side scan sonar). The work package is delivered after completion of the marine survey activities of Work Package A.

All work packages includes, that the data acquired from the offshore investigations shall be processed, interpreted and supplied as a number of reports, charts and a set of digital deliverables.

Aerial coverage for the various sites are shown in Table 2-1. The geography of the area of investigations is described in chapter 5

This document - including enclosures - describe the requirements for the scope of services.

Table 2-1. Project sites and approximative spatial coverage.

Part	Site	Region	Area Km2	Work package
4	Bornholm I	Baltic Sea	255 ± 50	A, B
5	Bornholm II	Baltic Sea	298 ± 50	A, B

3. Time Schedule

3.1 Requirements to time schedule

The Client requests that the services are performed with respect to the following schedule:

3.1.1 WPA – Geophysical site survey

1. Marine survey activities are commenced no later than **May 2021**.
2. All marine survey activities are completed no later than **December 2021**.
3. Complete delivery package, revised issue, is provided no later than **2022-05-01**.
4. The Consultant must allow for the following amount of time for the Client to review and comment the draft work package deliverables: **4 weeks**.

3.1.2 WP B – Magnetometry box survey

5. To allow for the subsequent geotechnical activities, all marine survey activities are completed no later than **April 2022**
6. Complete delivery package, revised issue, is provided no later than **2022-06-01**.
 - a. The Consultant must allow for the following amount of time for the Client to review and comment the draft work package deliverables: **2 weeks**.

3.2 Contract milestones

As part of the Consultants tender response, the Consultant supplied milestone dates for the performance of the Scope of Services based on the template displayed in Figure 3-1.

Together with the Consultants detailed time schedule (Gantt style) the provided milestone dates constitutes the contracted time schedule. It appears from Table 3-1, that some selected milestones are subject to liquidated damages (LD) as described in the Service Agreement.

Table 3-1. Overview of contract milestones subject to liquidated damages.

Milestone	WP	Event	Project Part	Contract Lot
M 401	(all)	Premob deliverables provided	4	3
M 405	A	Report provided, draft issue		
M 409	B	Report provided, draft issue		
M 501	(all)	Premob deliverables provided	5	3
M 505	A	Report provided, draft issue		
M 509	B	Report provided, draft issue		

Item	Event	Note	Due date	LD	Milestone
1	Commencement of contract		2021-05-03		
2	Project execution and QHSE plans provided				
3	Kick-off meeting				
4	Premob deliverables provided	3, 4		YES	401
5	Work Package A - Geophysical site survey				
6	Marine operations commenced	1			402
7	Marine operations commenced, 2D UHRS	1			403
8	All marine operations completed				404
9	Report provided, draft issue	2		YES	405
10	Report, Client review		(4 weeks)		
11	Report provided, revised issue	2			406
12	Work Package B - Magnetometry box survey				
13	Marine operations commenced	1			407
14	All marine operations completed				408
15	Report provided, draft issue	2, 3		YES	409
16	Report, Client review		(2 weeks)		
17	Report provided, revised issue	2			410
Note 1	Event has occurred at first day with working time recorded as OPERATIONAL TIME.				
Note 2	Event has occurred when report, including all charts and all digital deliverables have arrived at the Clients' office in Fredericia, Denmark.				
Note 3	Milestones marked with "YES" in the table column "LD" are subject to potential delay damages acc. to contract.				
Note 4	Premobilization deliverables must be provided within 20 calendar days of contract signature. Premobilization deliverables include evidence for meeting the insurance requirements and the performance guarantee. See the Consultancy Agreement for detailed requirements.				

Figure 3-1. Template for contract milestones that must be completed by Consultant as part of his proposal. The milestones regarding provision of the draft reports are subject to liquidated damages (LD) as described in the Service Agreement. The template apply for project parts 4 and 5.

4. Requirements

For the areas of investigation described in section 5 the Consultant must provide data acquisition, seabed sampling and testing, laboratory analyses, data processing, data interpretation and reporting that satisfies the requirements described in section 4.

Work packages A and B apply for all project parts, numbers 4 and 5, Lot 3

4.1 Functional Requirements

4.1.1 Work Package A– Geophysical site surveys

The Consultant must carry out a detailed mapping of the seabed surface to provide:

- Accurate bathymetric data and charts in the surveyed area.
- The morphology and natural features of the seabed surface such e.g. as mega-ripples, sand-waves, boulders, outcropping geology, seaweed and reefs.
- Possible man-made features such as wrecks, debris, fishing gear, trawl marks, anchor scars, objects of potential archaeological interests.
- Identification of features of potential conservation interest including but not limited to; sandbanks, gravel reef, cobble reef, rocky reef and biogenic reef structures.

The Consultant must carry out mapping of the upper part of the subsurface in a sufficient level of detail to:

- Map all major geological layers and structures to at least 100m below seabed.
- Locate structural complexities or geohazards within the shallow geological succession such as faulting, accumulations of shallow gas, buried channels, soft sediments, etc.

4.1.2 Work Package B – Magnetometry box survey

Within the areas of investigation for this work package (see section 5) the Consultant must carry out a detailed mapping of the seabed surface to:

- Identify and locate any man-made or natural objects on the seabed larger than 0.5 m.
- Identify and locate any buried objects with a ferrous mass larger than 50 kg that are buried up to 2 m below the seabed surface.
- Supplement existing survey data to provide a complete data set for target interpretation in the surveyed area
- Chart any findings and observations relevant to the geotechnical contractor (e.g. boulders, wrecks and other Man-Made-Objects), in an appropriate chart format suggested by the Consultant.

4.2 Technical Requirements

To meet the functional requirements the following technical requirements described in this section shall apply.

Detailed technical requirements applying for the scope of services are described in Enclosure 1.

4.2.1 Work Package A – Geophysical survey

The Geophysical survey includes the following:

- **Multi-Beam Echo-Sounding** including **backscatter** for bathymetric mapping, complete coverage within the area of investigation.
- **Side Scan Sonar** (dual frequency) for mapping of the seabed surface. The coverage must have overlap to cover nadir of adjacent survey lines.
- **Magnetometer** for screening of ferrous objects and crossing cables and pipelines.
- **Grab sampling** to support the interpretation of the seabed surface geology.
- **Seismic investigations** using multiple systems
 - Single-channel, high-resolution sub-bottom profiler for mapping of shallow soils in in OWF area.
 - 2D Ultra High Resolution Seismic (2D UHRS) system for mapping of soil units to at least 100m below seabed in the OWF area.

4.2.2 Work Package B – Magnetometry box survey

The magnetometry box survey include the following:

- An appropriate **multi magnetometer / gradiometer** setup, proposed by the Consultant, that can identify ferrous objects placed on the seabed, partly buried and shallow buried within a given accuracy.
- **High-resolution multibeam echo-sounding** and dual frequency **Side Scan Sonar**, complete coverage within the area of investigation.
- Conduct an equipment verification test over a known object as part of the Consultants offshore mobilization.

Important note:

The Client recognizes that the acoustic spread (MBES and SSS) will cover seabed that already during Work Package A has been surveyed with these methods. The purpose of Work Package B is to achieve a more detailed object resolution on and below the seabed surface. Therefore MBES and SSS acquisition are required again for Work Package B. Detailed requirements are specified in Enclosure 1.

4.3 Reporting and Data delivery

The Consultant shall process and interpret all data acquired during surveying as well as carry out all necessary reporting according to the requirements specified in the documents

- Enclosure 1 - Technical Specifications and
- Enclosure 2 - Standards of Deliverables.

4.4 HSE requirements

To manage the Health, the Safety and the Environmental under the assignment a number of requirements attached as Enclosure 3 must apply for Consultants provision of the services.

4.5 Quality requirements

To manage the Quality under the assignment a number of requirements attached as Enclosure 4 must apply for Consultants provision of the services.

5. Areas of investigation

The coordinates for the areas of investigation subject to this assignment are provided by the Danish Energy Agency as part of their instruction to Energinet.

Coordinate lists and ESRI shape files for the area of investigation (OWF – Bornholm I & II) are prepared for the project.

The coordinates lists for project parts 4 and 5 are found in Annex 1 to Annex 2 and the ESRI shape files are enclosed in the Scope of Services.

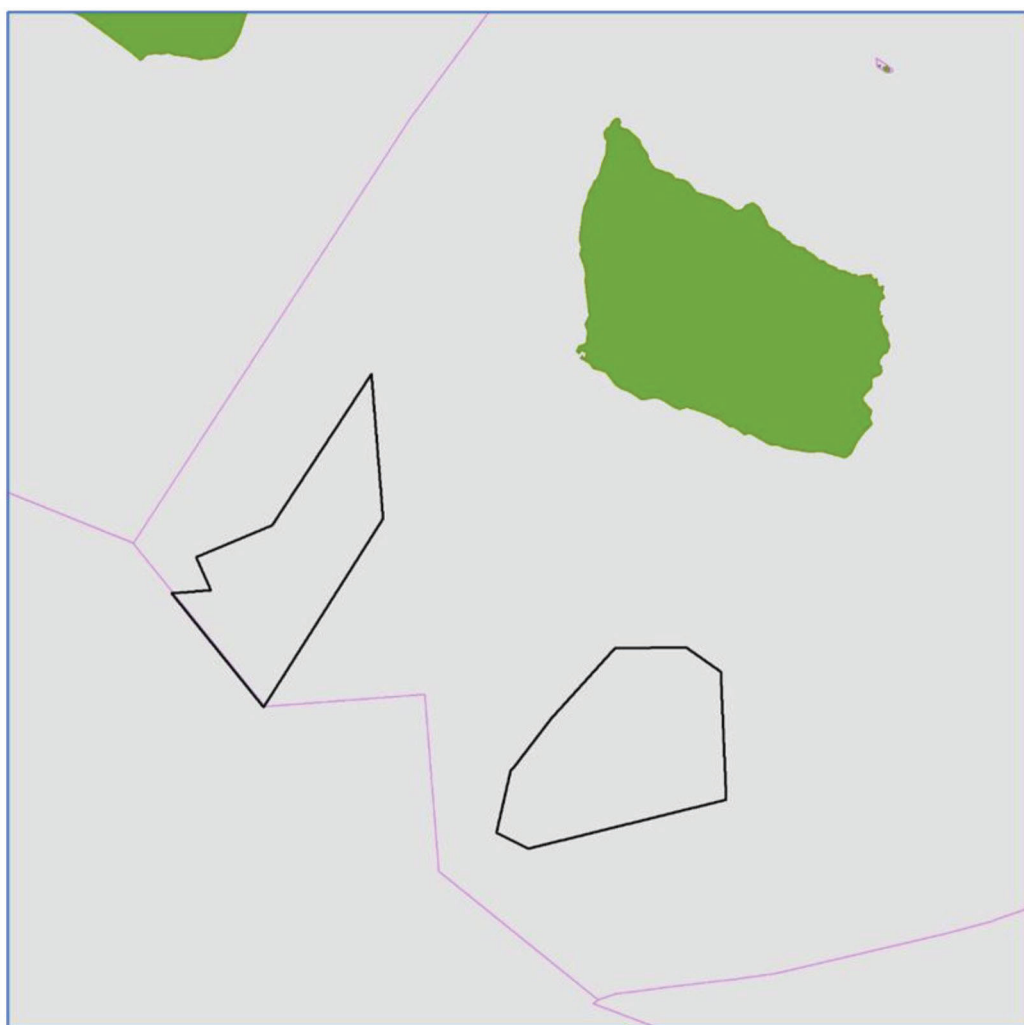


Figure 5-1. Overview of the project site geography. Areas of investigation for the two OWF sites (project parts 4 and 5).

5.1 Admiralty charts

Figure 5-2 show the areas of investigation together with admiralty charts.

In the Baltic Sea, it is seen that offshore wind farm no 5 is intersected by multiple utilities including existing (NordStream) and planned pipelines (Baltic Pipe).

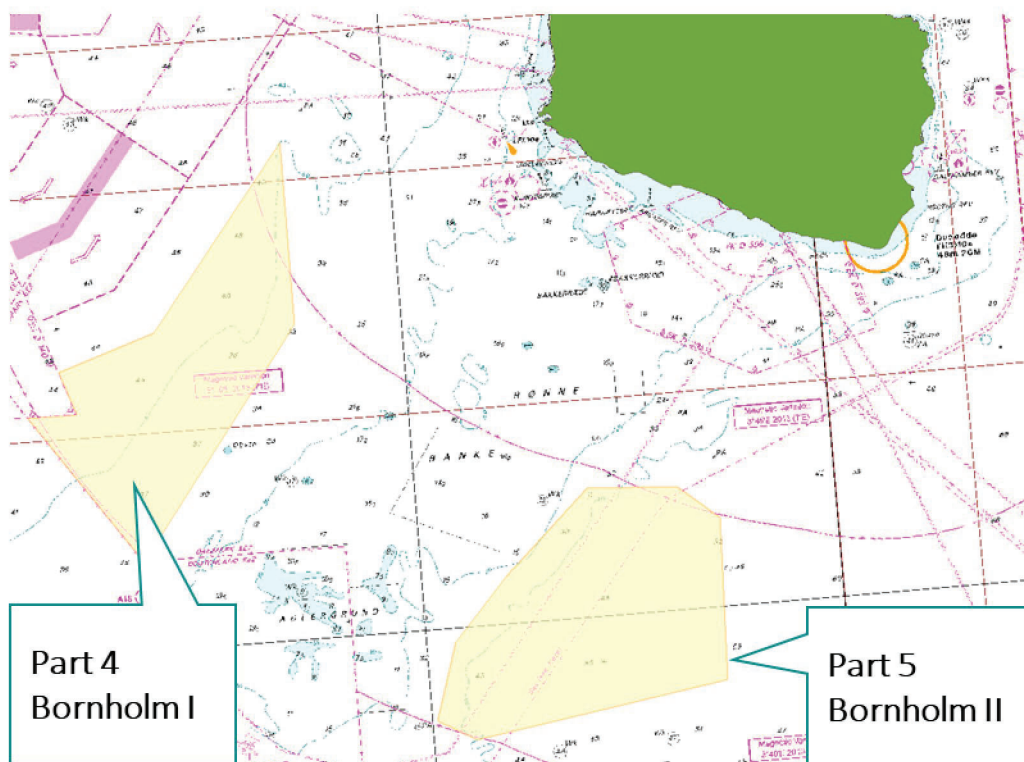


Figure 5-2. Yellow polygons show the areas of investigation for project parts 4 and 5.

5.2 Water depths

The Clients expectations to the water depths in the areas of investigation are seen in Table 5-1 and Figure 5-3. The bathymetrical DTM information in the figures are based on regional models of ca. 100m spatial resolution (Emodnet 2018 MSL). From the figures the following expectations to the minimum/maximum water depths may be assumed:

Table 5-1 Expected water depths within the areas of investigation.

Part	Site	Water depth ranges
4	Bornholm I	30m to 55m
5	Bornholm II	30m to 55m

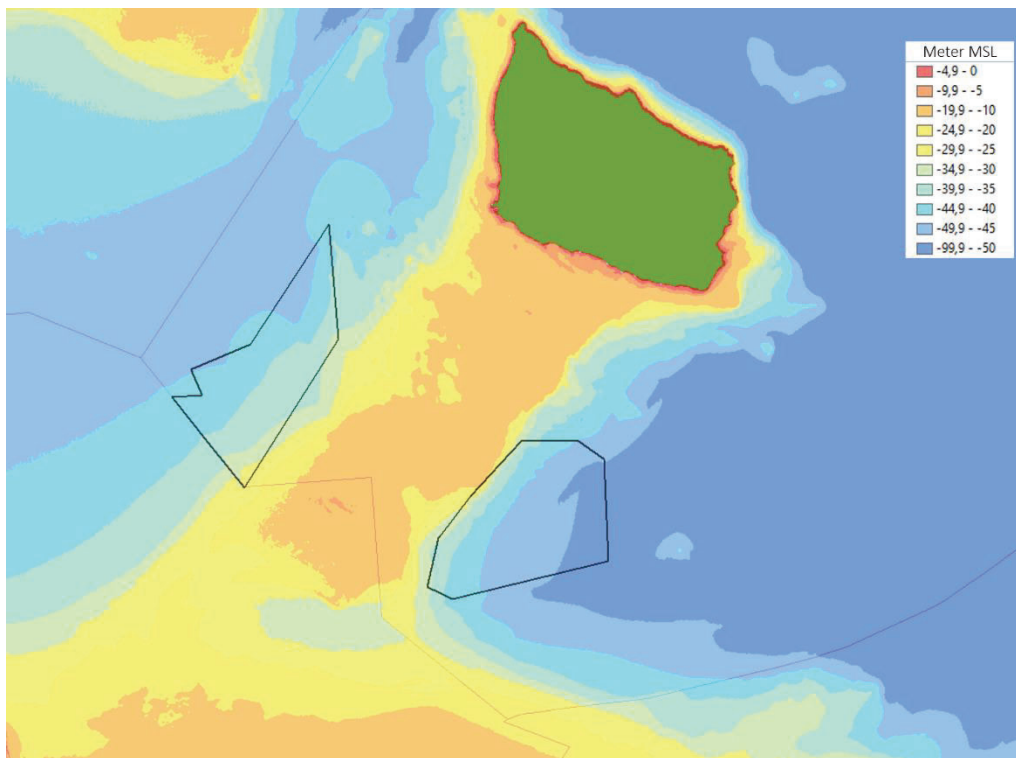


Figure 5-3. Water depths (Emodnet 2018 MSL). BLACK POLYGONS show the areas of investigation for project parts 4 and 5. The SW-NE going shallow water feature represents the "Rønne Banke".

5.3 Geology

Figure 5-4 show the surface geology in the areas of investigation based on models from GEUS (Danish Geological Survey) 2015.

The Client is in the process of establishing geological baseline desktop studies intended for supporting the interpretation of the geophysical and seismological investigations. The studies will be made available for the Consultant.

Baltic Sea

The two offshore wind farm sites no 4 and 5 are located on the outer margins of the *Rønne Banke* formation. This is in particular seen from Figure 5-3. From Figure 5-4 it appear that the seabed geology primarily consists of fine-grained, deposits of marine sand, silt and clay.

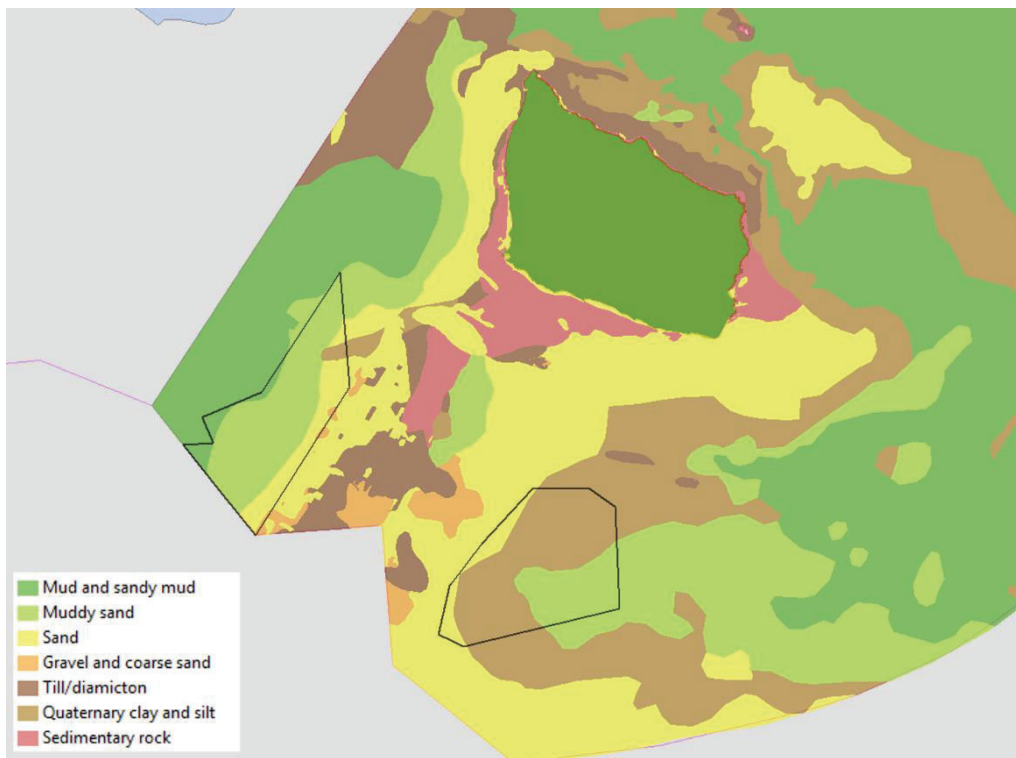
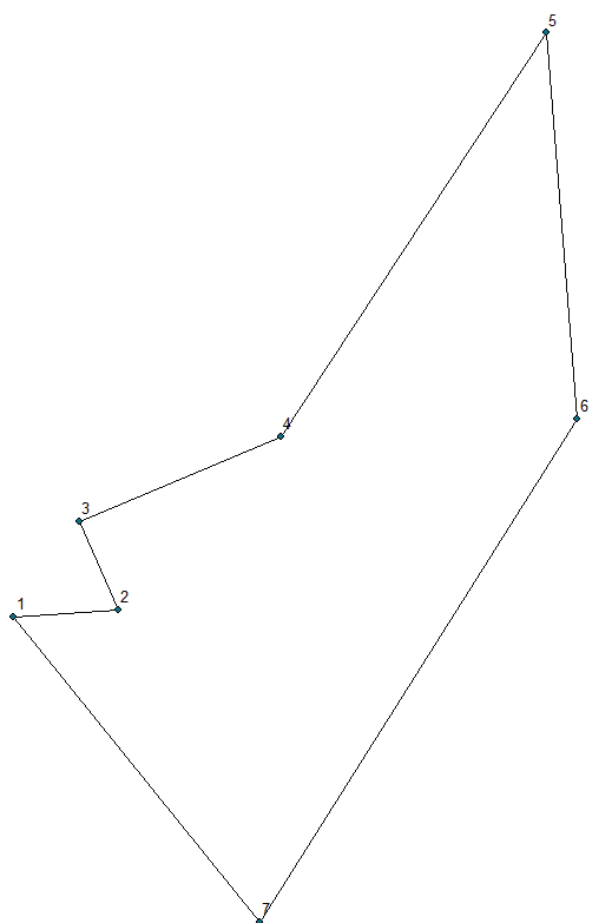


Figure 5-4. Geology, seabed surface (GEUS 2015). BLACK POLYGONS show the areas of investigation for project parts 4 and 5.

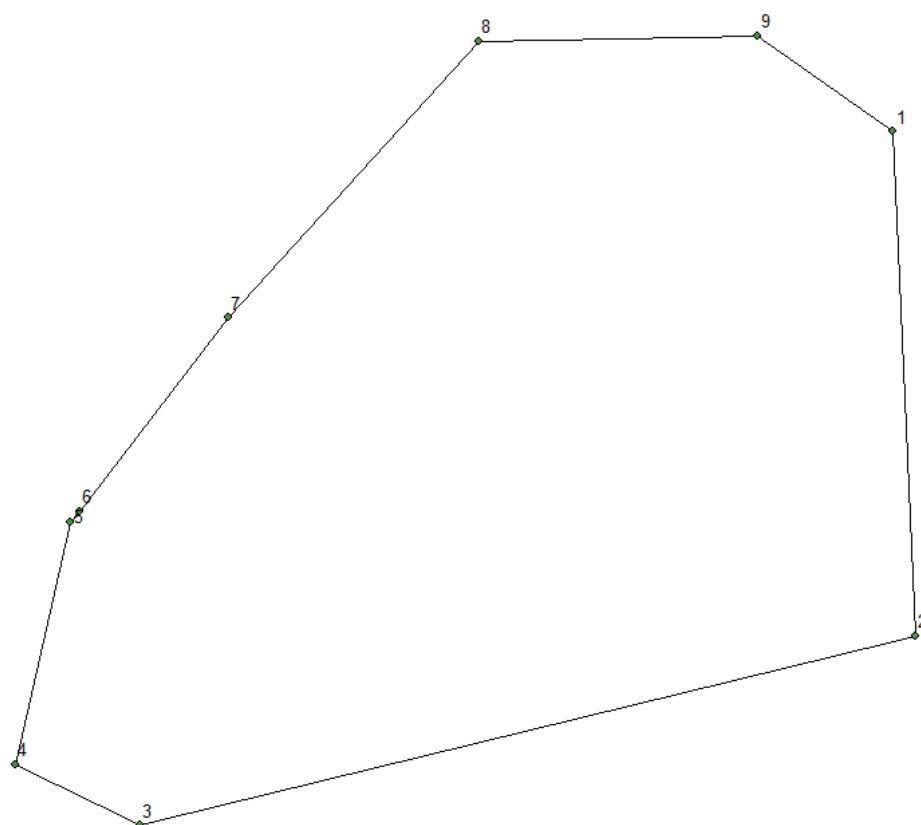
Annex 1 - Part 4 – Baltic Sea – Bornholm I

POINTID	EASTING [meter]	NORTHING [meter]	LATITUDE [DD mm.mmm]	LONGITUDE [DD mm.mmm]
1	438 848	6 085 950	54° 55,008' N	14° 2,759' E
2	442 635	6 085 900	54° 55,008' N	14° 6,304' E
3	441 494	6 089 210	54° 56,785' N	14° 5,196' E
4	449 026	6 091 630	54° 58,139' N	14° 12,225' E
5	459 856	6 105 370	55° 5,606' N	14° 22,258' E
6	459 773	6 091 350	54° 58,047' N	14° 22,299' E
7	446 750	6 074 200	54° 48,728' N	14° 10,285' E



Annex 2 - Part 5 – Baltic Sea – Bornholm II

POINTID	EASTING [meter]	NORTHING [meter]	LATITUDE [DD mm.mmm]	LONGITUDE [DD mm.mmm]
1	490 998	6 073 870	54° 48,714' N	14° 51,596' E
2	490 487	6 061 450	54° 42,017' N	14° 51,143' E
3	471 025	6 058 420	54° 40,339' N	14° 33,042' E
4	468 094	6 060 170	54° 41,272' N	14° 30,303' E
5	469 981	6 066 000	54° 44,422' N	14° 32,024' E
6	470 209	6 066 260	54° 44,563' N	14° 32,234' E
7	474 267	6 070 700	54° 46,970' N	14° 35,993' E
8	481 015	6 076 960	54° 50,364' N	14° 42,264' E
9	487 876	6 076 510	54° 50,134' N	14° 48,674' E



TECHNICAL REQUIREMENTS

Project	Energy islands						
Assignment	Geophysical survey for offshore wind farms and energy island						
Document Title	Scope of Services – Enclosure 1 – Technical Requirements						
Document No.	20/08794-3						
Audience	Tenderers						
Version	Document status	Prepared by		Reviewed by		Approved by	
		Name	Date	Name	Date	Name	Date
1	Template	JCO	2021-01-20				
2	For tender	JCO	2021-01-24	NHW	2021-01-28	JRA	2021-01-28
3	For tender	JCO	2021-02-18	MZA	2021-02-18	MZA	2021-02-18
4	For rev tender	XMBHA	2021-03-12	JCO	2021-03-12	MZA	2021-03-12

Table of Contents

1. Introduction.....	2
2. Geodetic Reference system	3
3. Work packages and quantities	4
4. Planning.....	7
5. Permissions and consenting processes.....	9
6. Vessels	10
7. Personnel and crew	12
8. Equipment and Methods – WP A – Geophysical site survey	13
9. Equipment and methods – WP B – Magnetometry box survey ...	18
10. Equipment and methods – WP C – 3D UHR seismic survey	22
11. Equipment and methods – WP D – UXO survey and inspection ..	23
12. Data Processing	25
13. Data Interpretation	26
14. Reporting requirements.....	29
15. Meetings.....	35

1. Introduction

In the document "Scope of Services" the objectives and the general outcome of the survey activities are described.

This specification, when read in conjunction with the Agreement, referenced standards, specifications and other listed documentation, defines the minimum technical, functional and procedural requirements for the Services associated with the project.

The Consultant shall take responsibility to ensure all survey operations are conducted safely and with full regard to national, international and area specific environmental considerations.

1.1 Constraints

The Client's approval of the Consultant's time schedule, organisation plan, list of subcontractors, list of equipment, etc., shall not relieve the Consultant of any responsibility for the performance of his obligations.

The Consultant shall perform the Services in accordance with best professional standards and practice within the industry plus in accordance with equipment and software manufacturer's recommendations and descriptions.

The presence of and the inspection and supervision by the Client at the worksite as well as any approval, consent, comments and the like given to the Consultant by or on behalf of the Client shall not relieve the Consultant from his obligations and responsibilities.

All data and reports that are a result of the Services are confidential and cannot be distributed to third parties without written permission from the Client.

2. Geodetic Reference system

The survey data is acquired, processed, reported and charted with respect to the following geodetic requirements:

North Sea:

- Datum: ETRS89
- Projection: UTM 32N
- Vertical reference: Mean Sea Level (MSL)
Use model DTU18MSL

Baltic Sea:

- Datum: ETRS89
- Projection: UTM 33N
- Vertical reference: Mean Sea Level (MSL)
Use model DTU18MSL

All vertical information are provided as *depths* relative to MSL such that water depths are positive *downwards*.

3. Work packages and quantities

A number of Work Packages are defined to organize the different requirements in the Scope of Services:

- Work Package A – Geophysical survey
- Work Package B – Magnetometry box survey
- Work Package C – 3D UHR seismic survey
- Work Package D – UXO survey and inspection

This section describes the Work Packages that are necessary to complete the Scope of Services for the areas of investigations.

The requirements for the work packages have been organized in individual chapters in this document to reflect that the work packages have different purposes and different quality parameters:

- Chapter 8. Equipment and Methods – WP A – Geophysical site survey
- Chapter 9. Equipment and methods – WP B – Magnetometry box survey
- Chapter 10. Equipment and methods – WP C – 3D UHR seismic survey
- Chapter 11. Equipment and methods – WP D – UXO survey and inspection

3.1 Work Package A – Geophysical site survey

Within the area of investigation the following requirements must be fulfilled by the survey:

- Multi-beam Echo-sounding survey with full bathymetric coverage. The data quality must accommodate the preparation of digital elevation models (DTMs) of the bathymetry with 25cm spatial resolution.
 - Dual frequency side scan sonar with > 200% coverage to ensure overlap with nadir of adjacent survey lines. Detection of all objects > 0.5m.
 - Single magnetometer or gradiometer towed after vessel, all survey lines.
 - Sub-bottom profiling with two high resolution seismic systems:
 - One high resolution and relative high frequency single channel system, all survey lines.
 - 2D UHRs: One deep penetration and relative medium frequency multi-channel system with survey line spacing of maximum 250m and cross-lines every 1000m.
 - Horizontal positioning uncertainty < 0.5m for vessels.
 - Horizontal positioning uncertainty < 2.0m for towed equipment.
 - Grab samples to support interpretation of bathymetric and side scan sonar data.
- Quantities as listed in Table 3-1.

Furthermore Work Package A include processing and interpretation of the acquired data as described in section 12 and section 13 and specified in the document “Scope of services – Enclosure 2 – Standards of deliverables”.

Table 3-1. Scope for grab sampling. Planning basis for individual project parts based on sampling density of 1 grab sample pr. 3 km².

Part	Site	Area	No of grab samples
1	OWF – zone east	526km ²	150
2	OWF – zone west	533km ²	150
3	NA		
4	Bornholm I	255km ²	85
5	Bornholm II	298km ²	100
6	Energy island – location 1	20km ²	10
Option 1:			
7	Energy island – location 2	15km ²	10

3.2 Work Package B – Magnetometry box survey

For a number of discrete, rectangular subareas within area of investigations a high-resolution magnetometry survey must be performed.

The subareas span either 200m x 150m or 150m x 100m.

The quantities for Work Package B are listed in Table 3-2 but may vary plus/minus 25%.

Table 3-2. Scope for WP B magnetometry box survey for individual project parts.

Part	Site	No of locations 200m x 150m	No of locations 150m x 100m
1	OWF – zone east	20	50
2	OWF – zone west	20	50
3	NA		
4	Bornholm I	12	40
5	Bornholm II	12	40
6	Energy island – location 1	9	20
Option 1:			
7	Energy island – location 2	9	20

The locations of the subareas (boxes) are proposed by the Consultant (see section 4.3).

The high resolution magnetometry data must be combined with multibeam echo-sounding and side scan sonar data in order to identify anomalies caused by surficial or buried sources that potentially could be UXOs.

3.3 Work Package C – 3D UHR seismic survey

To mitigate soil risk at potential locations for offshore substations and platforms a 3D Ultra High Resolution Seismic survey is performed to image a rectangular volume with dimensions (width x lengths x depth) 2500m x 2500m x 60m.

3.4 Work Package D – UXO survey and inspection

The work package include the following main activities:

- High-resolution geophysical survey
- Inspection of selected targets and removal of confirmed UXOs.

3.4.1 High-resolution geophysical survey

The objective of the UXO survey is to provide a full assessment of any anomalies, caused by objects on the seabed surface or buried. Anomalies shall be identified via the geophysical datasets MBES, SSS and MAG that include:

- High resolution Seabed Bathymetry (MBES)
- High resolution Seabed Imagery (SSS)
- High resolution magnetometry (MAG)

It is of high importance that the geophysical anomalies are identified with the best possible horizontal accuracy, to benefit the next phase.

The quantities for this work package is determined by the area of investigation (see document “Scope of services”).

3.4.2 Inspection of selected targets and removal of confirmed UXOs

After completion of the UXO survey, the Consultant is required to deliver a target assessment and target list for the Clients UXO consultant, based on the interpretation of the geophysical anomalies from the UXO survey. Further requirements are specified in the document “Scope of services – Enclosure 2”.

The quantities for this work package is determined by the number of targets for inspection and removal. See quantities pre-printed in the price list.

3.5 All work packages: Reporting and data delivery

All work packages include preparation of reports and charts as described in section 14 and specified in detail in the document “Scope of Services – Enclosure 2 – Standards of Deliverables”.

4. Planning

As an integrated part of the Scope of Services the Consultant must carry out planning related to the Scope of Services. The planning work must include:

- Work Package A to D: Preparation of survey line plans.
- Work Package A: Planning of grab sampling locations.
- Work Package B: Planning of geotechnical program with boreholes and CPTs for subsequent 3rd party contractor.

4.1 Preparation of survey line plans

Before commencement of the marine activities the Consultant must prepare a survey line plan that meets the technical requirements for Work Package A to D.

The survey line plans must accommodate that the quality requirements described in section 8 are met.

On a continuous basis and during the survey the Consultant must monitor the quality of the acquired data and assess if the requirements are met. If the requirements are not met the Consultant must plan infill lines and progress with supplementary survey activities.

It is the responsibility of the Consultant to prepare survey lines plans including infill that consider the environmental and metocean conditions in the areas of investigation.

Additional survey lines may be instructed by the Client Representative and agreed as variation orders to the Agreement.

4.2 Planning of grab sampling

For Work Package A the Consultant must prepare a program for grab sampling on basis of a preliminary interpretation of the geophysical data.

The program for grab sampling will primarily be related to selecting the geographical locations for sampling. The locations shall be selected such that seabed surface units of variable sonar reflectivity are sampled.

The program must be reviewed and approved by the offshore Client Representative.

4.3 Planning of geotechnical boreholes and CPTs

In 2022 the Client plans to let a third party supplier perform preliminary geotechnical investigations with boreholes and seabed CPTs at the wind farm site.

To mitigate the risk towards drilling platforms and seabed units from UXOs, wrecks, debris and large boulders the scope of Work Package B is required.

The Consultant propose a program for geotechnical boreholes and CPTs for the quantities stated in Table 3-2 plus 25%.

The proposal is developed on basis of a preliminary interpretation of the 2D UHRS results. The response format consists of a table with location coordinates and a short memo that summarizes the selection principles and considerations.

5. Permissions and consenting processes

The following permits and consenting processes are required ahead of the marine activities:

1. Danish Energy Agency, Permission for site investigations
2. Danish Geodata Agency, Permission for survey
3. Danish Maritime Agency, Risk Assessment of traffic safety
4. Danish Maritime Agency, Notice to Mariners

The Client is responsible for acquiring #1 and #2 and part one of #3.

The Client has defined 2021-04-07 as deadline for completing #1 to #3.

The Consultant is responsible for completion of part two of #3 and submission of #4.

6. Vessels

6.1 General requirements

Based on the Consultant's experience and detailed operational knowledge, it's the responsibility of the Consultant to select the proper number of vessels necessary for performing the Scope of Services.

It is required that vessels for Work Package A and Work Package B and have full processing and interpretation capabilities on-board.

Based on the Consultants experience and availability of appropriate vessels, it's the responsibility of the Consultant to propose and carry out most favourable mode of operations.

The vessels shall have been built for survey activities or suitably converted to undertake the specified work in the designated geographic area.

The vessels shall be able to operate under the meteorological and oceanographic conditions within the limitations stated by the Consultant in his tender.

The vessel(s) shall be equipped with adequate communication equipment for telephone communication plus continuously high-speed internet connections with a speed of at least 1 Mbit/s for digital data distribution.

The vessels shall be proven to be acoustically quiet to enable good quality acoustic data to be acquired. The acoustic noise signature shall be acceptable outside the acoustic frequency range of the survey equipment to be deployed from the vessels.

Vessel deck areas used for survey operations shall have good lighting and be free of trip hazards. All areas of the vessel used for the survey equipment deployment/recovery shall be either visible from the bridge, or good quality closed-circuit video of such areas shall be provided on the bridge at all times of such operations.

6.2 AIS

The vessels shall be equipped with AIS. The AIS transponder on board the vessels shall automatically, and with the required accuracy and update rate, provide other vessels and authorities with relevant information about the vessels and their navigation.

6.3 Offshore Client Representative

The Client will employ a Client Representative to provide offshore presence during the mobilisation and operation at any vessel offered by the Consultant.

The specific roles and responsibilities of the offshore Client Representatives will be addressed at the project kick-off meeting.

On the offshore vessels, operated at 24 hours basis, the Consultant must allow for two (2) Client Representatives. If vessels are operated at 12 hours basis, the Consultant must allow for one (1) Client Representative.

As a minimum the Client Representative cabin shall be a single cabin and fitted with telephone, at least 1 Mbit/s internet connections and adequate offline facilities for evaluation of the results.

6.4 Marine Mammal Observer and Passive Acoustic Monitoring system

It is required to provide Marine Mammal Observer (MMO) and PAM (Passive Acoustic Monitoring) for work packages A and C.

The detailed requirements will be defined by the Danish Energy Agency as part of the survey permit.

7. Personnel and crew

The manning of the survey team is the responsibility of the Consultant. The Consultant must provide sufficient competent supervisory, technical and other personnel to properly perform the service.

The Consultant may not replace key personnel without written approval from the Client. All marine personnel should be qualified in accordance with the requirements of the flag of registration.

The master and other principal vessel officers must be fluent in written and spoken English. All personnel sailing on the vessels are expected to be medically fit and the Consultant is required to ensure that regular medical examinations are undertaken.

The Party Chief shall be the Consultant's nominated offshore Survey Representative and shall liaise directly with the offshore Client Representative.

8. Equipment and Methods – WP A – Geophysical site survey

The Consultant's equipment, materials, supplies and tools shall be of first-class quality and shall be in good and safe operational condition, approved for use in the survey area. The Consultant shall maintain and repair all equipment and tools and maintain adequate stock levels and spare parts and spare equipment in order to ensure timely operations.

All equipment shall be installed and operated in such a way no interferences or disturbances between the various equipment units or the vessel and the equipment units occur.

All equipment and instruments must be able to operate under the meteorological and oceanographic limitations stated by the Consultant in his tender.

As a minimum but not limited to, the vessels shall be equipped with the equipment specified below.

8.1 Vessel Positioning System

The positioning of the vessels shall be determined with a highly accurately Global Navigation and Satellite System (GNSS) positioning system(s). Positioning shall be carried out such that coordinates are derived with sufficient accuracy to meet the objectives and needs of the project as specified in section 3.

As part of the mobilisation and acceptance test in the port(s) of mobilisation, the GNSS antennas position determined by the GNSS-system(s) shall be compared with the GNSS antennas position determined by land survey methods.

At least two independent vessel positioning systems need to be available. Furthermore the vessel(s) shall be equipped with motion sensor and gyro.

The vessel gyro shall meet the following specifications:

- Dynamic heading accuracy of $\pm 0.2^\circ$ or better
- Static heading accuracy of $\pm 0.05^\circ$ or better

The horizontal and vertical uncertainty of the vessel position shall be less than 0.5m.

8.2 Towed Equipment Positioning System(s)

All towed equipment shall be positioned relative to the vessel by highly accurately positioning systems, e.g. Ultra-Short Baseline (USBL) systems, with a horizontal uncertainty less than 2m.

The relative positions of all the towed equipment in relation to the vessel shall be interfaced to the positioning computer to provide orientations and distances for computation of offset positions from the GNSS antenna(s) as well as absolute positions. Mini-beacons must be provided to support the positioning of towed equipment.

The relative as well as the absolute positions of the towed equipment shall be stored in the positioning database.

The tow cable winch shall be remotely controlled from the geophysical survey instrument room and fitted with a remote alarm.

Layback of the towed equipment shall be measured by a calibrated meter on the deployment pulley and by USBL. Alterations to the tow cable length during surveying shall automatically be recorded in the acquisition system.

8.3 Bathymetric System(s)

The bathymetric data shall be acquired with a multi-beam echo-sounding (MBES) system and provide a spatial density that at least has 16 depth soundings pr. square meter.

The acquired set of soundings are feasible for manufacturing digital elevation models (DTMs) of the bathymetry with 25cm spatial resolution such that the grid standard deviation (95% confidence interval) is less than 0.2m.

The data shall be acquired in *equal distance* mode.

The MBES system shall record backscatter images.

The bathymetric system shall be supplied with ability to compensate for motion such as Pitch, Roll, Yaw and Heave.

8.4 Sound Velocity Profiler

The speed of sound in water shall be measured in the survey area at intervals not exceeding 6 hours.

The measurement shall be made using calibrated sound velocity profiler. Measurements shall be taken at suitable intervals from the sea surface to the seabed.

A second set of readings shall be taken from the seabed to the sea surface and the speed of sound computed from the measured values.

It's the responsibility of the Consultant to ensure the required vertical as well as horizontal resolutions are achieved and maintained during all periods of surveying. If so needed, the Consultant must apply and operate a moving sound velocity profiler system, which allows continuous monitoring of the entire water column. If also so needed to be able to achieve the required resolutions, acoustic ray bending algorithms shall be applied for depth and position calculations.

8.5 Dual Frequency Side Scan Sonar System(s)

A dual channel side scan sonar system shall be provided. The Consultant shall propose an instrument with operating HF and LF frequencies that will optimize the performance with respect to coverage and resolution in relation to the objectives of this survey.

Objects larger than 0.5m along the shortest axis must be resolved in the sonar images.

The applied operational range of the side scan sonar system shall be selected to ensure as high resolution as possible plus to ensure side scan sonar overlap to cover nadir regions of adjacent survey lines (i.e. coverage > 200%).

The Client anticipates that the side scan sonar system shall be installed and operated in a terrain following mode at a fixed height above seabed at 8-12% of the operational range. The Consultant may propose other configurations if this is a benefit for the survey.

The towing system shall be designed and operated to ensure the side scan sonar system is adequately decoupled from vessel's heave, pitching and rolling motion.

The survey speed at which side scan sonar surveys are undertaken shall normally be maintained at 4.0 knots ($\pm 10\%$).

8.6 Seismic profiling

Two high resolution seismic systems must be provided:

- One relative high-frequency single channel system for mapping the geology to 10m below seabed.
- One relative medium frequency multi-channel system for mapping the geology to 100m below seabed.

8.6.1 Relative high-frequency single channel system

The sub-bottom system shall be able to in details to map at least the uppermost 10m of seabed sediments and sedimentary bedrock in a variety of geological conditions.

One high-frequency single-channel sub-bottom profiler system must be provided (e.g. Innomar SES-2000 or similar) to map shallow geology including layer interfaces to 10m below seabed with a vertical resolution better than 0.3m.

To achieve this to Consultant must provide a system that is optimized for the above-mentioned objective regarding:

- Altitude of towfish with seismic system
- Ping rate
- Signal frequency

8.6.2 2D UHRS: Relative medium frequency multi-channel seismic system

The system could be using e.g. GeoSparker 200, or similar for detailed geological mapping of at least the uppermost 100 m of the seabed sediments. Especially, the system shall be designed, operated and data processed for seabed multiple suppression and relative deep penetration. The system(s) shall be towed after the vessel(s) and shall as a minimum have the following general specifications:

- Fundamental frequency between 1 and 3 kHz.
- Vertical resolution better than 0.3m.
- Penetration to at least 100m below seabed.
- Fire rate ≥ 2 pulses/second.
- Variable energy levels between 100 and 1000 Joules.
- A suitable multi-channel and multi-element hydrophone streamer (e.g. 48 channels @ 3.125m) with depth control plus depth measurement for continuously monitoring and recording of streamer depth.

8.7 Magnetometer

A marine magnetometer (e.g. Geometrics G-882 or similar) must be towed behind the vessel.

The magnetometer must be towed in a distance from the vessel such that the instruments are free of the vessel magnetic noise.

The seabed altitude of the magnetometer must be recorded with an altimeter.

The following requirements shall apply for the magnetometer:

- Magnetometer seabed altitude: ≤ 5 m
- Magnetometer measurement sensitivity: 0.01 nT
- Magnetometer sampling frequency: 1 – 20 Hz (selectable)
- Noise level ≤ 2 nT.
- All measurements must be recorded digitally.

8.8 Grab sampling

An appropriate numbers of Ground Truth Sampling, e.g. grab samples or similar, must be carried out to be able to, in conjunction with the results from the side scan sonar and bathymetric system(s) to characterize the seabed according to industry standard.

The locations for grab sampling must be selected together with the Client's Representative on basis of a preliminary interpretation of the swathe bathymetric and side scan sonar results.

The Grab Sampling shall be carried out not more than 5m from the designated position. The accuracy of the positioning of the Ground Truth Sampling shall be better than 2m.

If less than 5 kg of geological sample material is obtained, the Client Representative may instruct up to two (2) additional attempts on each site, without any extra costs.

Samples shall be preserved. After a preliminary visual geological description of the soil, the samples shall be carefully sealed and stored on the vessel for potential later transportation to an onshore laboratory for potential further testing.

All grab samples must be subject to a geological characterization according to

- A guide to engineering geological soil description. G. Larsen et. al. DGF-Bulletin 1. Danish Geotechnical Society.

Among other things this requirement means that samples must be described regarding:

- Lithology
- Depositional environment
- Geological age

A selected number of grab samples must be subject to the following geotechnical classification tests:

- Particle size, Sieve analysis
- Particle size, Hydrometer analysis
- Organic content, Loss on ignition

9. Equipment and methods – WP B – Magnetometry box survey

The Consultant's equipment, materials, supplies and tools shall be of first-class quality and shall be in good and safe operational condition, approved for use in the survey area. The Consultant shall maintain and repair all equipment and tools and maintain adequate stock levels and spare parts and spare equipment in order to ensure timely operations.

All equipment shall be installed and operated in such a way no interferences or disturbances between the various equipment units or the vessel and the equipment units occur.

All equipment and instruments must be able to operate under the meteorological and oceanographic limitations stated by the Consultant in his tender.

As a minimum but not limited to, the vessels shall be equipped with the equipment specified below.

The geophysical vessel shall, be equipped with the equipment specified in this chapter.

9.1 Vessel Positioning System

Section 8.1 apply.

9.2 Towed Equipment Positioning System

Section 8.2 apply.

9.3 Bathymetric System(s)

The provided bathymetry system(s) shall be suitable for the water depths (20 – 50 m) and conditions likely to be encountered in the survey areas (e.g. weather, wave height and currents).

The swathe bathymetry system shall be supplied with the following general specifications:

- Frequency: ≥ 300 kHz
- Soundings: Equidistant
- Number of soundings per ping: ≥ 250
- Ping rate: ≥ 30 Hz
- Depth resolution: ≤ 1 cm
- SV measurements on transducer: Yes
- Roll, pitch and yaw stabilised: Yes
- Backscatter recording: Yes

In addition to these quality parameters the bathymetric soundings must be acquired to facilitate a DTM with a spatial resolution of 20cm.

9.4 Sound Velocity Profiler

Section 8.4

9.5 Side Scan Sonar System

A dual channel side scan sonar system shall be provided with the following general specifications:

- Operation frequency: 400/900 kHz or comparable
- Horizontal beam width: ≤ 0.3 degree
- Operational range (meters/side): ≤ 50 m
- Resolution across track: ≤ 5 cm
- Chirp technology: Yes
- Multi-pulse technology: Yes

The applied operational range of the side scan sonar system shall be selected to ensure as high resolution as possible plus to ensure coverage $>200\%$ of side scan sonar to cover nadir of adjacent survey lines.

The Consultant is requested to submit a note in the tender on how to handle this, in order to provide high quality data.

The towing system shall be designed and operated to ensure the side scan sonar system is adequately decoupled from any vessel heave, pitching and rolling motion. The tow cable winch shall be remotely controlled from the geophysical survey instrument room.

Layback of the side scan sonar system shall be measured by a calibrated meter on the deployment pulley. Alterations to the tow cable length during surveying shall automatically be recorded in the acquisition system.

9.6 Magnetometer / Gradiometer

The magnetometry survey shall satisfy the following requirements:

- Utilize total field magnetometer sensors.
- Utilize total field magnetometer sensors capable of recording variations in the magnetic field strength with sensitivity up to 0.02 nT/m.
- Record data digitally at a sample rate ≥ 10 Hz.
- Sensor height above seabed: Maximum 2.5 m
- Involve magnetometers equipped with altimeters and depths sensors.
- Provide 100% coverage in the areas of operation.
- Noise level ≤ 2 nT.

The magnetometers shall be with an operating range of $20,000$ to $100,000$ nanotesla (nT), and a counter sensitivity of less than 0.004 nT/ PHz rms. The magnetometers should have a heading accuracy of less than 1 nT over the entire 360° spin and tumble and an absolute accuracy of less than 3 nT throughout range. They should be suitable for use in the full range of water depth expected at the site.

Each magnetometer (or its fixed frame to which it is attached) shall be fitted with depth sensors and altimeters. Any proposal or method statement omitting depth and height sensors may be considered invalid. The maximum roll angle that the magnetometer/gradiometer can operate under and still have an error limit that is below the gradient required from the EVT needs to be accounted for as a cut-off factor for data quality.

Magnetometers are generally factory calibrated and cannot be altered. In port and at sea testing of the magnetometers shall be carried out prior to the commencement of the work and shall be witnessed and signed off by the Client's onsite representative.

At least two (2) spare magnetometers and altimeters should be available on each vessel.

9.7 Mobilisation

For each survey spread, all systems shall be tested and calibrated during mobilisation in port, upon arrival on site prior to commencing operations, whenever a system is replaced and at any time requested by Client if there is doubt as to its proper performance.

The purpose of the calibrations is to test that all data acquisition sensors and navigational equipment performs as specified by the manufacturer's instructions and the accuracies required under this contract.

The calibration shall at least include:

- Tests of the installation (if required) of all navigation and positioning systems to an in-port state of readiness of the required spreads.
- In-port tests and calibrations of positioning, navigation, geophysical and all other systems.
- Transit to site and on-site pre-operations tests and calibrations of the positioning, navigation, geophysical and any other systems as necessary.

The vessel is calibrated when all equipment are tested and the calibration reports have been signed.

9.7.1 Equipment Verification Test Brief

Prior to undertaking the UXO-specified geophysical survey, in accordance with best practice (see CIRIA C754), an EVT must be undertaken by the Consultant.

This phase does not cover the mobilisation and calibration of the survey equipment array, these activities are generally part of the vessel's mobilisation activities, but tests the functionality of all systems within the array as they will be used within the survey working together.

No potential UXO interpretive parameters or discriminatory data shall be derived from the test.

The Consultant shall qualify the equipment in the manner described in this document. Substitutions or alterations to the plan may need to be considered if, for example, the Consultant can demonstrate suitable tests that fulfil the verification objectives. Such changes or exceptions to this specification shall be clearly described and presented to the Client.

The Consultant should undertake an EVT using a known test piece (specified as a discrete item with a known response) which will aim to achieve the following:

- Document the capabilities and limitations of each geophysical detection instrument selected for UXO risk mitigation.

- Confirm the achievable probability of detection and confidence levels for a known item.
- Observe each geophysical detection instrument operating in the Consultant's configuration, using the Consultant's personnel and methodologies.
- Evaluate the Consultant's data collection, data transfer quality, and data QC method(s).
- Evaluate the Consultant's method(s) of data analysis and evaluation.
- Document system reliability.
- Illustrate how predictive models compare to a known item.

9.7.2 Selection of Test Item

The selection of the test item makes up the first stage of the EVT process. The item should not necessarily aim to replicate a specific item of UXO but provide a repeatable and meaningful test for the survey array to ensure all sensors and positional systems are functioning as designed.

For this, typically a tubular section of rolled steel with appropriate lifting eyes is sufficient although alternative items would be considered.

9.7.3 Equipment Verification Test Methodology

The EVT should aim to replicate survey activity contracted by the Client, therefore all sensors which are to be run in the full survey should be utilized and recorded. The test should take place close to or on the Site of the Project to ensure conditions during the test are as representative of the full survey as possible. The EVT methodology should be included in the Consultant's PEP.

The following shall at least be covered:

- Launch and recovery of the test item;
- Location recognizance to locate a magnetically "clean" and relatively featureless area of seabed for the EVT;
- Location of test;
 - N/S, S/N, E/W, W/E running of survey array over the item;
- Data outputs;
 - MBES; gridded GeoTiff;
 - SSS; mosaic GeoTiff, targets picked and measured;
 - MAG; all 4 runs independently gridded residual grid GeoTiff, targets picked and measured, Oasis Montaj project of EVT data and grids.

10. Equipment and methods – WP C – 3D UHR seismic survey

10.1 Vessel Positioning System

Section 8.1 apply.

10.2 Towed Equipment Positioning System(s)

All towed equipment is positioned in real-time using a network of dual-DGPS antennas located with the seismic sources, and at front and tail buoys for each individual streamer.

The position of each channel, for each shot, will be calculated based on the active positioning system.

Positioning data will be stored in a raw file, in the SEG-Y header and a P1/90 format navigation file will be generated for each swath.

The relative as well as the absolute positions of the towed equipment shall be stored in the positioning database.

The tow cable winch shall be remotely controlled from the geophysical survey instrument room and fitted with a remote alarm.

Layback of the towed equipment shall be measured by a calibrated meter on the deployment pulley and by USBL. Alterations to the tow cable length during surveying shall automatically be recorded in the acquisition system.

10.3 Bathymetric System(s)

No requirements. In advance of the survey a high-resolution bathymetrical DTM will be provided.

10.4 Relative medium frequency multi-channel seismic system

The system could be using a set of multiple GeoSparker 200, or similar for detailed geological mapping of at least the uppermost 60 m of the seabed sediments.

The system includes a set of multi-channel hydrophone streamers towed in parallel configuration after the vessel. Especially, the system shall be designed, operated and data processed for seabed multiple suppression and relative deep penetration.

The system is towed after the vessel(s) and is feasible for accommodating the following quality parameters:

- Horizontal resolution 0.5m
- Vertical resolution 0.3m
- Depth of penetration/mapping 60m
- Fold factor 12 (>90% of 2 x 2 m bins)

Coverage in areas of investigation 100% (full fold within 2500 x 2500 m area)

During survey it is possible to monitor the 3D binning in real-time to evaluate the data quality.

11. Equipment and methods – WP D – UXO survey and inspection

This section specifies requirements to equipment and methods for UXO survey, inspection and removal.

11.1 High-resolution geophysical survey

The UXO survey includes the following elements as main elements in the sensor spread:

- High resolution Seabed Bathymetry (MBES)
- High resolution Seabed Imagery (SSI)
- High resolution magnetometry (MAG)

The magnetometry acquisition is assumed to be performed using an ROTV connected with multiple magnetometers.

See chapter 9 regarding requirements to equipment and methods applicable for

- Vessel positioning system
- Towed equipment positioning system
- Bathymetric system(s)
- Sound velocity profiler
- Side scan sonar system
- Magnetometer / Gradiometer
- Mobilisation

11.2 Inspection and removal

The following are not given as fully comprehensive specifications and as such Consultant shall provide complete details and specifications within its proposal and method statement as to how the following requirements will be met and exceeded. The maximum sea state for safe vessel working and data acquisition should be stated for both the ROV and divers (or other identification methods proposed).

When working in areas of adverse environmental conditions such as high currents, the Provider shall propose methods to increase dive time windows wherever possible.

ROV

For the inspections the Consultant shall use a work-class ROV to locate pUXOs stipulated for positive identification as a result of the geophysical survey.

The ROV shall be equipped with:

- A system to accurately locate the pUXO such as e.g. TSS440.
- Lighting, video and stills photographic equipment (colour and black & white cameras).
- Ultra-high frequency (e.g. Blueview or equivalent) sonar, complete with a 3-dimensional sonar visualisation system.
- Altitude and depth measurement system.
- Excavation system for exposing of targets, such as a non-magnetic airlift system.
- Manipulators to relocate and investigate objects.
- USBL Underwater positioning.

- Underwater INS (Inertial Navigation System) and Gyrocompass, to enhance subsea positioning.
- Online 4-channel Digital Recording System for recording Navigation, Magnetometer data, Video & Sonar including an overlay system to add survey-data to the recording.

The ROV shall be

- Feasible for operating with the subsea conditions that must be expected in the areas of investigation, such as sea current, rugged seabed and water depths.
- Able to provide a stable platform for the measuring equipment. The performance shall be sufficiently documented by the Consultant.

12. Data Processing

The Consultant shall process all data acquired during the survey operations.

The data processing shall improve the subsequent interpretation and ensure the highest possible quality and resolution of the digital deliverables.

Requirements to data formats and specific deliverables are described in the document “Scope of services – Enclosure 2 – Standards of Deliverables”.

In particular for Work Package A and D that include processing of 2D and 3D UHRS data respectively, the Consultant propose a sequence of processing steps for the Client’s approval.

According to the Agreement the Consultant is obligated to amend any non-conformances of the provided services.

Therefore the Consultant shall include safe storage of all digital hydrographical, geophysical, grab samples and other data that has been acquired as a part of the project.

13. Data Interpretation

To meet the objectives of the Services plus the requirements for charting, reporting and digital deliverables, the Consultant shall interpret all the acquired and processed data to meet the highest possible quality.

The Consultant must carry out a number of integrated interpretations using both the geophysical and grab sample data.

13.1 WP A – Geophysical site survey

13.1.1 Geophysical anomalies

When processing of the geophysical data is completed then the data must be analysed to identify anomalies in Multi-beam Echo-sounding, Side Scan Sonar, Sub-Bottom Profiling and Magnetometer.

After the identification of the anomalies they have to be analysed and interpreted e.g. as man-made-objects or as natural seabed features.

Detailed requirements for the deliverables from the interpretations are listed in the document “Scope of Services – Enclosure 2 – Standards of Deliverables”.

13.1.2 Integrated seabed surface interpretation

An integrated data analysis of the geophysical and the grab sample data must be carried out to identify and interpret the following seabed surface themes:

1. **Seabed Surface Features** including morphological units such as dynamic seabed, biology, scars from man-made activities, gas escape features, slopes, scour patterns, erosion and deposition features and boulders.
The Consultant must propose criteria for interpretation of survey data as individual boulders or areal boulder zones. The Client anticipates that “large” boulders are always individually picked in data.
2. **Seabed Surface Geology** including lithological zones, zones of different boulder coverage, outcropping till and others. The Client requests consistency between the geophysical data and the grab sample investigations in the results of the interpretation of the Seabed Surface Geology.
3. **Debris and Man-Made-Objects** including wrecks, potential UXO objects, fishing gear and others.

The integrated interpretation of the abovementioned items #1, #2 and #3 must be done such that full class coverage is obtained within the area of investigation.

Detailed requirements for the deliverables from the interpretations are listed the document “Scope of Services – Enclosure 2 – Standards of Deliverables”.

13.1.3 Geology

Seismic data acquired with the single-channel and multi-channel systems (2D UHRS) must be interpreted for all survey lines.

The seismic lines must be interpreted to be used for assessment of:

- Morphological features below the seabed, e.g. stone and bubble reefs.
- Depth, thickness and distribution of geological layers.
- Geological hazardous features below seabed, e.g. soft seabed, shallow gas, pock-marks, boulders and peat.

The description of the seismic units shall use the nomenclature for soil unit descriptions defined by the reference:

- A guide to engineering geological soil description. G. Larsen et. al. DGF-Bulletin 1. Danish Geotechnical Society.

The seismic data shall be interpreted to achieve consistency with the ground-truthing information from available archive geotechnical information and the surface geophysical results.

Adjacent survey lines must be compared and seismic reflectors must be correlated and joined to form a set of interpretation points, such that layer surface grids and isochore grids can be derived coherently for the area of investigation.

Detailed requirements for the deliverables from the interpretations are listed the document "Scope of Services – Enclosure 2 – Standards of Deliverables".

13.2 WP B – Magnetometry box survey

13.2.1 Interpretation of Objects and Lineaments

The acquired geophysical data – including bathymetrical data, Side Scan Sonar and magnetic data – shall by the Consultant be analysed to identify point- and linear-shaped anomalies.

The object and lineament interpretation must identify any targets on the seabed or objects that are partly or completely buried at shallow depths.

The object and lineament interpretation must identify any seabed features such as pipelines, cables, wrecks, debris, boulders, archaeological features, lost fishing gear, waste, UXO or reefs.

The interpretation must include:

- Analysis of magnetic data for object identification.
- Analysis of swathe bathymetric depth as well as side scan sonar data for object and lineament identification
- Combined analysis of magnetic data with swathe bathymetric depth as well as side scan sonar data for object and lineament validation.

13.3 WP C – 3D UHR seismic survey

To the extent that the data resolution allows, the acquired seismic data is interpreted to identify all geological features relevant for the project such as geological interfaces, faults, buried landscapes and paleo-valleys, glacial morphological features, boulders and shallow gas formations.

13.4 WP D – UXO survey and inspection

To the extent that the acquired ROV data allows, the acquired inspection data is interpreted based on information provided by the Client.

13.4.1 Interpretation of Objects and Lineaments

See section 13.2.1.

14. Reporting requirements

During the various stages of the assignment the Consultant has to deliver a number of plans, reports and digital deliverables.

Table 14-1 provides a schematic and staged overview of the outputs that must be provided as an integrated part of performing the Scope of Services for each individual work package.

Section 14 gives in conjunction with the document “Scope of Services – Enclosure 2 – Standards of Deliverables” a description of the requirements that apply to the deliverables.

Furthermore - in order for the Client to complete his part of the application for permissions the Consultant must upon request and without delay provide the Client with any supplementary relevant master data or metadata relating the vessels, instruments, crew or other parameters related to the survey.

For the provision of the Draft deliverables indicated in Table 14-1 the Client will use the time indicated in the document Scope of Services, section 3 for Client review. Hereafter, the Consultant will finalize revised deliverables based on the Client’s comments and feedback.

Table 14-1. Schematic overview of the various deliverables that must be provided during the Agreement.

Event	Deliverable	Work Package				Section
		A	B	C	D	
Agreement	Project Execution Plan	X	X	X	X	14.1
	HSE Management Plan	X	X	X	X	14.1
	Quality Management Plan	X	X	X	X	14.1
Kick-off meeting						
Mobilization start	Acceptance Test Report	X	X	X	X	14.2
Mobilization end						
Survey operations	Daily Progress Reports	X	X	X	X	14.3
	Weekly Management Reports	X	X	X	X	14.4
	Monthly HSE Reports	X	X	X	X	14.5
De-Mobilization end	Operations Report	X	X	X	X	14.6
Provision of <u>Draft</u> deliverables	Geophysical site survey report	X				14.7
	Magnetometry box survey Report		X			14.8
	3D UHR seismic survey report			X		14.9
	UXO survey report				X	14.10
	UXO inspection report				X	14.10
Provision of <u>Revised</u> deliverables	Do.	X	X	X	X	Do.

14.1 Project Execution and QHSE management plan's

As a part of his project mobilization prior to marine activities the Consultant must prepare and forward three plans to the Client:

- A plan for Project execution
- A plan for HSE management
- A plan for Quality management

The Consultant shall forward the plans to the Client in due time for the Client to review before the kick-off meeting.

The Project Execution Plan shall at least include the following parts:

1. Program planning.
 - a. A high-level description of main activities and their order of performance.
 - b. Technical method statement regarding marine operations (e.g. LARS activities).
 - c. Description of survey line plan and how the plan accommodates that the quality requirements described in sections 8 to 10 are met. The survey line plan must be provided in an ESRI digital format.
 - d. Description of how to plan the scope for grab sampling.
2. Plan for technical quality assurance and quality control.
 - a. Plan for nomenclature and denomination of survey lines, tracks, locations and grabs.
 - b. Plan for nomenclature and denomination of digital deliverables.
3. Plan for the execution of the acceptance tests including pass criteria
 - a. Template for the acceptance test reports for instruments applied for the execution of the Services.

The HSE management plan shall fulfil the requirements specified in the document:

- Scope of Services - Enclosure 3 - HSE requirements

The Quality management plan meets the requirements in the document:

- Scope of Services - Enclosure 4 - Quality requirements

Based on the Client's comments the Consultant shall forward a final Project Execution Plan to the Client for approval.

No quality related services must be commenced prior to the approval of the Project Execution Plan by the Client. This means that the plan needs to be approved prior to commencing off-shore activities.

14.2 Acceptance Test Reports

The vessels are mobilized when all equipment are tested and calibrated and the data acquisition can begin.

As part of the mobilization of the vessels, the final testing and calibrating shall be witnessed by the Client Representative and reported by the Consultant in an Acceptance Test Report for each vessel to be applied for execution of the services.

The Client Representative and the Consultant's party chief shall by signing the Acceptance Test Report agree that the vessels are mobilized and ready for survey.

In particular for Work Package B – Magnetometry box survey, the Acceptance Test Report include also the results of the Equipment Verification Test.

14.3 Daily Progress Reports

Daily Progress Reports for a vessel shall be prepared and submitted from start of mobilization and uninterrupted until end of demobilization.

The Daily Progress Reports must include information regarding:

- Survey status: Completed quantities (current day and cumulated) and remaining quantities.
- Time break down: Mobilization, Operation, Standby, Transit, etc. (current day and cumulated).
- Weather observations (sea state, wind and visibility).
- Weather forecast – next 24 hours.
- Instrumental deviations from normal operation (break downs, calibration issues, etc.).
- QHSE incidents.

The Daily Progress Report must be submitted to the Client before 09.00 am the following day.

The final format of the Daily Progress Report should be addressed at the project kick-off meeting and agreed with the Client.

14.4 Weekly Management Reports

From commencement to completion of the Agreement, Weekly Management Reports (WMR) shall be prepared and submitted by the Consultants contract manager.

The purpose of the report is to inform managers, directors and non-technical stakeholders about the performance and progress. The Client assumes that the WMR's are prepared based on the business data available in the already provided Daily Progress Reports.

The weekly management reports shall cover the previous week's services plus the actual status of the project as on Sunday at 24:00 hrs. UTC.

The WMR is using a short (maximum two pages) and fixed format covering the following information:

Progress table displaying:

- Survey quantities (e.g. line-km, grab samples, box surveys, inspections,...), planned
- Survey quantities, completed last week
- Survey quantities, completed in total
- Survey quantities, remaining

Time-break-down table displaying information about the time categories

- Operations
- Transit
- Down-time, weather
- Down-time, other
- Port call
- ...

For each time category the following figures are provided:

- Planned time
- Time completed last week
- Time completed in total
- Time expected remaining

A table with status on selected milestones

- All marine activities completed
- Report provided, revised issue

For each milestone the following figures are provided:

- Milestone date agreed, time of contract
- Milestone date agreed, revised agreement
- Consultants forecast of date for completion

The Weekly Management Reports are issued every Monday before EOB.

14.5 Monthly HSE reports

On a monthly basis the Consultant is required to submit work hour statistics to the Client. The requirements to the HSE report is described in the document "Scope of Services - Enclosure 3 - HSE requirements", section 1.22.

The specific format of delivery is discussed and agreed at the project kick-off meeting.

14.6 Operations Report

The Consultant must submit an Operations Report that documents vessels, instruments and equipment, methods and procedures, etc.

The Operations Report must cover the operations of all on- and offshore resources. The Acceptance tests reports must be attached the Operational Report.

Requirements to the Operations Report are described in the document "Scope of Services – Enclosure 2 – Standards of Deliverables".

14.7 Geophysical site survey report

The Consultant must submit a Geophysical site survey report by the time indicated in the contracted time schedule.

In general, the Geophysical site survey report inclusive charts and digital deliverables shall present the results and findings of the survey.

The Geophysical site survey report shall be interpretative and provide a detailed assessment of the seabed and sub-seabed conditions by correlating the results gained from the various instruments during the survey activities.

The preparation of the Geophysical site survey report must follow the requirements described in the document "Scope of Services – Enclosure 2 – Standards of Deliverables".

Throughout the preparation of the Geophysical site survey report, the charts and the digital data deliverables, the Consultants Reporting Manager shall maintain a regular dialogue with the Client.

14.8 Magnetometry box survey report

The Consultant must submit a draft Magnetometry box survey Report incl. digital deliverables. In general, the Magnetometry box survey Report incl. digital deliverables shall address all the objectives of the Services.

The Magnetometry box survey Report incl. digital deliverables must follow the requirements described in "Scope of Services – Enclosure 2 – Standards of Deliverables".

The report shall be interpretative and provide a detailed assessment of the seabed by correlating the results gained from the various instruments during the survey activities.

Throughout the preparation of the report and the digital deliverables, the Consultants reporting manager shall maintain a regular dialogue with the Client. The Consultant shall immediately inform the Client of any potential difficulties/areas of concern for the project. Interim results shall be released during the reporting phase if requested by the Client.

14.9 3D UHR seismic survey report

The Consultant submits a 3D UHR seismic survey report by the time indicated in the contracted time schedule.

In general, the 3D UHR seismic survey report inclusive charts and digital deliverables shall present the results and findings of the survey.

The report shall be interpretative and provide a detailed assessment of the seabed and sub-seabed conditions by correlating the results gained from the various instruments during the survey activities.

The preparation of the report must follow the requirements described in the document “Scope of Services – Enclosure 2 – Standards of Deliverables”.

14.10 UXO survey and inspection report

The Consultant must submit two independent reports by the time indicated in the contracted time schedule:

- UXO survey report and
- UXO inspection and removal report

In general, the reports, inclusive charts and digital deliverables, shall present the results and findings of the survey.

The reports shall be interpretative and provide a detailed assessment of the seabed and sub-seabed conditions by correlating the results gained from the various instruments during the survey activities.

The preparation of the reports must follow the requirements described in the document “UXO Survey and Inspection - Scope of Services - Annex 2 - Standards of Deliverables”.

14.11 Digital deliverables

Together with the reports a number of digital deliverables must be supplied. Digital deliverables include the measured data from the various geophysical and hydrographical sensors as well as GIS deliverables.

The digital deliverables must be provided for all work packages.

The format and specifications of these deliverables must follow the requirements described in the document “Scope of Services – Enclosure 2 – Standards of Deliverable”.

15. Meetings

The meeting activities described in this chapter cover all work packages.

There must be an individual kick-off meeting for each specific work package.

When convenient, the weekly and monthly management meetings may process work and activities from multiple work packages.

15.1 Kick-off meeting

The Consultant must facilitate a project kick-off meeting at his own premises where at least the following topics will be a part of the agenda:

- Mobilization and acceptance test criteria
- Project execution plan and Daily Progress Reports
- Principles for planning and adjusting the program of work
- Project Deliverables
- Time Schedule
- Organisation, roles and responsibilities
- QHSE
- Commercial matters
- Contractual matters

The project kick-off meeting shall be scheduled prior to the mobilization of the marine resources.

15.2 Weekly Management Meetings

From commencement of the services and uninterrupted until the completion of the services, every Tuesday morning and based on the previous days weekly management and technical reporting, management web-meetings between the Consultants and the Client's project management incl. reporting manager shall be held.

The Consultant shall facilitate the web-meetings.

The Consultant shall minute the meetings and not later than 24 hours after ending of the meeting, the minutes shall be distributed as on the project kick-off meeting.

15.3 Monthly Status Meeting

The Consultant participates in monthly status meetings that will be hosted every second month by the Client in Frederica, Denmark and every second month by the Consultant.

The purpose of the Status Meeting is to address the status and progress, the data quality, the deliverables as well as the commercial and contractual status of the Agreement. Furthermore relevant technical key topics may be addressed depending on current project phase.

The Consultant shall at least be represented by two persons of whom the Consultants project manager is one of them.

Unless otherwise agreed the Monthly Status meetings shall be held until the agreed deliverables have been accepted by the client.

Enclosure 3 – HSE requirements

Excluded.

Enclosure 4 – Quality requirements

Excluded.