

FYRSKEPPET
OFFSHORE AB



Fyrskpeppet Offshore

Bilaga M4: Hazardous barrel report

HAZARDOUS BARREL REPORT

GEOPHYSICAL SURVEY

2022062-FYR-CMS-FYR_BARRELREP

REVISION 02

FYRSKEPPET OFFSHORE AB



Clinton Marine Survey AB
Kajskjul 107, Frihamnen 16B, SE-417 70 Göteborg, Sweden
Switchboard: +46-(0)8-549 00 860, Fax +46-(0)8-549 00 865, E-
mail: info@clinton.se
www.clinton.se/marine



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Responsibility	Position	Name
Content, Check	Geophysical Manager	Robin Dymind
Approval	Project Manager	Philip Ljungström

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ABBREVIATIONS

DGPS	Differential Global Positioning System
DTM	Digital Terrain Model
ETRS	European Terrestrial Reference System
FFT	Fast Fourier Transformation
FMGT	Fledermaus Geocoder Toolbox
FLO	Fisheries Liaison Officer
gmS	Gravelly muddy sand
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
gS	Gravelly sand
IGS	International GNSS Service
IMU	Inertial Measurement Unit
ITRF	International Terrestrial Reference Frame
kHz	Kilohertz
LAT	Lowest Astronomical Tide
MAG	Magnetometer
MBES	Multibeam Echo Sounder
MRU	Motion Reference Unit
mS	Muddy sand
msG	Muddy sandy gravel
MSL	Mean Sea Level
MSGL	Mega scale glacial lineations
MSS	Mean Sea Surface
M/V	Motor Vessel
OWP	Offshore Wind Park
PPP	Precise Point Positioning
PPS	Pulse Per Second
PTU	Passive Transmitter Unit
QA	Quality Assessment
QC	Quality Control

RMS	Root-mean-square
ROV	Remotely Operated Vehicle
RTK	Real Time Kinematic
S	Sand
SBP	Sub Bottom Profiler
sG	Sandy gravel
SIS	Seafloor Information System
SSS	Side Scan Sonar
SV	Sound Velocity
SVP	Sound Velocity Profile
SVS	Sound Velocity Sensor
THU	Total Horizontal Uncertainty
TPU	Total Propagated Uncertainty
TVU	Total Vertical Uncertainty
USBL	Ultra-Short Baseline
UTM	Universal Transverse Mercator
VORF	Vertical Offshore Reference Frame
WGS	World Geodetic System

1. INTRODUCTION

1.1. Project Overview

A new windfarm is planned at the Fyrskeppet area in the Bay of Bothnia. This survey acquired multibeam echo sounder (MBES), Backscatter (BCS) and Sub Bottom Profiling (SBP).

The purpose of the survey is partly to map the seabed surface and the subsoil with focus on seabed analysis, technical development, surface sediments and archaeology inventory, sediment layers and any obstacles that may affect the installation of the coming windfarm. A total area of 535 km² has been surveyed. Since this area is in close proximity to where a known old dumping site of mercury waste barrels there has been an interest to determine whether there are any within the Fyrskeppet survey area utilizing these instruments as well.

The project area is located North East of the bank 'Finngundsbanken', in the Bay of Bothnia. The area is located North East of Gävle. There is a Natura 2000 area ('Finngundet Östra Banken') next to the project area.

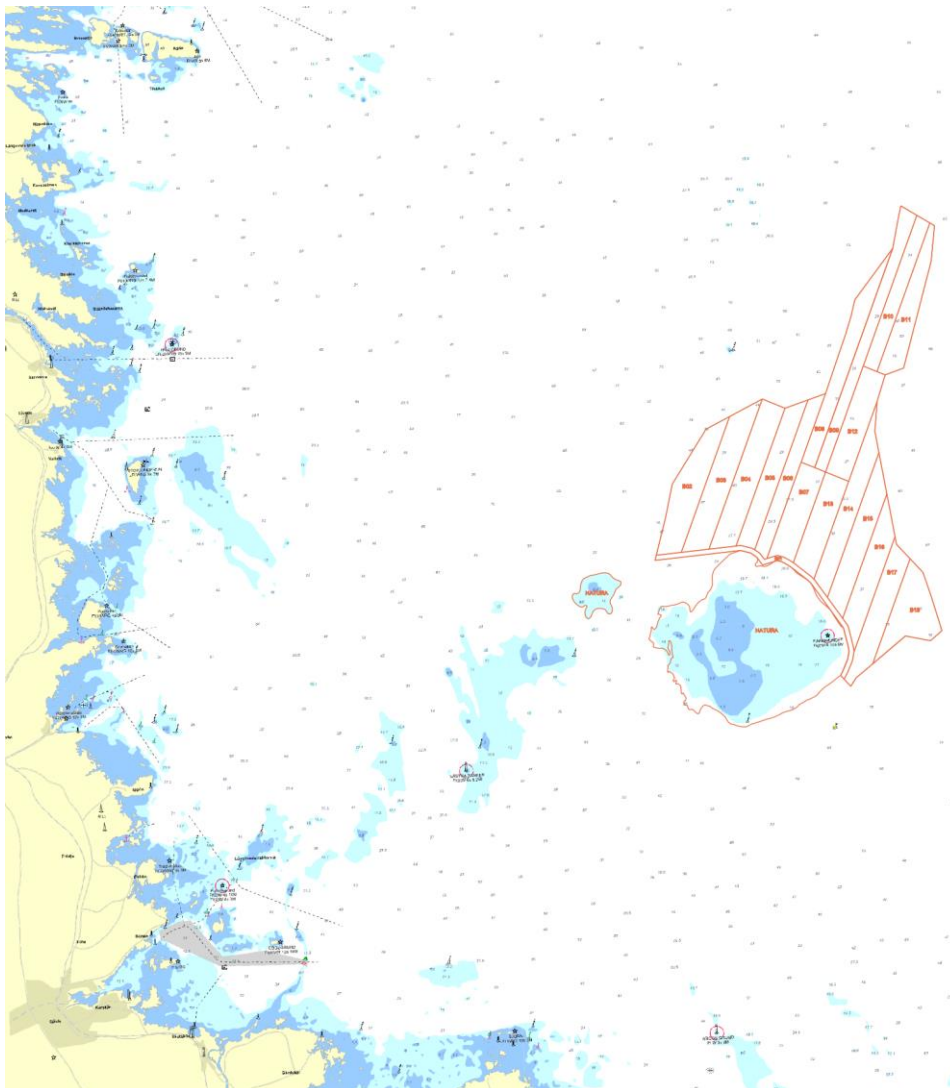


Figure 1 Location overview of the Fyrskeppet project area

1.2. Key personnel

Table 1 Clinton Key Personnel

Name:	Position:	Email:	Telephone:
Martin Wikmar	CEO	martin.wikmar@clinton.se	+46 708 79 90 20
Philip Ljungström	Project Manager	Philip.ljungstrom@clinton.se	+46 708 79 90 26
Anders Wikmar	Technical Manager/ Deputy Project Manager	anders.wikmar@clinton.se	+46 708 79 90 25
Robin Dymind	Geophysical Manager	robin.dymind@clinton.se	+46 708 79 90 27
Jessica Ask Wikmar	Hydrographic Manager	jessica.ask@clinton.se	+46 708 79 90 94
Johan Lindskog	Fleet Manager	johan.lindskog@clinton.se	+46 708 79 90 28

1.3. Purpose of Document

The purpose of this report is to summarize the Fyrskeppet survey results and interpretations, and to present the findings related to any potential hazardous barrels.

1.4. Reference Documents

Table 2 lists all documents that are referenced in the report and provide further information on procedures and results not presented in this report.

Table 2 Reference documents

Document Title:	Document Number:	Document Owner:
Mobilisation and Calibration Checklist	2022062_WPD_Fyrskeppet_Inspection_Test	Clinton
Mobilisation and Calibration Report	Calibration Report Skyborn Renewables Fyrskeppet 2022 Northern Wind_	Clinton
Project Manual	2022062_WPD_Fyrskeppet-PEP	Clinton
HSEQ-Manual	2022062_WPD_Fyrskeppet-HSEQMAN	Clinton
Operations Report	2022062-FYR-CMS-FYR-OPERREP	Clinton
Survey Report	2022062-FYR-CMS-FYR_SURVEYREP	Clinton
Potential Barrel Investigation	2022062-FYR-CMS-FYR_BARRELREP	Clinton

2. GEODETIC INFORMATION

2.1. Geodetic Datum and Grid Coordinate System

The geodetic datum and projection parameters are presented in Table 3 and Table 4.

Table 3 Geodetic Parameters

Datum Parameters ETRS89	
Spheroid	GRS 80
Semi Major Axis	6 378 137.000
Semi Minor Axis	6 356 752.314
Inverse Flattening	298.25722
Eccentricity Squared	0.0066924801

Table 4 Projection Parameters

Projection Parameters	
Projection	SWEREF 99 TM
Central Meridian	15° 00' 00"E
Latitude origin	00° 00' 00"
False Northing	0m
False Easting	500 000m
Central Scale Factor	0.9996
Units	Metres

Data has been acquired in ITRF2014 and transformed to ETRS89 in NaviEdit using a 7-parameter 3D-Helmert transformation model (Figure 2). The accuracy of the transformation formula is 1-2 cm. The transformation parameters have been calculated for epoch 2021, and this is the most recent epoch for which calculated transformation parameters are available based on ITRF2014. Further details on the transformation can be found in "L.Jivall Simplified transformations from ITRF2014/IGS14 to ETRS89 for maritime applications"

$$\begin{pmatrix} X \\ Y \\ Z \end{pmatrix}_{\text{ETRS89}} = \begin{pmatrix} \Delta X \\ \Delta Y \\ \Delta Z \end{pmatrix} + (1 + \delta) \mathbf{R} \begin{pmatrix} X \\ Y \\ Z \end{pmatrix}_{\text{ITRF}}$$

$$\mathbf{R} = \mathbf{R}_Z \mathbf{R}_Y \mathbf{R}_X = \begin{pmatrix} \cos \omega_Z & \sin \omega_Z & 0 \\ -\sin \omega_Z & \cos \omega_Z & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} \cos \omega_Y & 0 & -\sin \omega_Y \\ 0 & 1 & 0 \\ \sin \omega_Y & 0 & \cos \omega_Y \end{pmatrix} \begin{pmatrix} 1 & 0 & 0 \\ 0 & \cos \omega_X & \sin \omega_X \\ 0 & -\sin \omega_X & \cos \omega_X \end{pmatrix}$$

$$\mathbf{R} = \mathbf{R}_Z \mathbf{R}_Y \mathbf{R}_X = \begin{pmatrix} 1 & \omega_Z & -\omega_Y \\ -\omega_Z & 1 & \omega_X \\ \omega_Y & -\omega_X & 1 \end{pmatrix}$$

Figure 2 The 7-parameter 3D-Helmert transformation

Table 5 Transformation Parameters ITRF2014 to ETRS89 Baltic Sea epoch 2021.5

Transformation from ITRF2014 epoch 2021.5 to ETRS89	
Shift X (m)	0.97637
Shift Y (m)	1.17886
Shift Z (m)	-0.82343
Rotation X (")	0.039864
Rotation Y (")	-0.021001
Rotation Z (")	-0.035961
Scale (ppm)	-0.01381

2.2. Vertical Datum

Data (MBES) has been reduced to the vertical reference RH2000 by using a post-processed kinematic PPP (Precise Point Positioning) solution and the SWEN17 geoid model. A positive up, negative down frame of reference is used for all deliverables, i.e. all depths are negative below RH2000.

2.3. Time Protocol

All survey systems on board the vessels were in UTC, together with all displays, logbooks and overlays. The daily progress report was referenced to UTC.

3. SURVEY OPERATION

This is a short summary of the equipment, field work and progress during the survey operation. Further information can be found in the Mobilization and Calibration Report and the Operational Report.

3.1. Vessel

More detailed information on the vessels, their reference frames and sensor alignments can be found in the Mobilization and Calibration Report.

3.1.1. M/V Northern Wind

The vessel Northern Wind is a high-resolution, aluminium hulled, survey vessel with a permanent spread for geophysical and hydrographical work. The vessel is 19.5 m and is well suited for surveys in shallow waters as well as offshore as it can operate 24/7.

3.2. Equipment

Table 6 includes a summary of the equipment used in the project.

Table 6 Equipment used during the project on M/V Northern Wind

Equipment	
Positioning & Attitude	Seapath 330+ with Hemisphere H10 corrections from an Atlas Link demodulator
Secondary positioning	Fugro 9205 with Fugro G2 corrections
Multibeam Echo Sounder	Kongsberg EM2040D 0.35°x0.7° at 400 kHz
Sub Bottom Profiler	Innomar SES-2000 Medium 100 kHz Primary Frequency
Sound Velocity Sensor	Valeport mini SVS
Moving Sound Velocity Profiler	Valeport SVX2
Sound Velocity Profiler	Valeport Swift SVP

4. PROCESSING

The datasets of the area were manually reviewed by a team of Geophysicists and Hydrographic processors.

There were often difficult to distinguish between boulders and barrels in the 0.5 to 1 m size range. If groupings of 6-12 (or more) of these spots were found together especially in MBES they were then investigated further and more closely in SBP and BCS.

Examples of this is seen in the Skyborn_Renewables_Fyrskeppet_Potential_Barrel_Investigation report which was sent to client early on in the reporting stage of Fyrskeppet project.

Final verdict would often come to the review of SBP data and BCS, if the SBP indicated a substrata which could contain boulders and that the BCS did not indicate the same reflected amplitude as confirmed barrels had, then these would be marked as boulders.

5. RESULTS

There were no findings of any potential barrels which could be related to the dumped mercury barrels.

There were areas early on in the project which were of concern due to high density of irregular shapes, however these were in detail reviewed in all datasets and deemed as geological in origin, see report [Skyborn_Renewables_Fyrskeppet_Potential_Barrel_Investigation](#).

The in depth investigations of these areas were then later on applied to the rest of Fyrskeppet survey area in order to discriminate boulders from potential mercury barrels.

6. DISCUSSION

The client had concerns regarding the potential possibility that these mercury barrels could be located in the Fyrskeppet survey area. These would then pose a serious environmental hazard for further development of the offshore windfarm.

Barrels were confirmed to be detectable with the instruments that were used in the Fyrskeppet project by a small test survey in an area with known barrels. These were situated in close proximity to the mainland coast. It would be easier to detect and or determine the provenance of 0.5-1 m objects on the seafloor if magnetometry was also used in the survey.

There were no such indications that could be seen in the Fyrskeppet survey area, it does not however guarantee that the area does not contain such barrels.

7. CONCLUSION

The Fyrskeppet survey area is situated far from the coastline in the Bothnian Bay. The known locations of dumped barrels were in close proximity to the coastline. Historical documents detail that the transports which originated from northern Sweden down to Gotland, and that the dumping were done in transit. Most likely the vessels were travelling close the coastline rather than in the middle of Bothnian Bay to minimize weather and risks. Based on this as well as no findings in the Fyrskeppet survey area makes it unlikely to have been used as a dumping area for hazardous mercury barrels.

REFERENCES