Netherlands Enterprise Agency

Site Studies Wind Farm Zone Hollandse Kust (zuid)

An archaeological assessment of geophysical survey results (phase II)

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Cultural Heritage Agency
Ministry of Education, Culture and Science

Smallepad 5
3811 MG Amersfoort
P.O. box 1600
3800 BP Amersfoort
The Netherlands
www.cultureelerfgoed.nl

Contactpersoon
Andrea Klomp

T 033 421 76 88
F 033-421 77 99
a.klomp@cultureelerfgoed.nl

Rijksdienst voor Ondernemend Nederland
t.a.v. Ir. F.C.W. (Frank) van Erp
Postbus 8242
3503 RE Utrecht

Date 13-10-2016
Subject Archaeological assessment report Hollandse Kust Zuid

Reference
B-2016-57

Dear Mr. van Erp,

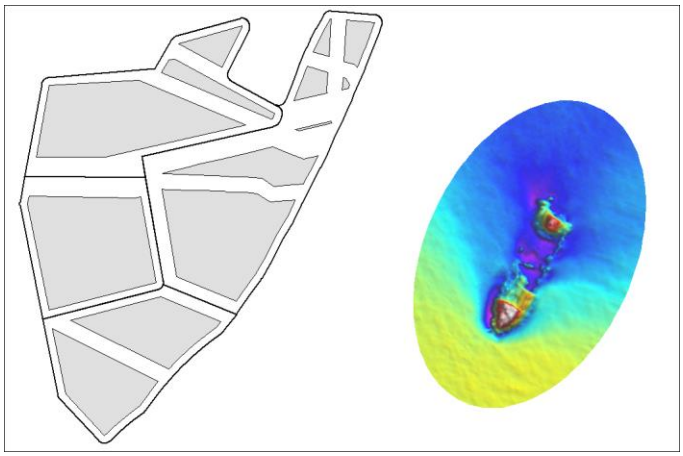
The Cultural Heritage Agency has assessed the report 'An archaeological assessment of geophysical survey results Hollandse Kust Zuid', version 2.0, dated 4th of October 2016. The Cultural Heritage Agency approves the content of this report, including the conclusions and recommendations.

Yours sincerely,

Ms. A.D.C. Klomp
Maritime Policy Advisor
Cultural Heritage Agency

Hollandse Kust (zuid)

An archaeological assessment
of
geophysical survey results



Authors
R. van Lil, S. van den Brenk and E.A. van den Oever

At the request of

Fugro Survey B.V.
P.O. Box 128
2260 AC Leidschendam

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Reviewers	
Organization	**Name**
Fugro	M. Hogerwerf
RvO.nl	F. van Erp
Rijksdienst voor het Cultureel Erfgoed	A. Klomp, J. Opdebeeck
Ministerie van Economische Zaken	B. Wilbrink
Rijkswaterstaat	T. Collette
Blix	B. de Sonneville

Colophon

Periplus Archeomare Report 16A009-01
Hollandse Kust (zuid) – An archaeological assessment of geophysical survey results
Authors: R. van Lil, S. van den Brenk and E.A. van den Oever

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Authorization:

B.E.J.M. van Mierlo

Periplus Archeomare
Kraanspoor 14
1033 SE - Amsterdam
Tel: 020-6367891
Fax: 020-6361865
Email: info@periplus.nl
Website: www.periplus.nl

Content

Table 1. Dutch archaeological periods

Period	Time in Years				
Post-medieval / Modern Times	1500	A.D.	-	Present	
Late medieval period	1050	A.D.	-	1500	A.D.
Early medieval period	450	A.D.	-	1050	A.D.
Roman Times	12	B.C.	-	450	A.D.
Iron Age	800	B.C.	-	12	B.C.
Bronze Age	2000	B.C.	-	800	B.C.
Neolithic (New Stone Age)	5300	B.C.	-	2000	B.C.
Mesolithic (Stone Age)	8800	B.C.	-	4900	B.C.
Paleolithic (Early Stone Age)	300.000	B.C.	-	8800	B.C.

Table 2. Administrative details

Location:	North Sea
Toponiem Dutch:	Hollandse Kust (zuid)
Chart:	1801-01
Coordinates (enveloping framework) Geodetic datum: ETRS89 Projection: UTM31N	 Centre E 574 286 N 5 795 646 Southwest E 561 983 N 5 780 570 Northeast E 586 589 N 5 810 722
Depth (LAT):	16.9 to 27.4; average 21.5 meter
Surface area	389 km^2
Environment:	Tidal currents, salt water
Area use:	Shipping lane, fishing and recreation, sand extraction
Area administrator:	Rijkswaterstaat - Department of Waterways and Public Works
Authorities	Ministry of EZ
Advisor authorities	Dutch Cultural Heritage Agency
ARCHIS-research report (CIS-code):	4010360100
Periplus-project reference:	16A009-01
Period	August - september 2016

Samenvatting (Abstract in Dutch)

In opdracht van Fugro Survey B.V. heeft Periplus Archeomare een archeologische analyse gemaakt van de gefysische data die zijn verzameld in het kader van de voorgenomen aanleg van Windmolenpark Hollandse Kust (zuid).

Doel van de analyse is het toetsen van de archeologische verwachting die op basis van het bureauonderzoek is opgesteld. Specifieke doelen van dit onderzoek waren:

- Het vaststellen van een mogelijke historische of archeologische waarde van objecten aangetroffen tijdens het onderzoek;
- De verificatie van de locaties van bekende objecten in het gebied;
- Reconstructie van het prehistorisch landschap op basis van de seismische gegevens.

Een grote hoeveelheid data opgenomen met side scan sonar, magnetometer en multibeam echosounder van vier windmolengebieden is geanalyseerd. De totale oppervlakte van de gebieden inclusief een bufferzone van 500 meter die onderzocht zijn bedraagt 389 km^2.

Het archeologisch bureauonderzoek heeft aangetoond dat binnen de onderzoeksgebieden 52 objecten en wrakken bekend zijn. 27 van deze objecten bestaan uit losse voorwerpen zoals verloren kabels en kettingen, en hebben geen archeologische waarde. Voor de overige 25 objecten is de archeologische waarde nog niet vastgesteld. In totaal zijn zeven van deze objecten teruggevonden. De overige achttien objecten zijn waarschijnlijk bedekt met zand als gevolg van de migrerende zandgolven in het gebied.

Naast de bekende objecten zijn 558 nieuwe contacten aangetroffen met side scan sonar. De analyse van deze contacten resulteerde in drie objecten met een mogelijke archeologische waarde.

Zolang de archeologische waarde van de objecten niet is vastgesteld, wordt geadviseerd om de locaties met mogelijke archeologische voorwerpen (28 in totaal), inclusief een bufferzone van 100 meter rondom niet te verstoren. Dit geldt ook voor het graven van sleuven voor kabels en het gebruik van verankeringen van werkschepen.

Met de magnetometer zijn in totaal 2394 magnetische anomalieën waargenomen. 679 van deze anomalieën kunnen worden gerelateerd aan bekende pijpleidingen of kabels. Slechts 32 kunnen worden gerelateerd aan zichtbare objecten op de zeebodem, waargenomen met side scan sonar.

De overige 1683 magnetische anomalieën worden veroorzaakt door de aanwezigheid van onbekende afgedekte ijzerhoudende objecten in de bodem. 245 van deze anomalieën hebben een amplitude van 50 nanoTesla of meer.

Met betrekking tot deze begraven ijzerhoudende objecten, wordt geadviseerd om deze locaties inclusief een bufferzone van 100 meter te vermijden bij het installeren van de windturbines en de aanleg van kabels. Benadrukt moet worden dat de oorsprong van de objecten die deze anomalieën veroorzaken onbekend is. Behalve archeologische resten kunnen de anomalieën ook de aanwezigheid van conventionele explosieven markeren.

Als het niet mogelijk is de gerapporteerde locaties te ontzien, is aanvullend onderzoek nodig om de aard en archeologische waarde van deze objecten te bepalen. Geadviseerd wordt, om een eventueel explosievenonderzoek binnen 100 meter van de locaties uit te voeren onder archeologische begeleiding. Afhankelijk van de uitkomst van dit explosievenonderzoek kan besloten worden of aanvullend onderzoek (bijvoorbeeld door ROV of duikers) nodig is.

Van de geïnterpreteerde seismische gegevens kan worden geconcludeerd dat door de afwezigheid van de Formatie van Boxtel en de Laag van Wijchen en erosie van de top van de pleistocene opeenvolging op 0 tot 8,4 meter onder de zeebodem geen in situ resten van prehistorische nederzettingen worden verwacht.

In het bureauonderzoek en de recente publicatie van Deltares wordt aangegeven dat binnen Site I en II prehistorische resten verwacht konden worden. Deze archeologische lagen zijn echter niet geïdentificeerd in de seismische profielen. Aanvullend onderzoek naar prehistorische resten binnen Site I en II wordt daarom niet nodig geacht.

In Site I en IV is het Brown Bank Laagpakket aanwezig. Binnen Site IV zijn zones gedefinieerd die archeologische resten uit het Midden-Paleolithicum zouden kunnen bevatten. In feite is weinig bekend over de werkelijke aanwezige sedimenten en de omgeving waarin deze sedimenten zijn afgezet. In het kader van geotechnisch onderzoek zijn boringen gepland. Geadviseerd wordt om de boormonsters vanuit een archeologisch perspectief te analyseren conform de AMZ-cyclus. Het onderzoek beperkt zich tot de zones binnen Site IV waar archeologische resten uit het Midden Paleolithicum verwacht worden op 13 tot 22 meter onder de zeebodem.

Tijdens de aanleg van het windmolenpark kunnen archeologische resten aan het licht komen die volledig begraven waren of niet als een archeologisch object zijn herkend tijdens het geofysisch onderzoek. We raden daarom passieve archeologisch begeleiding aan op basis van een goedgekeurd Programma van Eisen. Passief betekent dat een archeoloog niet tijdens de uitvoering van het werk aanwezig is, maar altijd op afroep beschikbaar. Hierdoor kunnen vertragingen tijdens de werkzaamheden voorkomen worden wanneer onverwacht archeologische vondsten gedaan worden. Eventuele vondsten dienen gemeld te worden aan het bevoegd gezag.
Het bevoegd gezag is de Minister van Economische Zaken op grond van de Wet windenergie op zee. Rijkswaterstaat (RWS) is door de Minister van Economische Zaken gemandateerd om het toezicht op grond van die wet uit te voeren. De Rijksdienst voor Cultureel Erfgoed (RCE) zal door RWS geconsulteerd worden ten aanzien van archeologische aspecten.

Deze meldingsplicht voor archeologische vondsten dient in het bestek of Plan van Aanpak van het werk te worden opgenomen.

Summary

Fugro Survey B.V. (FSBV) has contracted Periplus Archeomare B.V. to conduct an Archaeological assessment of geophysical survey results of the future Wind Farm Zone (WFZ) Hollandse Kust (zuid) (HKZ).

The purpose of this assessment is to test the desk study based expectancy for archaeological remains in the area. The goals set for this assessment are:

- To determine the historical or archaeological value of contacts found in the geophysical survey
- The validate the locations of known wrecks
- Assess the prehistoric landscape based on the seismic data

A large quantity of survey data (*side scan sonar, magnetometer* and *multibeam* echosounder) recorded within the four wind farm zones (including a safety zone of 500 meters) covering a total area of 389 km^2 were analyzed in order to conduct an archaeological assessment (see figure 1 for survey outline).

The current analysis of geophysical survey results is the second step in the Archaeological assessment, following the desk study. The desk study has shown that a total of 52 objects and wrecks are known within the boundaries of the wind farm sites. 27 of these objects consist of small objects, lost cables or chains, and are not considered to be of archaeological importance. For the remaining 25 objects the archaeological value has not been determined.

Five of these objects have been found exposed at the seabed; two objects presumably are marked by a magnetometer anomaly. The other eighteen objects which, based on the findings of the desk study were expected in the area, have not been found. These objects are likely to be covered with sediments due to migration of the sand waves in the area.

Apart from the five known objects found, 558 other contacts were reported with side scan sonar. The analysis of these contacts resulted in a final selection of six unknown objects and structures which may have an archaeological value, based on their shapes and dimensions. From these six contacts four have been found proximate to one another in Site IV and are considered to form one site.

A summary of all objects with a possible archaeological expectation is listed in the table below.

Objects with a possible archaeological expectation	**WFS I**	**WFS II**	**WFS III**	**WFS IV**	**Total**
Known objects (NCN) found with SSS exposed at the seabed surface	-	-	-	5	5
Known objects (NCN) found with MAG buried beneath the seabed surface	1	-	-	1	2
Known objects (NCN) not found, probably covered with sediments	7	4	6	1	18
Unknown objects found with side scan sonar	2	-	-	1*	3
Total	**10**	**4**	**6**	**8**	**28**

* cluster of contacts at one site.

A map showing the distribution of the objects is presented in the next figure.

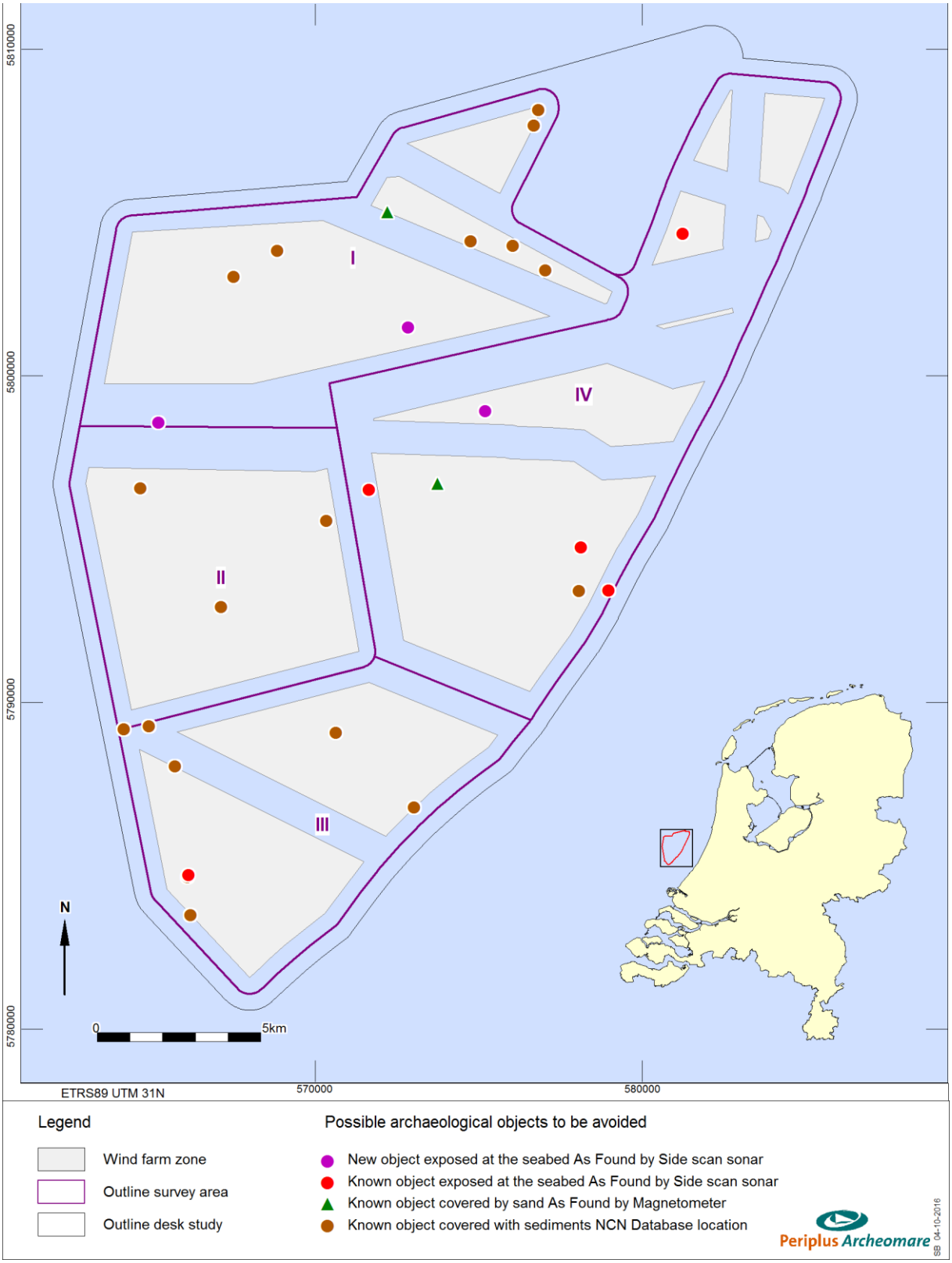
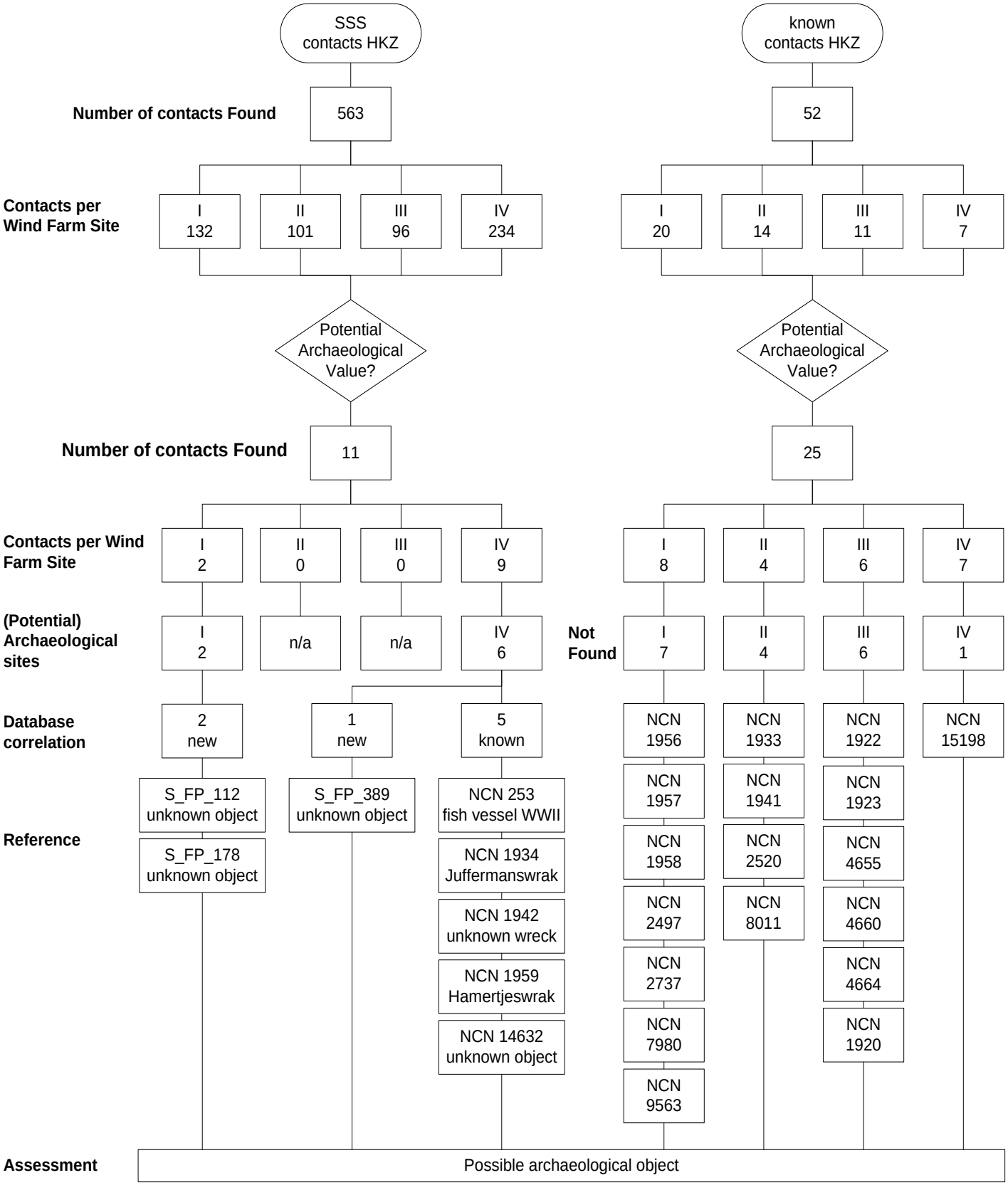


Figure 1. Overview of the potential archaeological objects found with side scan sonar and multibeam

As long as the archaeological value of the objects is not determined, it is advised not to conduct activities which could affect the locations with possible archaeological objects (28 in total) including a buffer zone of 100 meters around. This also applies to cable trenching and anchorages of work vessels.



The buffer zone of 100 meters is a standard that applies to the protection of cultural heritage, this distance may be reduced if it can be substantiated that the applied disturbance has no effect on the archaeological object. For example, when no anchoring is used during cable lay operations the buffer zone can be decreased.

Reduction of the distance may be approved by Rijkswaterstaat (RWS). Rijkswaterstaat is the enforcing authority, acting on behalf of the Ministry of Economic Affairs. The Cultural Heritage Agency of the Netherlands (RCE) acts as an advisor to Rijkswaterstaat.

A total of 2394 magnetic anomalies have been observed. 679 of these anomalies can be related to known pipelines or cables. Only 32 can be related to side scan sonar contacts.

A total of 1683 magnetic anomalies cannot be related to known pipelines and cables, or visible objects at the seabed surface. They are related to unknown ferrous objects buried in the seabed, covered by sediments. 245 of these anomalies have an amplitude of 50 nT and more.

Concerning these buried ferrous objects, it is advised to avoid these locations including a buffer zone of 100 meters areas whilst installing wind turbines and the various inner field and export cables. It should be stressed that the origin of the magnetic anomalies is unknown and apart from possible archaeological remains any type of man-made objects can be encountered including unexploded ammunition, anchors, pieces of chains and cables, debris, etcetera.

If it is not feasible to avoid the reported magnetometer locations, additional research is required in order to determine the actual archaeological value of the reported locations. It is advised that the UXO research within 100 meter of the 245 magnetometer anomalies are carried out under onboard archaeological supervision. Depending on the outcome of the UXO research it can be decided if additional research (for instance by means of ROV or dive investigations) is needed. If the UXO research indicates that the object has no archaeological value, the location can be omitted.

Prehistory

From the interpreted seismic data can be concluded that due to the inferred absence of the Boxtel Formation and Wijchen Member and erosion of the top of the Pleistocene sequence at 0 - 8.4 meters below the seabed - at least at this stratigraphical level - no *in situ* remains of prehistoric settlements are expected.

Based on the desk study and the study from Deltares, prehistoric remains were expected to occur in Site I and Site II. However, these archaeological layers have not been identified in the seismic data. Additional research for prehistoric remains within Sites I and II is therefore not considered necessary.

In Site I and IV the Brown Bank Member occurs. Within Site IV zones have been defined which could contain archaeological remains from the Middle Paleolithic. In fact little is known about the actual sediments present and the environment in which these sediments have been deposited. In the course of the wind farm development bore hole samples are being taken. It is advised to look into these samples from an archaeological perspective, following the *AMZ* cycle. This advice applies to samples taken from the Brown Bank Member in the zones in which Middle Paleolithic remains are expected in Site IV.

In general the development of the wind farm is an opportunity to learn about the Eemian landscape and related archaeology. The wind farm development is not considered to be a possible threat for these landscapes.

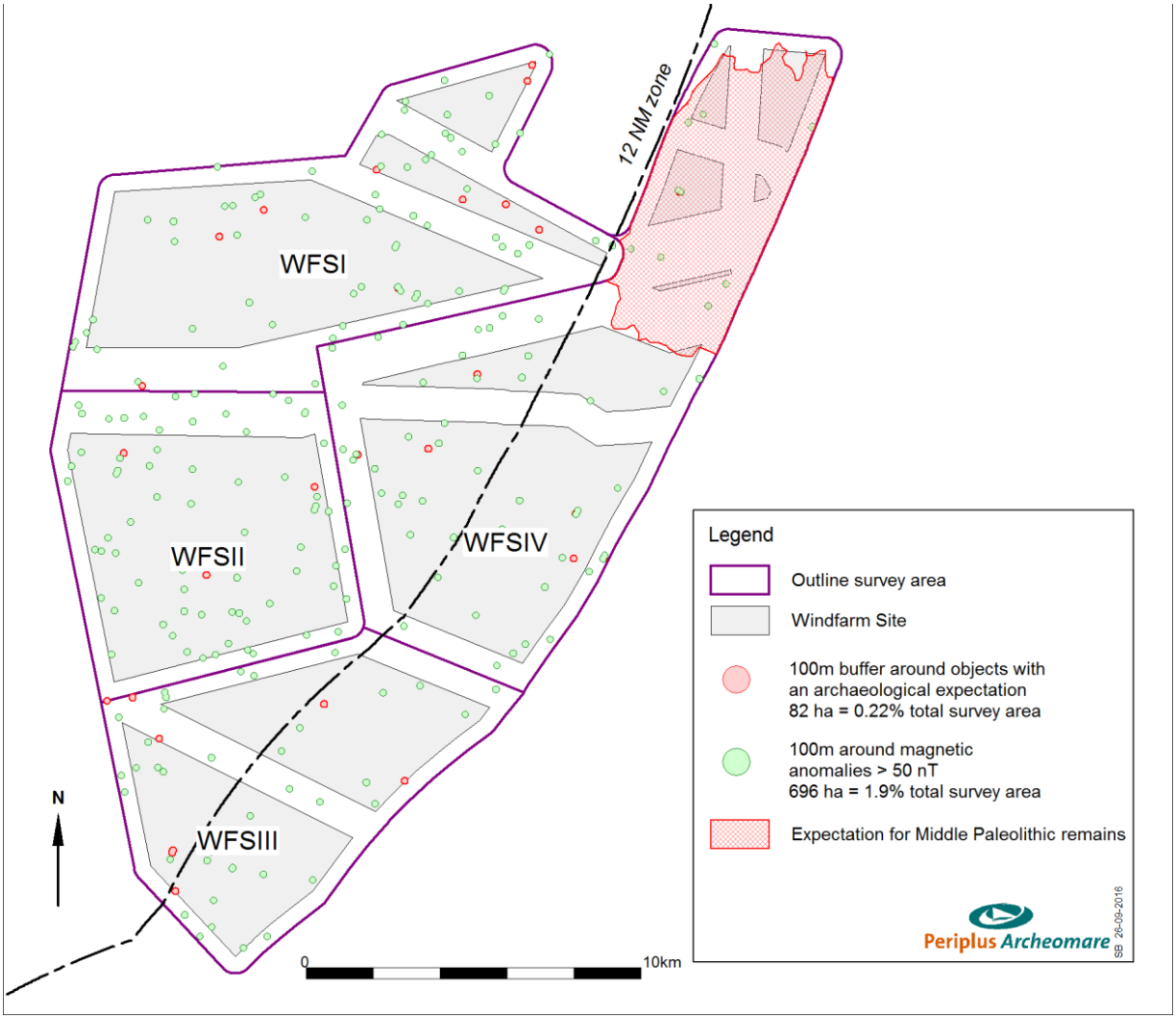


Figure 2. Buffer zones (100m) to scale around contacts and zone with expectancy for prehistoric remains

During the installation of the wind turbines and cable lay operations, archaeological objects may be discovered which were completely buried or not recognized as an archaeological object during the geophysical survey. We recommend passive archaeological supervision based on an approved Program of Requirements. Passive archaeological supervision means that an archaeologist is not present during the execution of the work but always available on call. Following this recommendation would prevent delays during the work when unexpectedly archaeological remains are found. In accordance with the Erfgoedwet, it is required to report those findings to the competent authority. This notification must also be included in the scope of work.

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1 Introduction

1.1 Location

Fugro Survey B.V. (FSBV) has contracted Periplus Archeomare B.V. to conduct an Archaeological assessment of geophysical survey results of the future Wind Farm Zone (WFZ) Hollandse Kust (zuid) (HKZ).

The HKZ WFZ is divided into four sites which are subdivided into separate parcels (see figure 3).

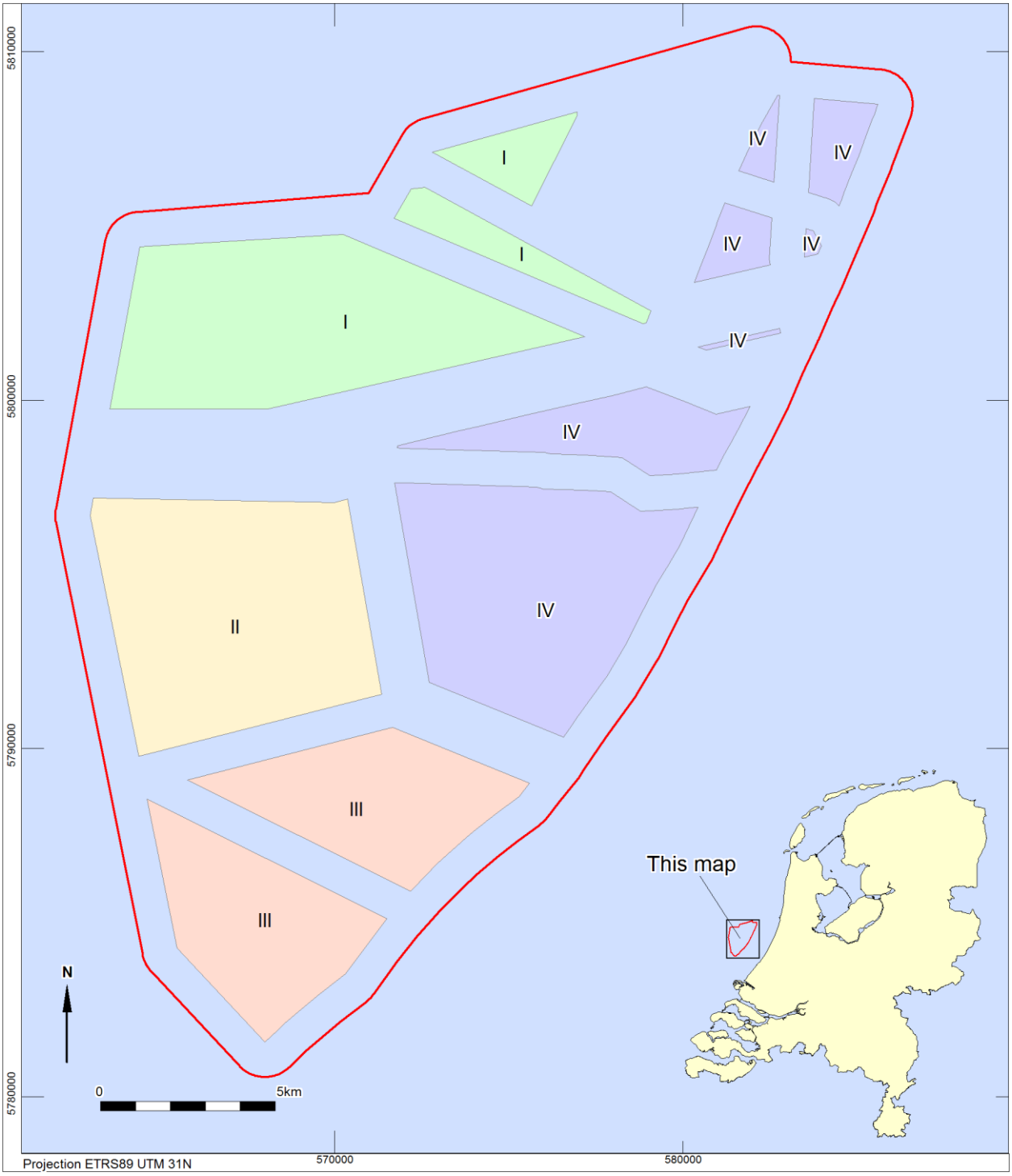


Figure 3. Location map

1.2 Background

The parties to the Energy Agreement for Sustainable Growth have agreed that 4,450 MW of wind power at sea will be in operation by 2023.[1] This means that an additional 3,500 MW of wind power at sea must be installed, in addition to the existing wind farms and the ones under construction.[2] Through an interim revision of the National Water Plan 2009-2015 the HKZ-area - initially assigned as search area - was designated for offshore wind energy in 2014.

In March and April 2016 FSBV conducted a geophysical survey to improve the bathymetrical, morphological and geological understanding of Wind Farm Sites (WFS) I, II, III & IV of the HKZ WFZ. The geophysical results will be used together with the geotechnical results to create a ground model. The ground model will serve as the base for the design and installation requirements.[3]

In the Erfgoedwet[4] the protection of the archaeological heritage embedded. Planned activities, such as the installation of a wind farm in the North Sea, may affect the archaeological values if present. If the remains are in jeopardy there is a statutory obligation to conduct archaeological research. In line with this obligation an archaeological desk study has been carried out.

An archaeological desk study is the first step in the so-called *AMZ* cycle (Archeologische Monumenten Zorg). The *AMZ* cycle includes a description of procedures for subsequent phases of archaeological research to be performed in order to ensure the protection of archaeological heritage in the Netherlands.

The second phase of the *AMZ* cycle is an inventory archaeological field study. As a rule this field study comprises a geophysical survey of the sea bed. The survey executed by FSBV was not primarily set to provide data to be used in the course of archaeological research. However, a scan of the survey data acquired, prove these data to be fit for an archaeological assessment.

The separate phases of the AMZ-cycle are embedded in the Dutch Quality Standard for Archaeology (KNA Waterbodems 4.0). This standard dictates a mandatory workflow for archaeologists. A detailed description of the different phases of archaeological research is included in appendix 2.

1.3 Results desk study[5]

In December 2015 and January 2016 an archaeological desk study has resulted in specific information on the archaeological remains which are to be expected within the HKZ WFZ. The study has proven that (remains of) ship wrecks and WWII plane wrecks are to be expected in the area. Figure 4 shows the known contacts which have been identified during the desk study. Locally *in situ* remains of Late Paleolithic and Early Mesolithic camp sites might be present.

Shipwrecks
A total of 19 shipwrecks are known in the area. Details like names, types and date of sinking are not known, nor are the exact locations. Further research is needed to determine the cultural-historical value.

Plane wrecks
During World War II, many airplanes crashed into the North Sea. Several sources are ambiguous about the number of aircraft still missing. It is at least hundreds. Remains are found on a regular base by fishermen or during

[1] Energy Agreement for Sustainable Growth 2013.

[2] National Water Plan 2016 – 2021.

[3] Nieboer 2016.

[4] De Erfgoedwet became effective on the 1st of July 2016.

[5] Brenk 2016.

sand extraction. In the vicinity of the research area, four locations of plane wrecks are known. It is quite possible to expect plane wrecks within the research area.

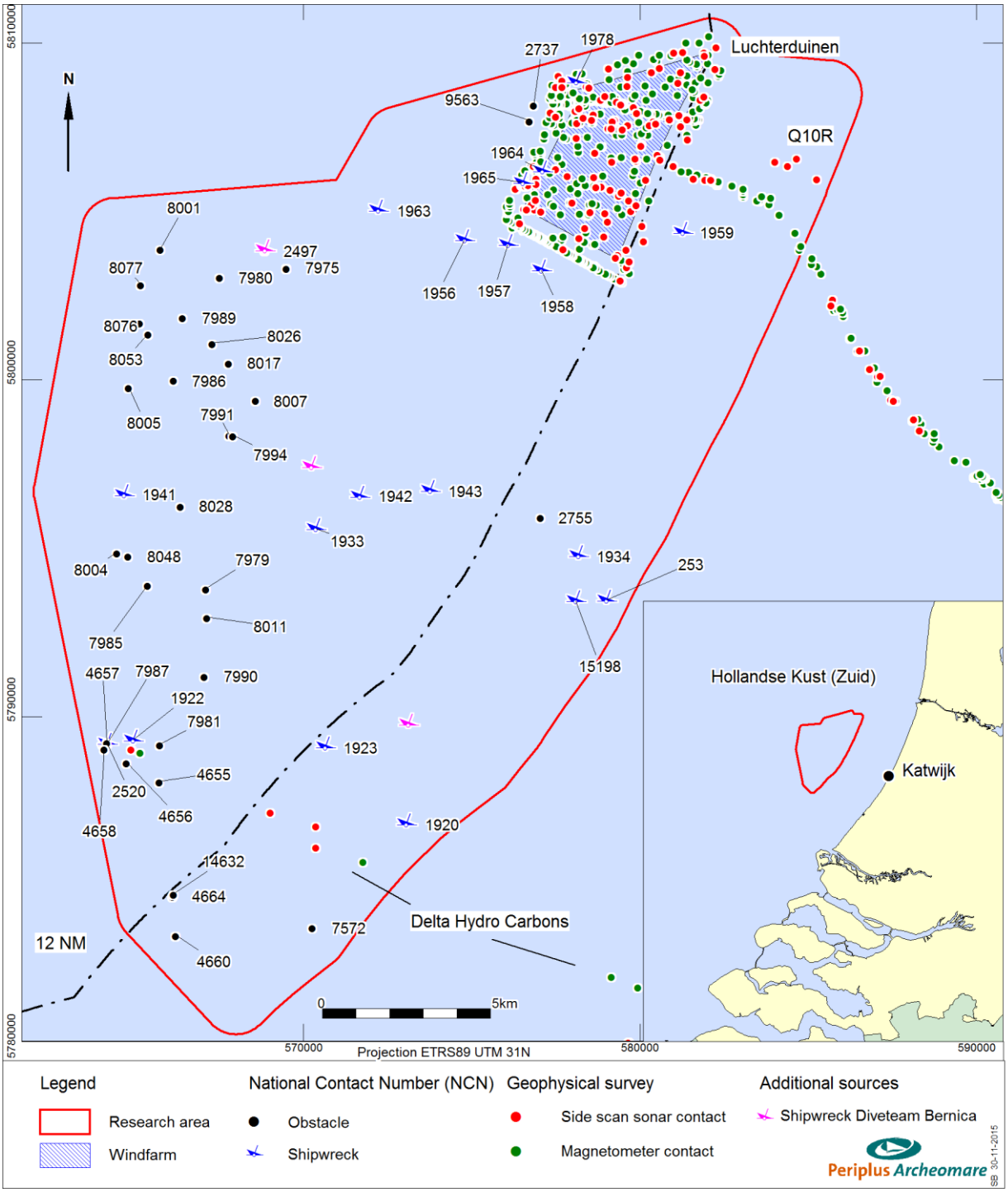


Figure 4. Overview of known objects and contacts in the research area[6]

[6] Van den Brenk, 2016.

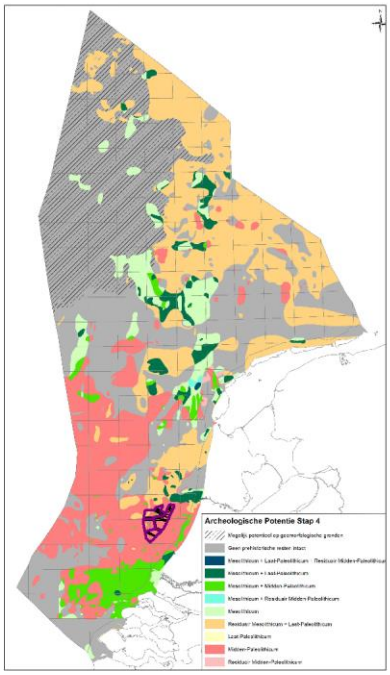
Prehistory

Remains of prehistoric camp sites are expected *in situ* in cover of sand dunes and ridges (Wierden Member), river dunes (Delwijnen Member) and river bank deposits (Wijchen Member) provided these units are un-eroded. Within the Basal Peat Bed well-preserved lost objects and dumps can be encountered. The archaeological levels of interest are located under a 0 - 5 meter cover of the Bligh Bank Member. Remains of Neanderthaler camp sites can be expected within lacustrine clays of the Brown Bank Member which is covered by the Kreftenheye Formation.

At this stage little is known about the integrity of the Pleistocene landscape. The Pleistocene units are encountered at shallow depths. Therefore erosion of these units and archaeological remains therein seems likely. Locally the Basal Peat Bed might have protected the Pleistocene landscape against erosion. By means of subbottom profiling in combination with analysis of *vibrocore* samples the Basal Peat Bed and the underlying well-preserved archaeological level can be mapped. It is unlikely however that archaeological remains of Paleolithic and Mesolithic camp sites can be identified with sufficient certainty (based on the geophysical and geotechnical surveys) to impose restrictions on wind farm development.

In 2016, Deltares published a new map describing the archaeological expectancy for prehistoric remains and settlements in the Dutch EEZ[7]. The expectancy within the HKZ sites matches the results from the desk study.

[7] Vonhögen – Peeters et al, 2016



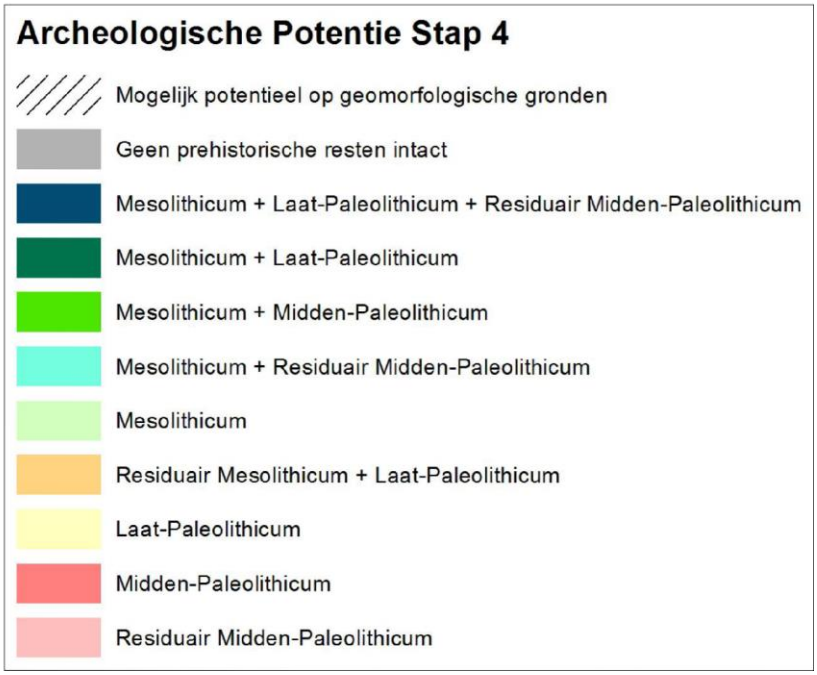


Figure 5. Archaeological expectation for prehistoric remains and settlements (Deltares 2016)

1.4 Objective

The purpose of the archaeological assessment is to test the desk study based expectancy for archaeological remains in the area. The expectancy covers remains of shipping related objects (wrecks), airplanes from World War II and prehistoric settlements.

The goals set for this assessment are:

- To determine the historical or archaeological value of contacts found in the geophysical survey
- The validate the locations of known wrecks
- Assess the prehistoric landscape based on the seismic data

1.5 Research questions

For the inventory archaeological field study, the following research questions have been defined in the program of Requirements[8]:

primary question:
Are any archaeological remains present within the Area of Interest and to what extent are these remains traceable?

with respect to side scan sonar, magnetometer and multibeam survey:

Are there any phenomena visible on the seabed?

If so:

What is the description of these phenomena?

Do these phenomena have a man-made or natural origin?

If these phenomena can be designated to be man-made:

What classification can be attached?

If these phenomena can be classified as archaeological:

Is it possible to interpret the nature of the archaeological objects?

If these phenomena can be identified as natural:

What is the nature of these natural phenomena?

Based on the acoustic image is it possible to designate zones of high, middle or low activity on the seabed?

If so:

How can these zones be interpreted?

General:

What is the relation between the observed objects and the topography of the seabed? Based on this relationship can risk-prone areas be marked selectively? Risk-prone areas are areas where the probability of archaeological remains is considered to be high. The risk involves both the degradation of archaeological remains by the development of the wind farm as the risks in terms of costs, progress and image of the wind energy project itself because of the presence of archaeological remains and the measures to be taken accordingly.

If no acoustic phenomena can be observed:

Are there any clues that this is a consequence of either natural erosion, sedimentation or human interference?

[8] Van Lil and van den Brenk, 2016

with respect to subbottom profiler- and sampling:

Based on seismic profiles and geotechnical data is it possible to map the Pleistocene landscape?

If so:

What is the depth of the Pleistocene landscape compared to the present seabed?

From Pleistocene to Holocene deposits is the transition gradual or instantaneous (erosive)?

Can zones be identified where prehistoric settlement remains can be expected?

If so:

Could these expected settlement remains be effected by the installation of the cables based on their vertical position related to the seabed?

Are there any indications observed on the seismic profiles for the presence of buried (man-made) objects?

If so:

Based on the presence of buried objects and its correlation with side scan sonar, magnetometer en multibeam data can something be said about the nature of these buried objects?

Are there any mitigating measures necessary to avoid disturbance of possible archaeological remains?

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2 Methodology

2.1 Introduction

As part of the installation of wind farm related infrastructure (monopiles, cables, power station, etc.) a pre-construction survey has been carried out by FSBV. The objectives and the general outcome of the survey activities including the minimum technical, functional and procedural requirements are described in a Scope of Services.

The following methods have been deployed:

- sidescan sonar (SSS)
- single beam echo sounder (SBES)
- magnetometer (MAG)
- multibeam echo sounder (MBES)
- sub-bottom profiler; pinger (SBP)
- ultra high resolution seismic; sparker (UHR)

The results of the survey and geotechnical activities have been recorded in reports, listings, drawings and images. The input for the archaeological assessment consists of the deliverables listed in table 3.

SSS	- XTF-files of all side scan records - event listings containing all contacts observed - geotiffs of all contacts listed
MAG	- event listings containing all anomalies observed
MBES	- validated multibeam XYZ point cloud dataset
SBP/UHR	- representative subbottom profiles
VC	- descriptions of the bore samples (if applicable)
CPT	- Cone penetration tests (if applicable)
Report	- survey report

Table 3. Data used for the archaeological assessment

2.2 Survey program

The investigation areas were surveyed by two different survey vessels: the MV Fugro Pioneer and MV Victor Hensen.

Site	Area (km^2)
WFS I	91.1
WFS II	97.1
WFS III	71.3
WFS IV	129.6
Total	389.1

For all lines the multibeam, side scan sonar, subbottom profiler and magnetometer were used simultaneously with a line spacing of 100 m. Multichannel seismic survey UHR data were acquired with a line spacing of 300 m. The cross lines were planned with a line spacing of 750 m.

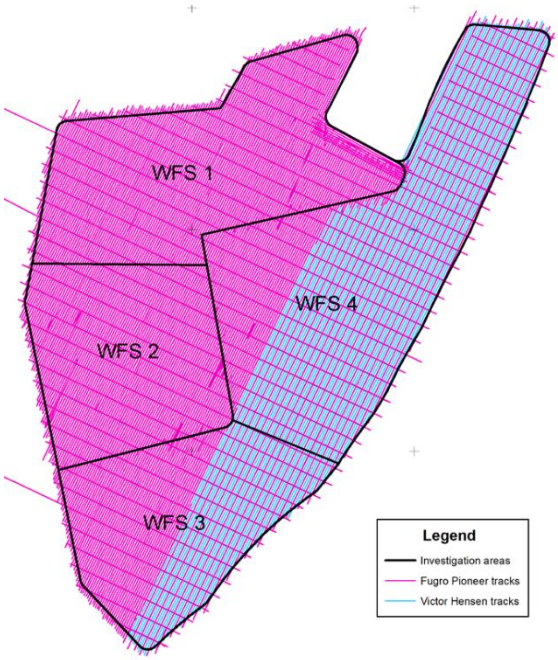

Figure 6 Survey tracks

2.3 Known objects

FSBV has summarized the side scan sonar contacts and magnetometer anomalies encountered within the survey area in detailed event listings. From different databases the occurrence of objects within the area is known. The contacts included in the survey event listings are compared with the database objects in the area. For this comparison four different datasets are used:

- The Hydrographic Service database (hereafter referred to as NLhono database);
- The Rijkswaterstaat Sonarreg database (hereafter referred to SR database);
- The Dutch Cultural Heritage Agency database ARCHIS;
- The Dutch Nationaal Contact Nummer database (hereafter referred to as NCN);

The National Contact Number (NCN)

The NCN database combines the data from three governmental databases:

- The Dutch Continental Shelf and Westerschelde wrecks register from the Hydrographic Service of the Royal Netherlands Navy;
- The SonarReg92 object database of Rijkswaterstaat;
- The ARCHIS database (the official archaeological database of the Ministry of Cultural Heritage)

The permission for the use of the NCN database for the analysis was granted by the owner (Rijkswaterstaat Sea and Delta)

The NCN database contains all basic information (E, N and description) of the NLhono, SR and Archis databases. More detailed information is gathered through the other datasets.

In addition to ship wrecks information on contacts referred to as ‘foul’ or ‘obstruction’ is included. From these objects the origin is not always known, but information on the location, dimensions and other valuable information is listed. Besides the databases other sources containing information on wrecks and historic finds are consulted for comparison with the survey results.

All known data is combined and plotted in a GIS. In this way an overview is made of the areas in which archaeological remains are present or to be expected. The known contacts are a reference framework for the assessment of data recorded during the route survey.

2.4 Archaeological assessment of survey data

The geophysical and hydrographic survey techniques employed include *side scan sonar* (SSS), *magnetometer* (MAG), *multibeam* (MBES) and subbottom profiling (SBP). With *side scan sonar* all objects and structures on the seabed can be made visible. Seabed sediment of different composition can be distinguished by their characteristic reflection. *Multibeam* images reveal the morphology of the seabed. Large objects and scouring can be mapped. Smaller objects, like thin cables, or flat objects lying on the seabed often are impossible to identify in *multibeam* images.

Magnetometer contacts are identified by the presence of ferro-metalic objects which induce an anomaly in the earth magnetic field. These objects can be buried or lying on the seabed. Unlike *side scan sonar* and *multibeam* the contacts are tagged at the sailed survey line. The actual object can be located at both sides of the survey line. Given the 100 meter spacing of the run lines the accuracy perpendicular to the line is in the order of 50 meter.

FSBV processed their survey data and produced detailed event listings of the *side scan sonar* and *magnetometer* contacts encountered within the survey areas. Alike the known objects the locations of the contacts are plotted in a GIS.

In the course of this archaeological assessment a selection is made based on the dimensions of the reported contacts. All contacts have been assessed, and the fraction of contacts larger than or equal to four (4) meter is looked into in more detail, because these objects are considered to be more likely to be related to wreck sites than the smaller contacts. This choice is based on best professional judgment and not prescribed by legislation or the KNA. Purpose of this analysis is to identify contacts that could reflect potential archaeological sites.

This is done by analyses of:

- *side scan sonar* images included in the survey reports;
- raw *side scan sonar* data (XTF-files) in SonarWiz;
- raw *multibeam*-data (xyz-files) in Autoclean, Qloud and Global Mapper;
- values of magnetic anomalies reported in the survey reports;
- comparison of *side scan sonar* and *magnetometer* contacts;

Apart from the survey data studied the geological constellation and seabed morphology of the area are taken into account as outcrops of geological strata and sedimentary structures can lead to (apparent) anomalies in the *side scan sonar* record.

The *side scan sonar* images are scanned in order to define potential archaeological sites. A selection of contacts was made of contacts to be studied in detail. The interpretation and selection of *side scan sonar* contacts is based on best professional judgment. If desired or needed the exact nature of the contacts observed can be established with certainty through the execution of additional research by means of a ROV or divers in a following phase.

FSBV has acquired and processed shallow seismic data using a sub-bottom profiler (SBP), a single channel sparker (SPK) and an ultra-high resolution multi-channel sparker (UHR). The processing involved an analysis of seismic profiles which had a line spacing of 300 m between SSW-NNE lines and 750 m for WNW-ESE lines. Observed seismic strata have been digitized and - based on known geological data from the area - lithostratigraphic units have been identified. The base of each lithostratigraphic unit has been interpolated into a grid. The results have been summarized and reported. In addition to the identification and occurrence of lithostratigraphic units seismic anomalies which are expected to reflect potential hazardous phenomena have been identified.

2.5 Data Analysis

The first step in the data analysis is to cross-reference known objects within the surveyed area with the survey data. For the comparison the results of the desk study and the survey datasets were used. All the known objects were projected in a GIS together with the survey data.

For the cross-reference we have assumed that all present possible contacts and anomalies have been reported and described by the survey contractor. Only the raw data is used, when available, to verify the description of found objects and anomalies as reported.

The positions of the interpreted contacts from the different surveys were compared with the positions of the known objects collected from the databases. Besides that, all the positions of both the survey contacts and the known objects were plotted on the high resolution *multibeam* grid to visualize the morphological influence of the presence of these objects. This assisted in the determination of possible archaeological value of the present remains. If an object had a potential archaeological value, the description of the object was finalised.

Besides the objects detected from the *side scan sonar* survey also the *magnetometer* contacts were plotted on the high resolution *multibeam* grid. For the *magnetometer* contacts that corresponded with the *side scan sonar* contacts within 50 meters of each other, these contacts were considered to be related. When at the position of the *magnetometer* anomaly no visible object was recognized the size of the anomaly was leading. If the magnetic anomaly of a contact is more than 50 nT (nano-Tesla) then it is stated that the contact could possibly be of archaeological value. All the *magnetometer* contacts above 50 nT but within 25 meter of the existing cable and pipeline routes are exempt for further investigation. It has to be stressed that within this assessment no distinction can be made between anomalies related to possible archaeological objects or anomalies related to (for example) unexploded ordinance (UXO's).

An archaeological assessment has been undertaken for all visible contacts. This interpretation is based on best 'professional judgment'.

The interpreted seismic data have been assessed in order to test the archaeological expectation with respect to remains of prehistoric settlements in the area. The archaeological desk study has resulted in the identification of lithostratigraphic units which could contain archaeological levels. The grids produced by FSBV have been used to get an insight both the lateral and vertical distribution of the lithostratigraphic units and the expected archeological levels herein. Thus testing the desk study based archaeological expectation. An important factor included in the assessment is the integrity of layer boundaries, because erosion by natural processes poses a significant threat to archaeological levels. Based on the assessment zones within the wind farm zone which are expected to contain archaeological remains are mapped and results are put in the context of the activities planned in order to predict of the activities might damage potential archaeological remains.

The analysis was executed in July and August 2016 by R. van Lil, S. van den Brenk (both KNA senior prospector) and E.A van den Oever (junior KNA prospector). The investigation is carried out according to specifications set up within the Dutch Quality Standard for Archaeology (*KNA Waterbodems 3.2; protocol 4103*).

2.6 Used Sources

The following sources were used for the analysis:

- Survey data FSBV, original survey data and reported interpretations;
- Archaeological desk study Periplus (15A024-01, RVO reference WOZ1500039);
- ARCHIS database Cultural Heritage Agency;
- Archeomare Database;
- NLhono database Hydrographic Service of the Royal Netherlands Navy;
- Wrecksite.eu;
- Database, Nationaal Contact Nummer (NCN).

For a complete list of used sources and literature see the reference list at page 59.

Italic written words are explained in the glossary at page 58.

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3 Results

3.1 Seabed bathymetry and morphology

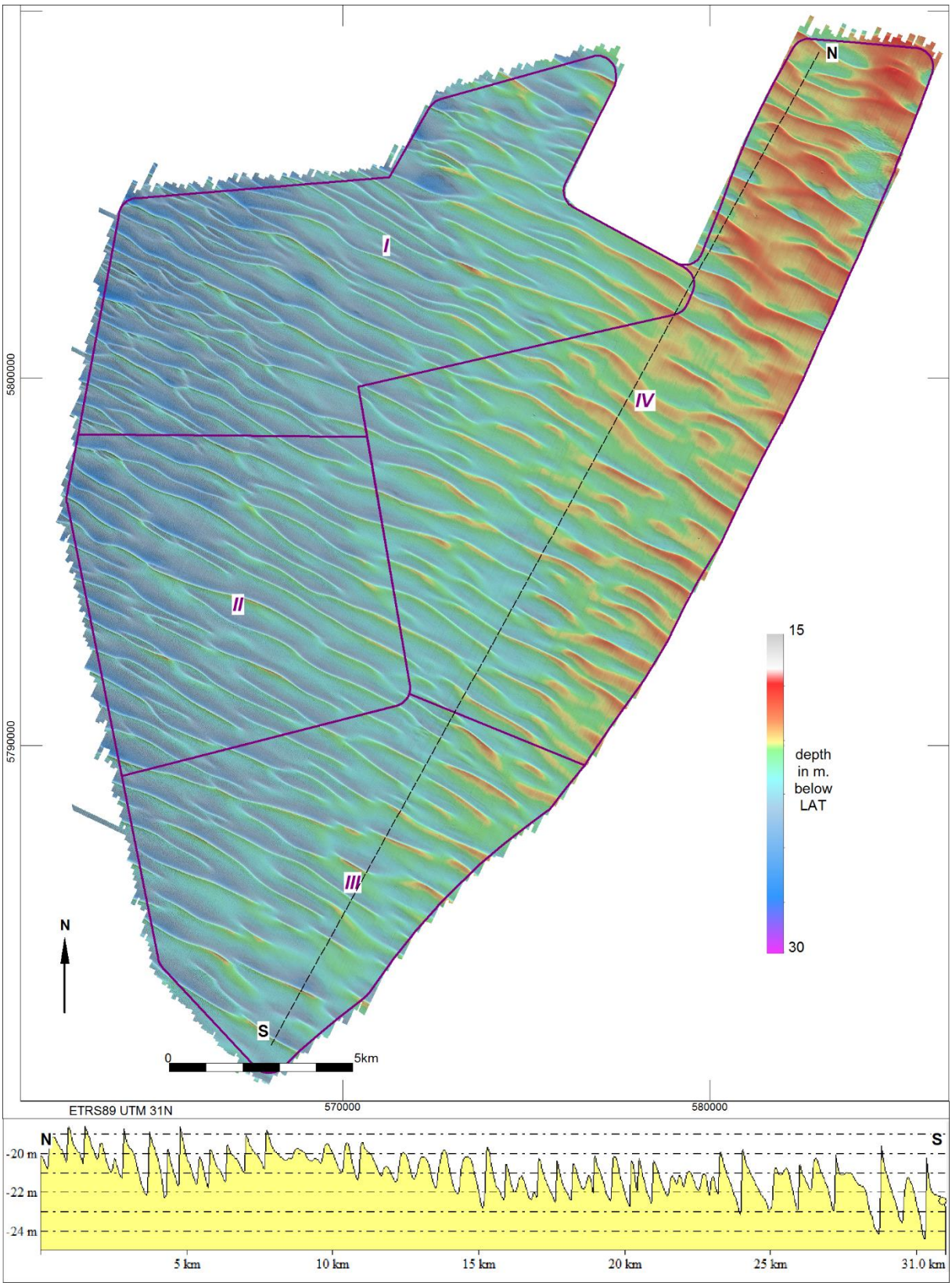

Figure 7. Bathymetry and north-south profile based on the multibeam recordings (source data: FSBV 2016)

The water depth within the sites varies from 15.6 to 27.9 below LAT.

Site	Minimum	Maximum
I	18.1	27.9
II	18.6	26.6
III	18.6	25.3
IV	15.6	24.5

Table 4. Water depth below LAT for the different sites

Site I
The seabed is characterised by sand dunes. Very large sand dunes were observed throughout the area with NW to SE trending crests with wavelengths ranging between 250 m and 1050 m, and height ranging from 2 m to 6 m. Maximum lee side slopes up to 20 degrees were observed. Medium sand dunes are superimposed on the very large sand dunes and have the same crest orientations. They have 4 to 20 m wavelengths and are typically 0.2 to 0.4 m in height. The very large sand dunes are expected to migrate at a rate of 2-4 m per year in a north-easterly direction[9].

Site II
The seabed is characterised by sand dunes. Very large sand dunes were observed throughout the area with NW to SE trending crests with wavelengths ranging between 300 m and 900 m and height ranging from 2 m to 5 m. Maximum lee side slopes up to 20 degrees were observed. Medium sand dunes are superimposed on the very large sand dunes and have the same crest orientations. They have 4 to 20 m wavelengths and are typically 0.2 to 0.4 m in height. The very large sand dunes are expected to migrate at a rate of 2-4 per year in a north-easterly direction.

Site III
The seabed is characterised by sand dunes. Very large sand dunes were observed throughout the area with NW to SE trending crests with wavelengths ranging between 300 m and 1000 m and height ranging from 2 m to 6 m. Maximum lee side slopes up to 20 degrees were observed. Medium sand dunes are superimposed on the very large sand dunes and have the same crest orientations. They have 4 to 20 m wavelengths and are typically 0.2 to 0.4 m in height. The very large sand dunes are expected to migrate at a rate of 2-4 m per year in a north-easterly direction.

Site IV
The seabed is characterised by large-scale sand dunes. Very large sand dunes were observed throughout the area with NW to SE trending crests with wavelengths ranging between 300 m and 1100 m and height ranging from 2 m to 4 m. Maximum lee side slopes up to 20 degrees were observed. Medium sand dunes are superimposed on the very large sand dunes and have the same crest orientations. They have 4 to 20 m wavelengths and are typically 0.1 to 0.4 m in height. The very large sand dunes are expected to migrate at a rate of 2-4 m per year in a north-easterly direction.

[9] Geological study Deltares, de Bruin et al 2015

3.2 Known objects: As Found positions versus database positions

Based on the desk study 52 objects (whereof 19 ship wrecks) are known within the HKZ WFZ.

The SSS contacts and MAG anomalies encountered during this survey have been stored in event listings. The positions of the contacts and anomalies in these listings are compared with the theoretical positions of objects in the NCN database. In order to conduct this comparison all SSS contacts and MAG anomalies found within a range of 50 meters around the database locations are selected.

The outcome of this comparison can be:

- The As Found position of a ship wreck is in agreement with the database position of a known wreck;
- The As Found position of a contact is in agreement with the position of a contact listed in the database, but the interpretations do not match;
- The As Found position of a ship wreck is not in agreement with the database position of a known wreck;
- A wreck listed in the database has not been found;
- A new wreck has been found.

An overview of the as found- versus not found known objects is presented in the next figure.

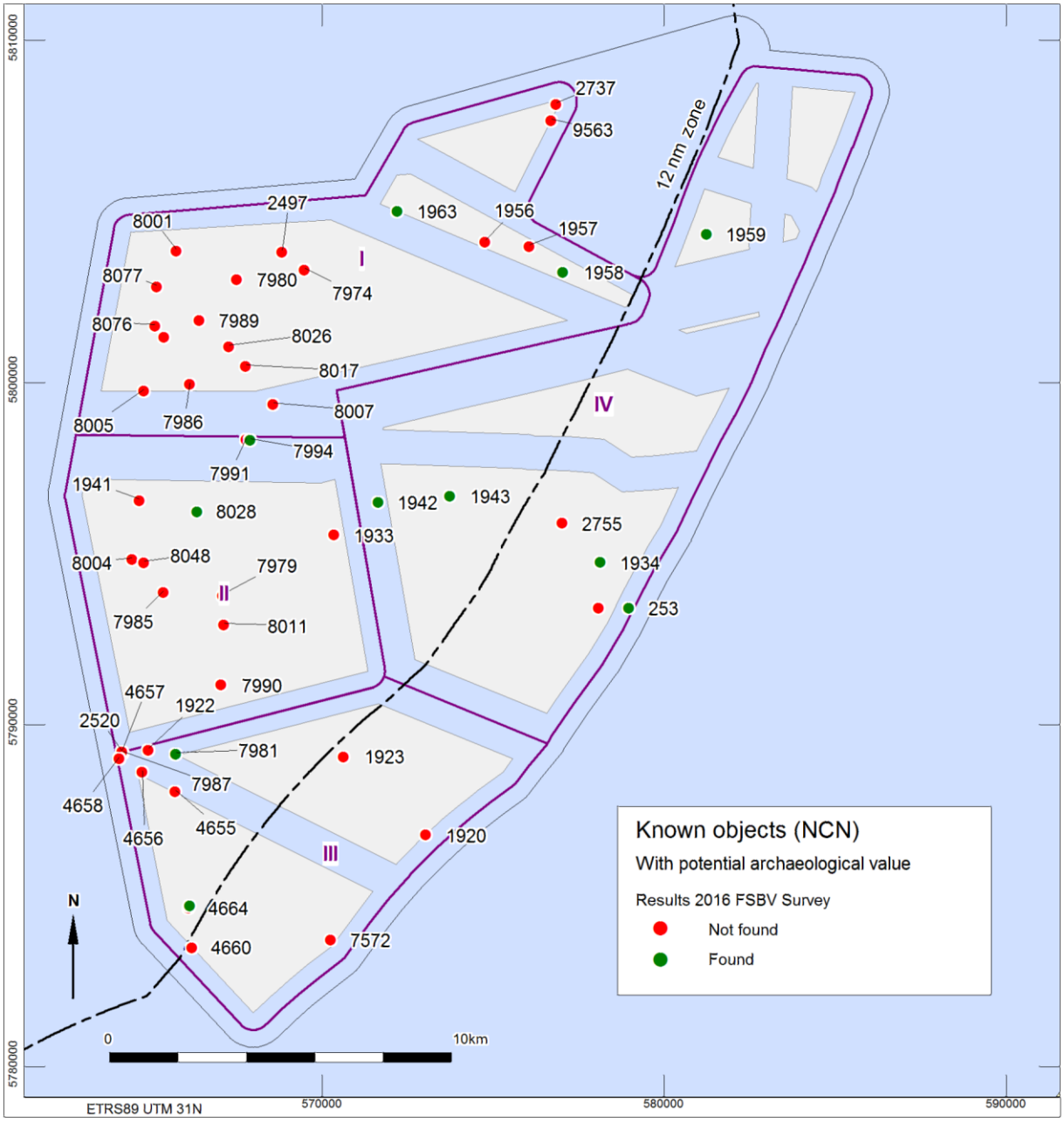

Figure 8. Known objects found or not found during the survey

The detailed results per site are discussed in the next paragraphs.

Site I

None of the 20 known objects in site I has been found with side scan sonar. Two objects (1958 and 1963) were possibly detected by the magnetometer.

Site I					
NCN	**Easting**	**Northing**	**R95**	**Description**	**Found**
1956	574777	5804155	5	Wreck Found by echo sounder	No finds within 250m
1957	576065	5804020	5	Wreck Found by echo sounder	No finds within 200m
1958	577061	5803263	5	Wreck Found by echo sounder	Magnetometer at 38m east
1963	572212	5805044	5	Wreck, archived - BDS 1699/2007	Magnetometer M_FP-1153 at 75m west, no sonar within 250m
2497	568847	5803855	5	Foul Found by echo sounder Unknown 20x0m	No finds within 250m
2737	576849	5808168	5	Obstruction Swept by side scan sonar	No finds within 250m
7974	569498	5803345	5	Cluster of small objects (1.7x1.1x0.3), 2009	No finds within 250m
7975	569493	5803334	5	Cluster of small objects (1.7x1.1x0.3), 2009	No finds within 250m
7980	567518	5803057	5	Elongated object (5.8x0x0), discovered in 2010	No finds within 500m
7986	566148	5800001	5	Ridge (8.7x1.5x0.1m) 2010	No finds within 350m
7989	566418	5801866	5	Elongated object (2.8x0.8x0.1), discovered in 2010	No finds within 70m
8001	565751	5803886	5	Possible cable or chain, 2010	No finds within 500m
8005	564808	5799794	5	Small (2.1 x 1.0x0.3) object, discovered in 2010	No finds within 350m
8007	568586	5799408	5	Contact or seabed disturbance (3.4x1.4x1.1m)	No finds within 150m
8017	567774	5800510	5	Small (1.4 x 1.1x0.2) object, discovered in 2010	No finds within 300m
8026	567293	5801089	5	Object (2.2 x 2.1x0.2), discovered in 2010	No finds within 200m
8053	565390	5801373	5	Small object (1.5 x 1.0x0.1), discovered in 2010	No finds within 500m
8076	565132	5801701	5	Small object (1.7 x 1.0x0.1), discovered in 2010	No finds within 500m
8077	565170	5802833	5	Cluster of small objects (1.6x1.0x0.0), 2010	No finds within 100m
9563	576711	5807696	5	Wreck remains at 1831m of wreck HY 2130	No finds within 500m

Table 5. Listing of known objects and results within site I

The position accuracy for all the known objects is 5 meters. The most plausible reason for not finding these objects is the possibility that they are covered by sediment, due to the migration of the sand waves. The majority of the objects do not have an archaeological expectation, except for the three wrecks. It is therefore advised to avoid the three wreck locations during construction of the wind farm.

Site II

Within the investigated area of site II, 14 objects were known. 12 of these objects haven not been found. 2 objects have been possibly detected by magnetometer. The results are listed in the table below.

Site II					
NCN	**Easting**	**Northing**	**R95**	**Description**	**Found**
1933	570361	5795591	5	Wreck, archived - BDS 1699/2007	No finds within 250m
1941	564665	5796595	5	Wreck Found by echo sounder	No finds within 400m
2520	564167	5789208	5	Wreck Found by multi-beam 2x2m. Additional information dive team Bernicia: Submarine Wiljo3.	No finds within 100m
4657	564156	5789245	5	Small (1.9 x 1.2x0.2) object, discovered in 2009	No finds within 50m
7979	567111	5793814	5	Possible cable or chain, 2010	No finds within 180m
7985	565380	5793913	5	Possible cable or chain, 2010	No finds within 500m
7987	564183	5789210	5	Seabed disturbance (17.2x9.3m)	No finds within 100m
7990	567064	5791212	5	Elongated object (2.7x0.6x0.0), discovered in 2010	No finds within 200m
7991	567790	5798376	5	Small (2.2 x 0.6x0.2) object, discovered in 2010	No finds within 100m
7994	567908	5798358	5	Elongated object (2.7x0.6x0.0), discovered in 2010	Magnetic anomaly M_FP_1864 10m to the north
8004	564462	5794879	5	Small (1.3 x 1.0x0.2) object, discovered in 2010	No finds within 100m
8011	567134	5792960	5	Manmade object (4.1x1.8x0.4) 2010	No finds within 300m
8028	566349	5796268	5	Possible cable or chain, 2010	Magnetic anomaly M_FP_0628 20m to the north
8048	564793	5794782	5	Possible cable or chain, 2010	No finds within 200m

Table 6. Listing of known objects and results within site II

The position accuracy for all the known objects is 5 meters. The most plausible reason for not finding these objects is the possibility that they are covered by sediment, due to the migration of the sand waves. The majority of the objects do not have an archaeological expectation, except for the three wrecks. It is therefore advised to avoid the three wreck locations during construction of the wind farm.

Site III

Within the investigated area of site III, 11 objects were known. Only 2 objects have been possibly found by side scan sonar or magnetometer. The results are listed in the table below.

Site III					
NCN	**Easting**	**Northing**	**R95**	**Description**	**Found**
1920	573048	5786823	0	Wreck Unknown Unknown	No finds within 350m
1922	564932	5789305	5	Possible wreck of Thisbe; French steamer by Dundee; for Maison Verel; 1903; 66x10,05x4,1m; 800 n.h.p.; coal fired engines. The Thisbe was sunk near to IJmuiden during a violent gale on 3rd December 1909. There were no victims (Noordzeeduiken.nl)	No finds within 400m
1923	570643	5789106	5	Wreck Swept by side scan sonar	No finds within 175m
4655	565725	5788081	5	Elongated object, discovered in 2009	No finds within 250m
4656	564748	5788653	5	Small (1.8 x 1.4x0.1) object, discovered in 2009	No finds within 250m
4658	564078	5789057	5	Small (3.4 x 1.0x0.3) object, discovered in 2009	No finds within 50m
4660	566205	5783526	5	Elongated object (4.1x0.6), discovered in 2009	No finds within 75m
4664	566116	5784683	5	Object (4,7x3,5x0,7) with scouring, discovered in 2009	No finds within 75m
7572	570270	5783757	5	Possible cable or chain, 2010	No finds within 100m
7981	565734	5789186	5	Contact or seabed disturbance (1.9x1.2x0.5m)	Magnetic anomaly M_VH_1779 10m to the south
14632	566137	5784742	5	Obstruction Found by multi-beam 2x2m	Sonar S_FP_0244

Table 7. Listing of known objects and results within site IV

The position accuracy for all the known objects is 5 meters or less. The most plausible reason for not finding these objects is the possibility that they are covered by sediment, due to the migration of the sand waves. The next figure presents an image of NCN 14632, which was described as an obstruction in the past. The multibeam data shows a partly buried solid object (4,7x3,0x1,0m), surrounded by scouring.

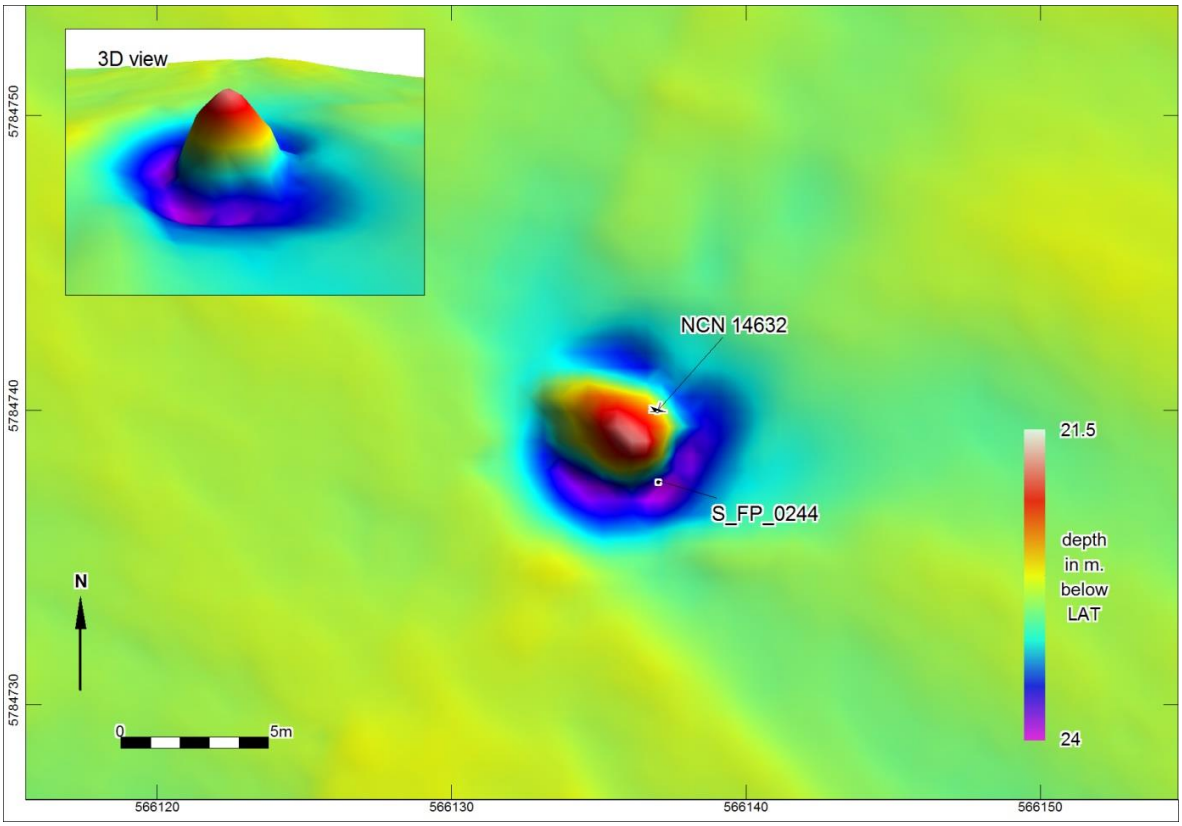

Figure 9. Multibeam image of NCN 14632, an obstruction

Figure 10. Georeferenced side scan sonar image of contact FP-0244

The possible archaeological value of this object and the three wrecks which are probably covered by sediments has not been established yet. It is therefore advised to avoid these four locations during construction of the wind farm.

Site IV

Within the investigated area of site IV, seven objects were known. two objects have not been found by sonar or magnetometer. The results are listed in the table below.

Site IV					
NCN	**Easting**	**Northing**	**R95**	**Description**	**Found**
253	578989	5793459	5	Wreck Swept by wire drag 41.5x8m. Additional info dive team Bernica: Fishing vessel, 45x8m, used in WOII by Germans	Sonarcontact S_VH_0001 at 25mS
1934	578156	5794786	5	Wreck Found by multi-beam 3x2m. Additional info dive team Bernica: “Juffermanswrak, olieleidingwrak”, 30x8m	Sonar S_VH_0042 at the location
1942	571658	5796547	5	Wreck Found by echo sounder Unknown 24x24m	Sonar S_FP_0342 at 12m SW
1943	573754	5796722	5	Wreck Unknown. Additional information dive team Bernicia: Fishing vessel, sunk 10-08-1907	Magnetometer M_VH-1555 at 18m south, no sonar within 125m
1959	581257	5804376	5	Wreck Found by echo sounder 34x11m. Additional info dive team Bernica: “Hamertjeswrak”	Sonar S_VH-0093
2755	577040	5795934	1000	Foul, archived - BDS 1242/05	No finds within 75m
15198	578092	5793448	5	Wreck remains HY 2087, 1995. ROV images available	No finds within 100m

Table 8. Listing of known objects and results within site IV

Images based on multibeamrecordings for the found objects are presented below.

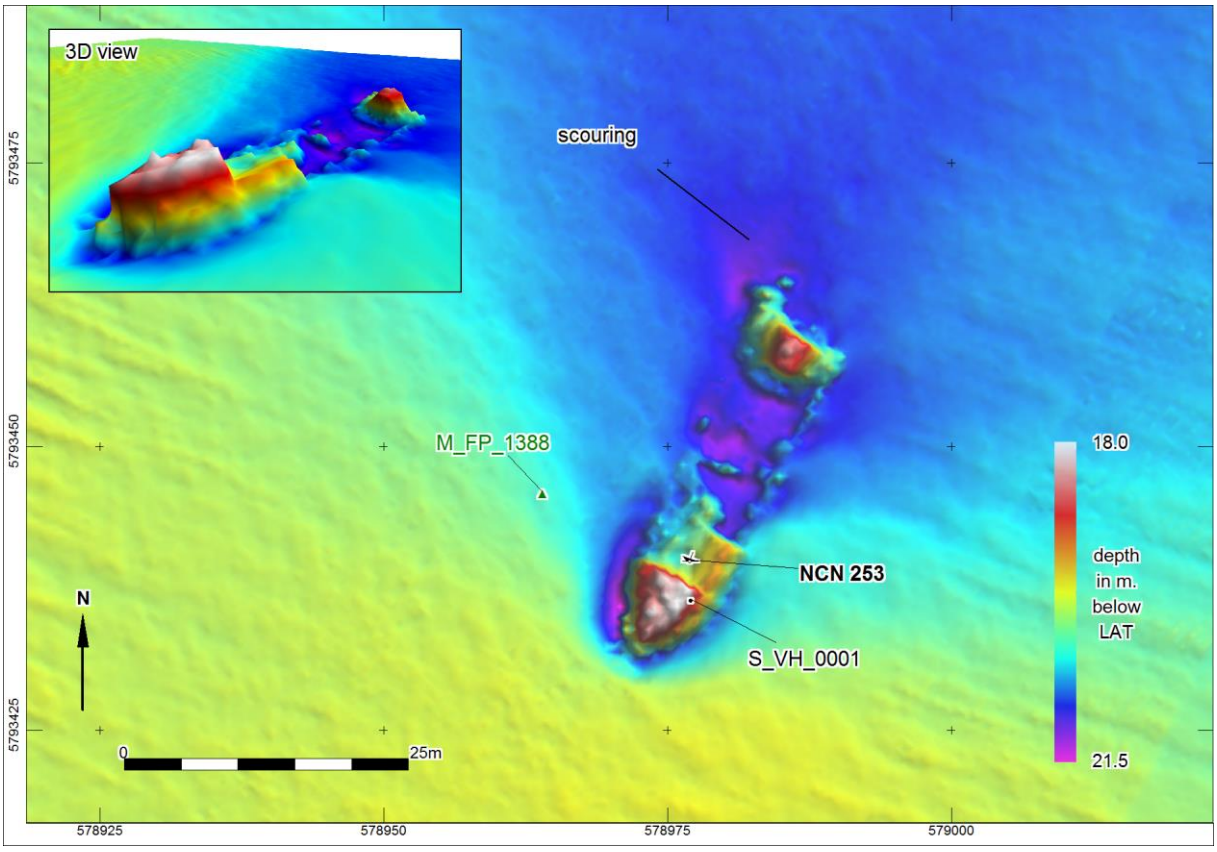

Figure 11. Multibeam image of NCN 253, a possible fishing vessel from WWII

The remains of the ship wreck NCN 253 are clearly visible. The remains are partly buried and cover an area of 34x10m. According to the historical information, this wreck dates from the second World War. The archaeological value has not been determined yet. It can form an obstruction for the installation of the wind farm.

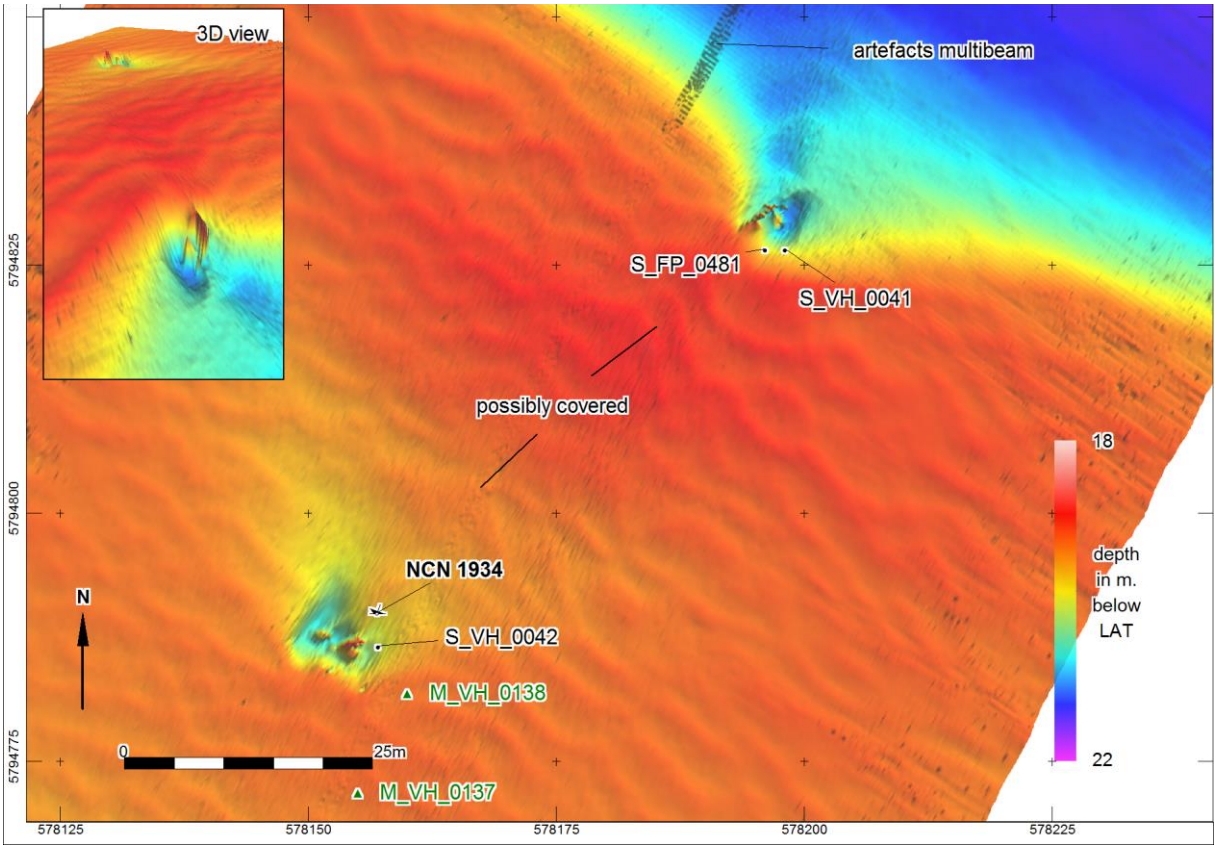

Figure 12. Multibeam image of NCN 1934, the so called 'Juffermanswrak'

The location NCN 1934 includes the remains of a shipwreck also known as the 'Juffermanswrak' or 'olieleidingenwrak'. The multibeam image shows, that most of the remains are covered with sediment. The archaeological value for this wreck has not been established. It is therefore advised to avoid this location during installation of the wind farm.

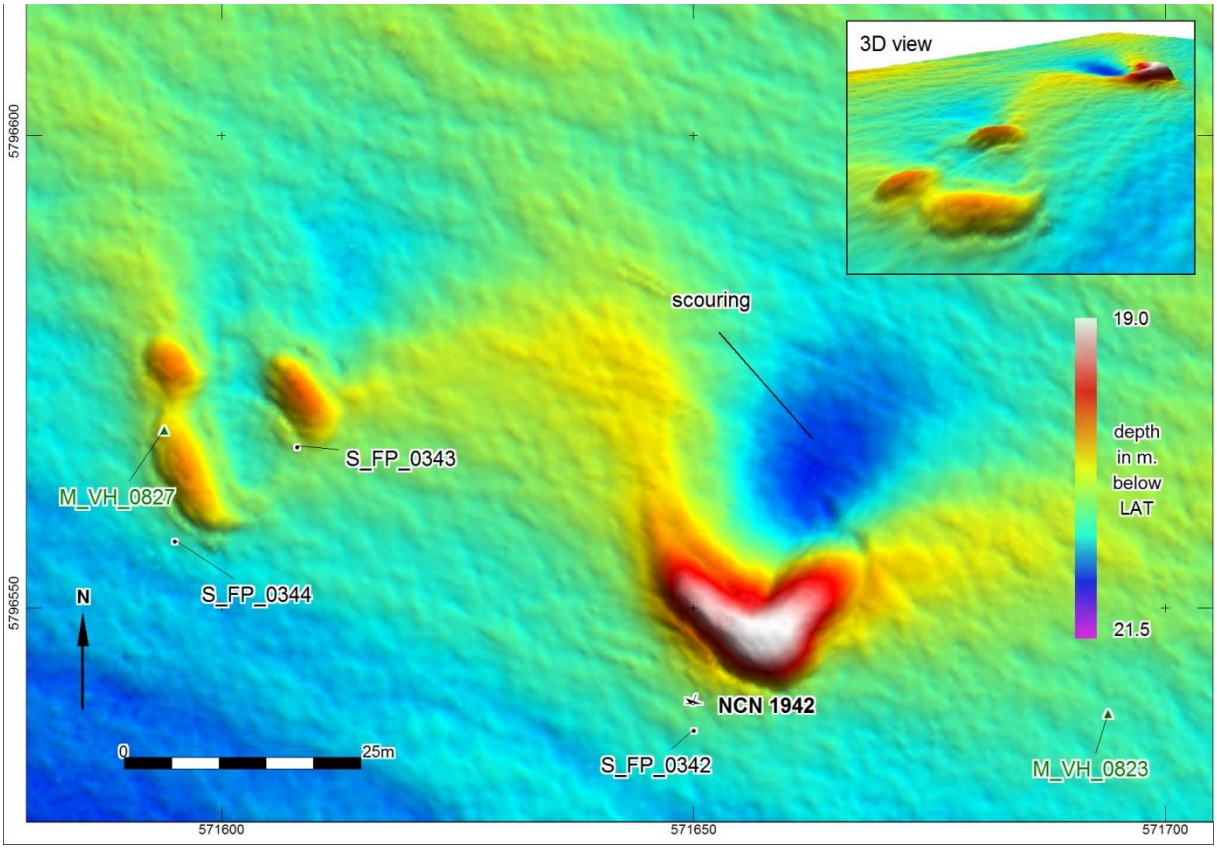

Figure 13. Multibeam image of NCN 1942, remains of an unknown wreck

The location NCN 1942 includes the remains of an unknown shipwreck. The multibeam image shows different objects or constructions. The largest object in the east measures 20x10x2m with a scour depression at the north. The archaeological value for this wreck has not been established. It is therefore advised to avoid this location during installation of the wind farm.

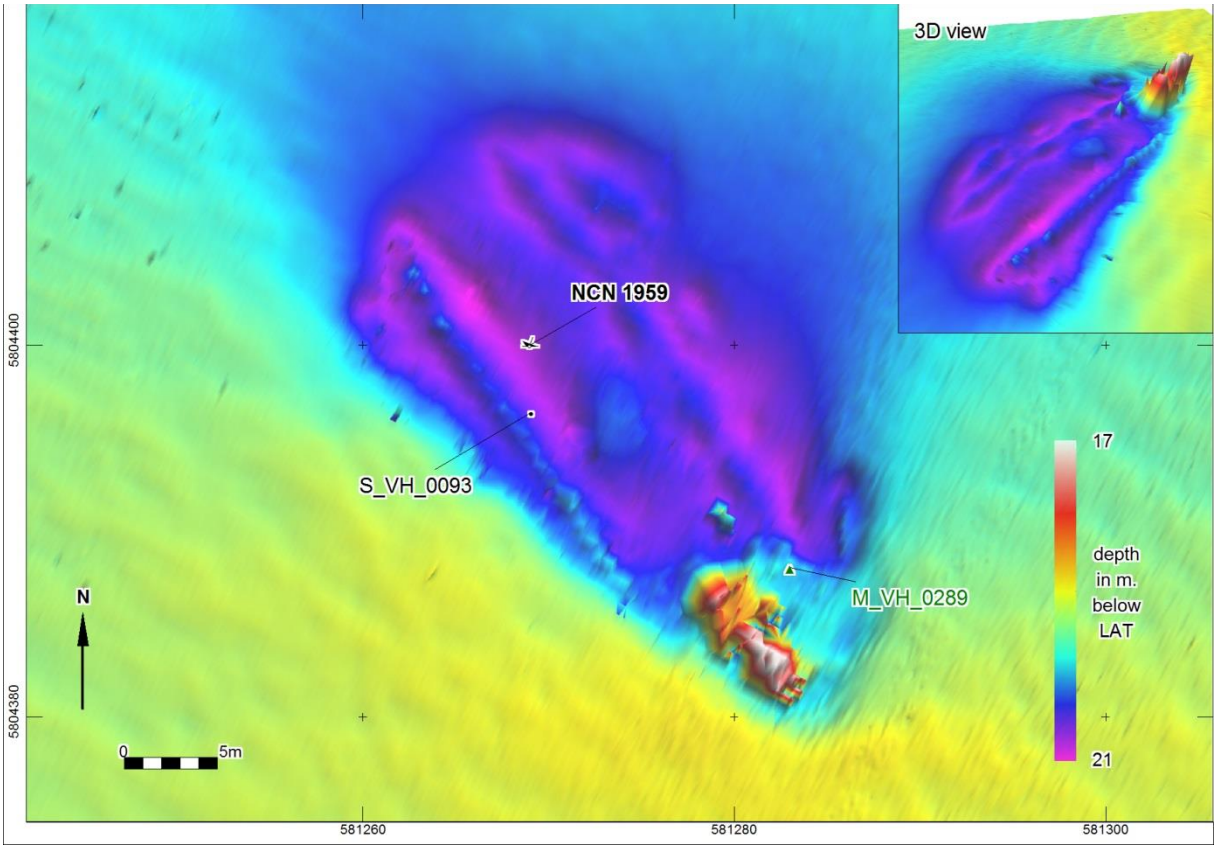

Figure 14. Multibeam image of NCN 1959, the so called 'Hamertjeswrak'

The location NCN 1959 includes the remains of a shipwreck known as the so called '' Hamertjeswrak'. The multibeam image shows mostly buried remains covering an area of 35x15m. A large (7514 nT) magnetic anomalie at the site indicates the presence of ferrous material. The archaeological value for this wreck has not been established. It is therefore advised to avoid this location during installation of the wind farm.

Summary of known objects

The desk study has shown that a total of 52 objects and wrecks are known within the boundaries of the wind farm sites. 28 of these objects consist of small objects, lost cables or chains, and are not considered to be of archaeological importance. For the remaining 24 objects the archaeological value has not been determined.
Five of these objects have been found exposed at the seabed; two objects presumably are marked by a magnetometer anomaly. The other seventeen objects which, based on the findings of the desk study were expected in the area, have not been found. These objects are likely to be covered with sediments due to migration of the sand waves in the area.

	WFS				
Known Objects	**I**	**II**	**III**	**IV**	**Total**
Total known objects	20 (19)	14 (9)	11 (6)	7 (5)	**52 (39)**
Known objects with an archaeological expectation	7 (7)	4 (3)	7 (5)	6 (4)	**24 (19)**
Known objects with an archaeological expectation found	1 (1)	0 (0)	1 (1)	5 (3)	**7 (5)**
(Between brackets: number within Windfarm parcel)					

Table 9. Summary of known objects

3.3 Sidescan sonar

FSBV has identified 563 side scan sonar contacts within the HKZ WFZ sites. In the table below the FSBV interpretation of these contacts and numbers per site are listed.

Classification	I	II	III	IV	Total
Suspected debris	121	84	55	113	373
High Backscatter	11	17	35	89	152
Boulders	-	-	4	20	24
Linear debris	-	-	1	8	9
Cable	0	0	0	0	0
Pipeline	0	0	0	0	0
Wrecks	0	0	1	4	5
Total	**132**	**101**	**96**	**234**	**563**

Table 10. Side scan sonar contacts identified in the HKZ WFZ

All contacts which match known objects have been discussed in the previous paragraph. The remaining *side scan sonar* contact and images have been scanned and checked for the presence of potential archaeological contacts. This is done by analyses of:

- *Side scan sonar* images included in the survey reports;
- Raw *side scan sonar* data (XTF-files) in SonarWiz;
- Raw *multibeam*-data (xyz-files) in Autoclean, Qlloud and Global Mapper;
- Comparison of *side scan sonar* and magnetometer contacts.

Apart from the survey data studied the geological constellation and seabed morphology of the area are taken into account as outcrops of geological strata and sedimentary structures can lead to (apparent) anomalies in the *side scan sonar* record.

All contacts larger than four meter are examined in detail, because these objects are considered to be more likely to be related to wreck sites than the smaller contacts. This choice is based on best professional judgment and not prescribed by legislation or the KNA. Purpose of this analysis is to identify contacts that could reflect potential archaeological sites. This selection of large contacts comprises a total of 79 contacts. Contacts identified by FSBV as pipelines and cables are not included in this selection. For a complete listing of the result of this examination is referred to Appendix 3. A summary of the outcome of the detailed inspection of selected contacts is presented in table 11.

Interpretation Periplus	Number
Boulder	5
Cable or chain	9
Natural phenomenon	53
Rock dump	1
Unknown object	11
Total	**79**

Table 11. Results of the assessment of selected side scan sonar contacts

The majority of the reviewed contacts has been classified as natural phenomena (sedimentary features). Nine contacts have been classified as pieces of cables or chains, which are very common finds in the North Sea.

Contact (S-VH-0049) contact includes an elongated pile (60x20x4.3m) of objects on the seabed. This contact has been identified as a rock dump which covers the TAT 14 Segment J – Eneco Luchterduinen Power cable crossing. The route of the Eneco Luchterduinen Power Cable displayed in figure 16 is the database geometry As Planned, as we do not avail of the As Laid or As Built geometry of this cable. The actual position of the cable can therefore be located a few meters more to the south under the rock dump.

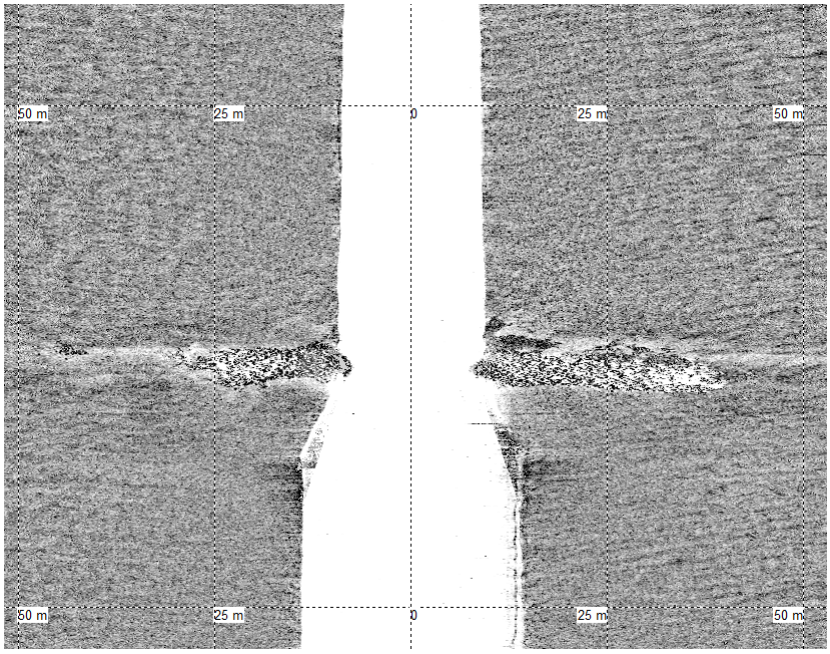

Figure 15. Raw sonar image of contact S_VH0049

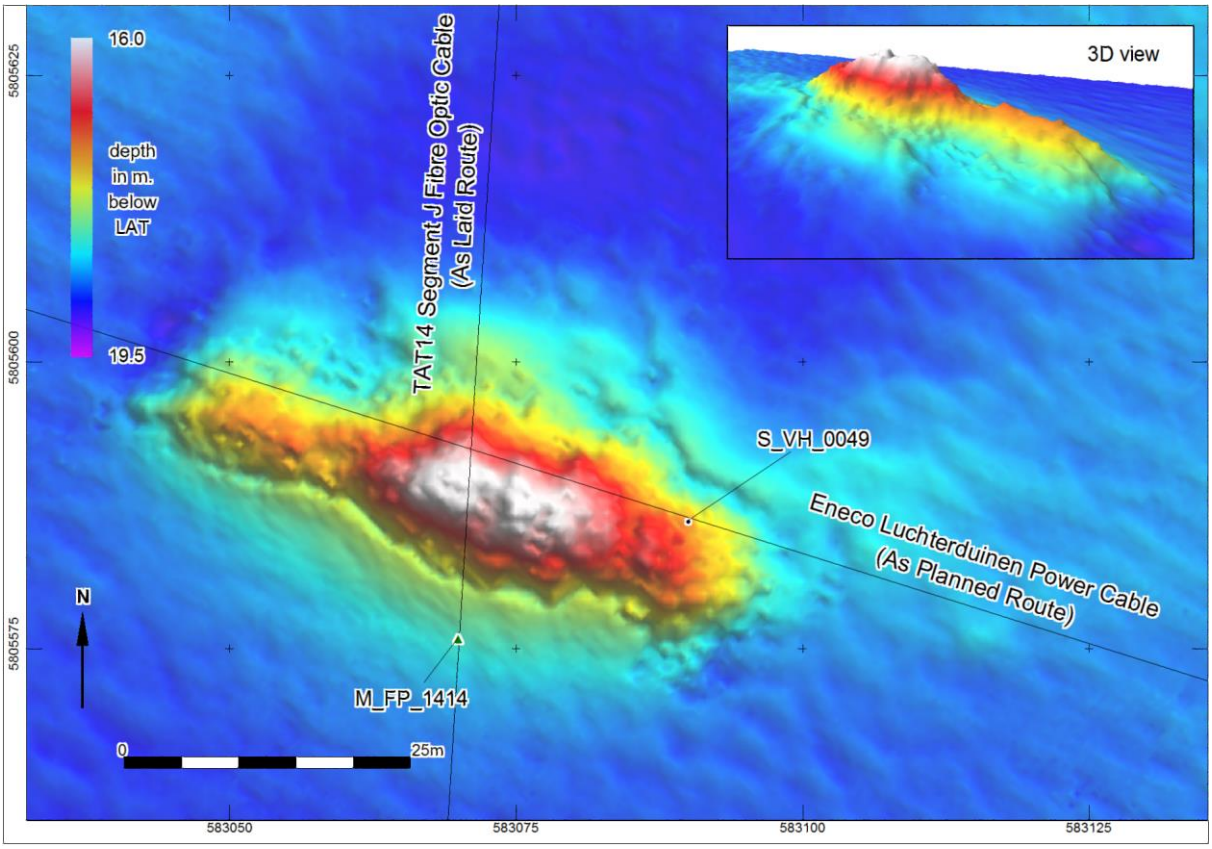

Figure 16. Multibeam image of sonarcontact S_VH-0049

The TAT 14 Segment J Fibre Optic Cable has resulted in the 71 nT magnetic anomaly M_FP_11414. The site is not to be considered as of archaeological value.

Eleven contacts have been classified as unknown objects. Six of these contacts may represent objects with an archaeological value. Four contacts occur as a cluster and are treated as one site. The contacts are discussed below.

WFS I
Contact S_FP_112

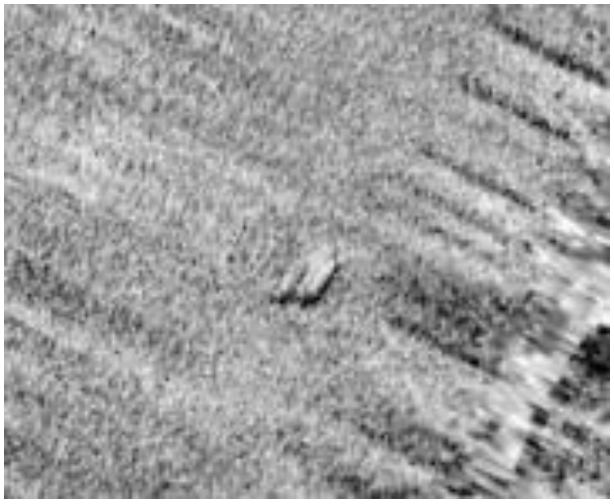

Figure 17. Side scan sonar image of contact S_FP_112

The side scan sonar image shows two cylindrical objects on the top of a sand ridge. Dimensions: 5,5 x 1.3 x 0,5m.

Contact S_FP_178

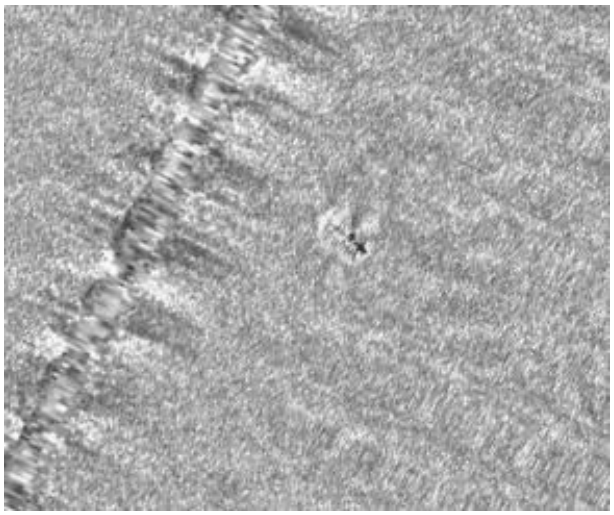

Figure 18. Side scan sonar image of contact S_FP_178

The side scan sonar image of contact 178 shows a faint elongated object with dimensions 5,8 x 1,0 x 0,6m. The object is clearly visible in the multibeam data as is illustrated in the next figure.

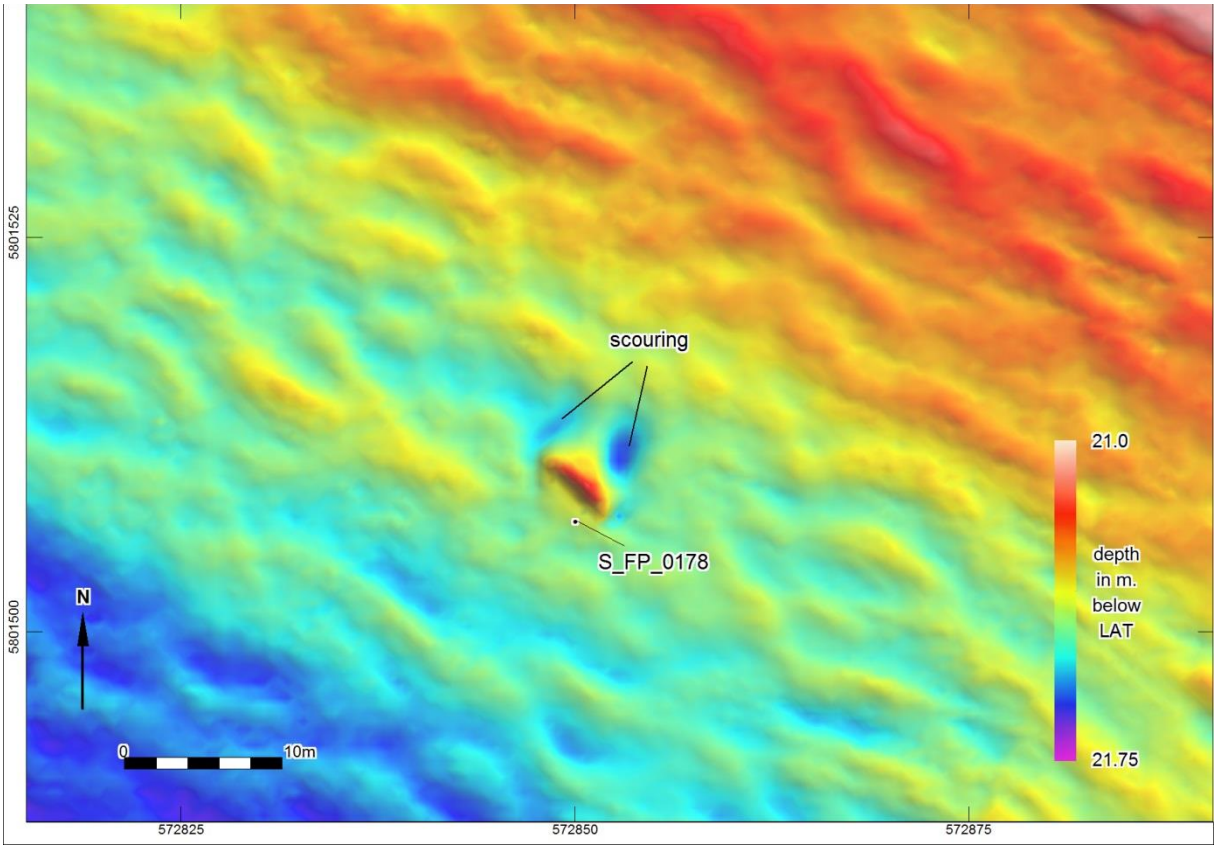

Figure 19. Multibeam image of contact S_FP_0178

WFS II

No side scan sonar contacts which are considered to be of potential archaeological interest have been found in WFS II.

WFS III

Apart from the side scan sonar contact which could be linked a known NCN contact (Sonar S_FP_0244/NCN 14632; see paragraph 3.2) no side scan sonar contacts have been found in WFS III which are considered to be of potential archaeological interest.

WFSIV

Contacts S_FP 388, 389, 390 en 391

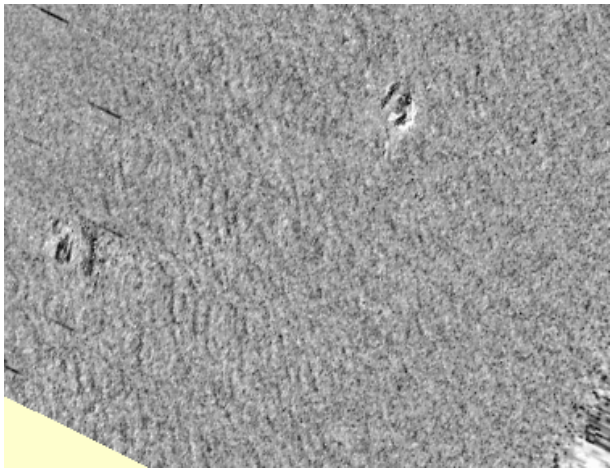

Figure 20. Side scan sonar image of a cluster of contacts

The side scan sonar image shows two clusters of contacts, approximately 45 meters apart. The multibeam image (see figure below) shows different objects with scour marks. Two small (14 and 19 nT) magnetic anomalies are recorded at the site. It is possible that a bigger structure is present, covered with sediments.

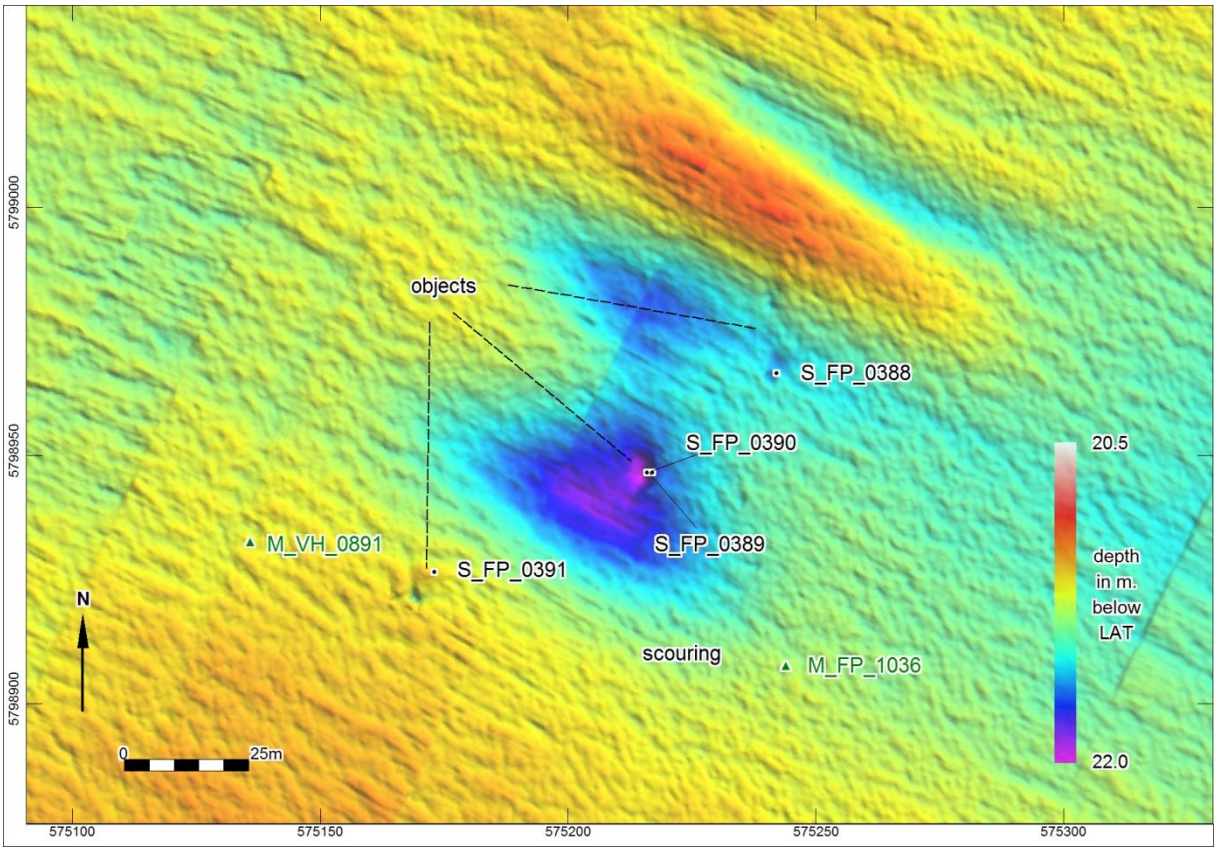

Figure 21. Multibeam image of contact S_FP_0388, 389, 390 and 391

3.4 Multibeam

Apart from the multibeam images discussed in section 3.2 no multibeam-features have been observed which are interpreted to reflect the presence of archaeological objects or structures.

3.5 Magnetometer

Besides the objects that are visible on the geophysical data and are selected as possibly archaeological valuable there also are large *magnetometer* anomalies which are not observed on the *side scan sonar* or *multibeam* data. Although the nature of these objects is not known it is possible that the anomalies represent archaeological remains buried in the seabed, and therefore have to be taken into account within this assessment.

A total of 2394 magnetic anomalies have been observed. 679 of these anomalies can be related to known pipelines or cables. Only 32 can be related to side scan sonar contacts.

A total of 1683 magnetic anomalies cannot be related to known pipelines and cables, or visible objects at the seabed surface. They are related to unknown ferrous objects buried in the seabed, covered by sediments 245 of these anomalies have an amplitude of 50 nT and more. An overview is presented in the figure below.

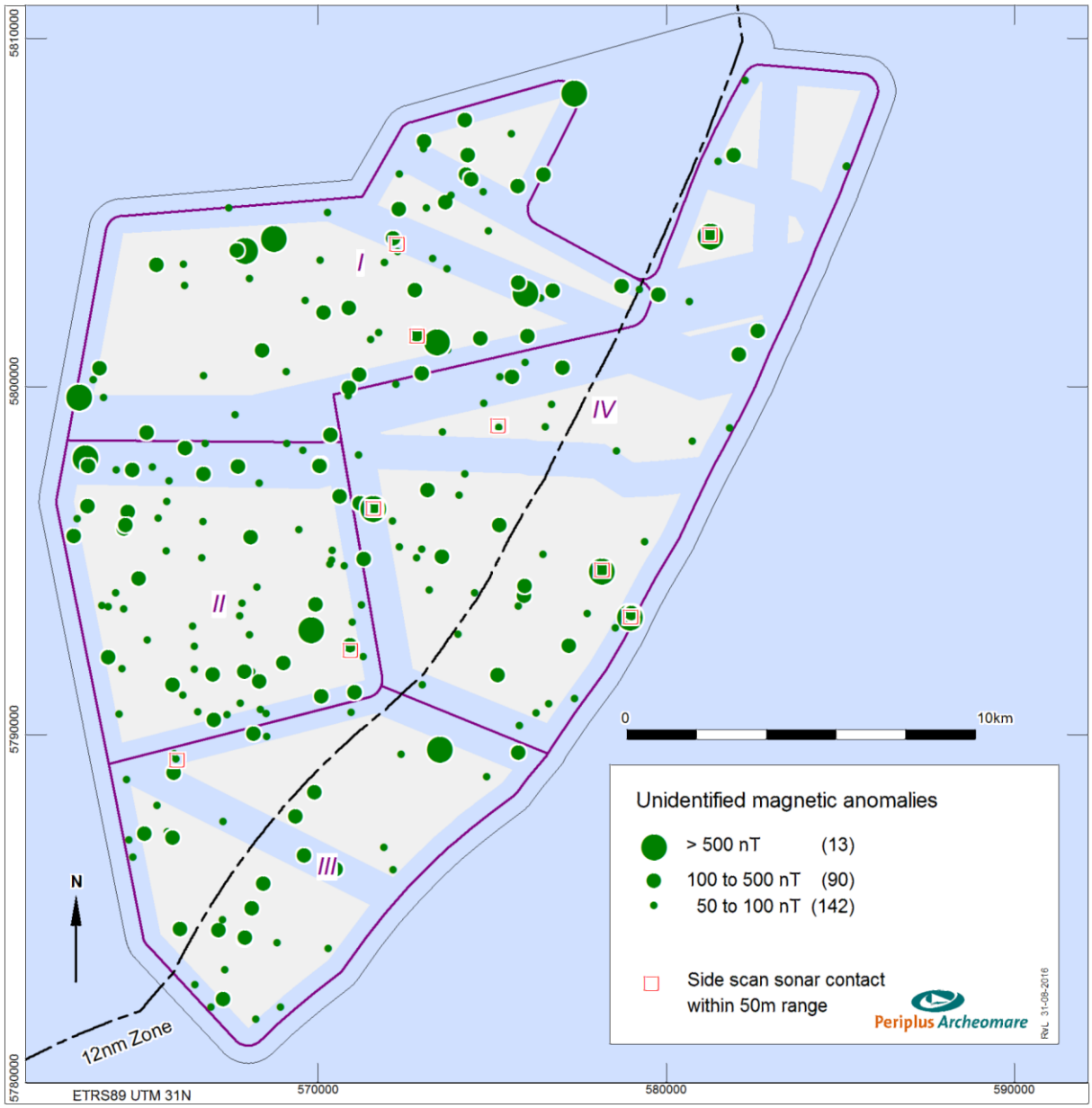

Figure 22. Unidentified magnetic anomalies

3.6 Subbottom data

Desk study results

Before discussing the survey results a summary of the lithostratigraphic sequence which, based on the desk study, is to be expected. The desk study results are displayed in the tables below.

Unit	Top -seabed	Base -seabed	Occurrence	Remark
Bligh Bank Member	0 - 5	0 - 5	total area	mobile layer, seabed
Basal Peat Bed	0 - 5	0 - 5	total area	presence uncertain
Boxtel Formation - Wierden Member - Delwijnen Member	0 - 5	0 - 5	western part (outside 12 nm)	occurrence and integrity uncertain
Kreftenheye - Wijchen Member	0 - 5	10 - 20	total area	layer boundary with Eem Formation uncertain
Eem Formation - Brown Bank Member	10 - 20	10 – 30	total area (?)	top and bottom of formation uncertain

Table 12. Lithostratigraphic units expected in the wind farm zone

Unit	Archaeological remains	In situ
Bligh Bank Member	reworked flint and bone artifacts	no
Basal Peat Bed	in situ finds: lost objects, dumps	yes
Boxtel Formation Wierden Member Delwijnen Member	camps sites of hunters and gatherers; flint and bone artifacts; burnt nuts and seeds; charcoal; hunting gear	 yes yes
Kreftenheye Wijchen Member	reworked flint and bone artifacts lost objects, dumps; possible camp sites	no yes
Eem Formation Brown Bank Member	reworked flint and bone artifacts camps sites Neanderthaler; flint artifacts	no yes

Table 13. Archaeological levels within the lithostratigraphic units

Survey results

From table 14 can be concluded the upper lithostratigraphic units encountered (Kreftenheye Formation and Bligh Bank Member) are to a large extent in agreement with the desk study based expectation. In fact the Kreftenheye Formation has been found throughout the area and the As Found thickness of the Bligh Bank Member (Southern Bight Formation) resembles the expected values including the westward thickening of the unit. The thickness of the Bligh Bank Member ranges from 0.4 up to 8.4 meters. Variations in thickness are related to the occurrence of sand dunes and superposed mega-ripples which have developed in the sandy mobile top layer throughout the area. However, the survey also resulted in some marked differences.

The expected Boxtel Formation has not been encountered or has not been identified as such in the seismic data. The absence of this unit is an important finding as within the top of this unit remains of prehistoric settlements are to be expected (provided the top of this unit has not been subjected to erosion). The Wijchen Layer, a stiff matured clay or silt layer at the top of the Kreftenheye has not been identified in the seismic data and is expected to be absent throughout the area.

The Brown Bank Member has been identified in Site II (49% of the area) and site IV (56% of the area). Contrary to the desk study expectation the unit was not found in the western part of site I and is inferred to be present in the northern part of Site IV.

Also contrary to the desk study expectation, the Eem Formation (including the Brown bank Member) has not been found covering all of the wind farm area. It is known that the top of the Brown Bank Member often is characterized by the presence of peat consisting of wood remains and moss. Acoustic blanking associated with peat at the top of the Brown Bank Member might have obscured underlying seismic reflectors because of which the base of the Bligh Bank Member could not be identified in the seismic data.

The top of the Eem Formation / Brown Bank Member coincides with the base of the Kreftenheye Formation and lies in most parts of the site at 12 up till 18 meters below the seabed. The depth at which the Eem Formation has been found is in line with the values expected (refer to table 12: 10 – 20 meters below the seabed). The Eem Formation is reported to contain gravel beds in Site I, III and IV. Within the Eem Formation at isolated spots in the western part of Site II and the along the western border of Site IV possibly peat layers and associated shallow gas are present. Acoustic blanking was not observed beneath these layers.

Seismic Unit	Reflectors		min m -seabed				max m -seabed				Layer transition	Lithology CPT	Env.	Unit	Age
	Top	Base	I	II	III	IV	I	II	III	IV					
A	Seabed	H01	0.8	0.7	0.4	0.6	8.2	8.4	7.2	7.2	erosional surface	Coarse SAND, with shells and shell fragments, rare SILT and CLAY laminae and rare GRAVEL	Marine	Southern Bight FM	Holocene
B	H01	H10	8	6	6	6	28	28	28	28	erosional surface	Medium to coarse SAND with shells, wood fragments and hard CLAY pebbles	Fluvial	Kreftenheye FM	Upper Pleistocene
C1	H10	H15	15	Not Found		27	28	Not Found		?	uneven surface	CLAY, SILT and SAND with presence of peat	Shallow marine	Brown Bank MB Eem FM	Upper Pleistocene
C2	H15	H20	31	29	25	?	49	46	37	58	erosional surface	Fine to medium coarse SAND, with shells and minor GRAVEL and CLAY	Shallow marine	Eem FM	Upper Pleistocene
D	H20	-	> LOI	> LOI	> LOI	> LOI	> LOI	> LOI	> LOI	> LOI	not visible	Medium-fine SAND, with CLAY lamination and local intercalation of peat	Fluvial	Yarmouth Roads FM	Lower to Middle Pleistocene

Table 14. Overview of the interpreted seismic units (after Nieboer 2016)

Transitions between all formations have been interpreted to be erosive. The transition between the Eem Formation and the Brown Bank Member has been described as an 'uneven surface'. The development of the Brown Bank Member in the area is probably caused by a regression at the end of the Eemian interglacial period. The Brown Bank Member can be considered to be an infill of lower laying parts of the landscape eventually evolving into a lacustrine environment at the onset of the Weichselien glacial period 115.000 years ago. Bore hole samples could prove or debunk this idea. Sample data were not available for analysis and interpretation at the time of the execution of this research yet.

By means of the grids created by FSBV is compiled (refer to figure 23). This figure shows that in the northwestern part of Site IV the base of the Brown Bank Member lies op till more than 30 meters below the seabed. It is expected that in this zone a continuous sequence of clay, silt and possibly peat has been deposited.

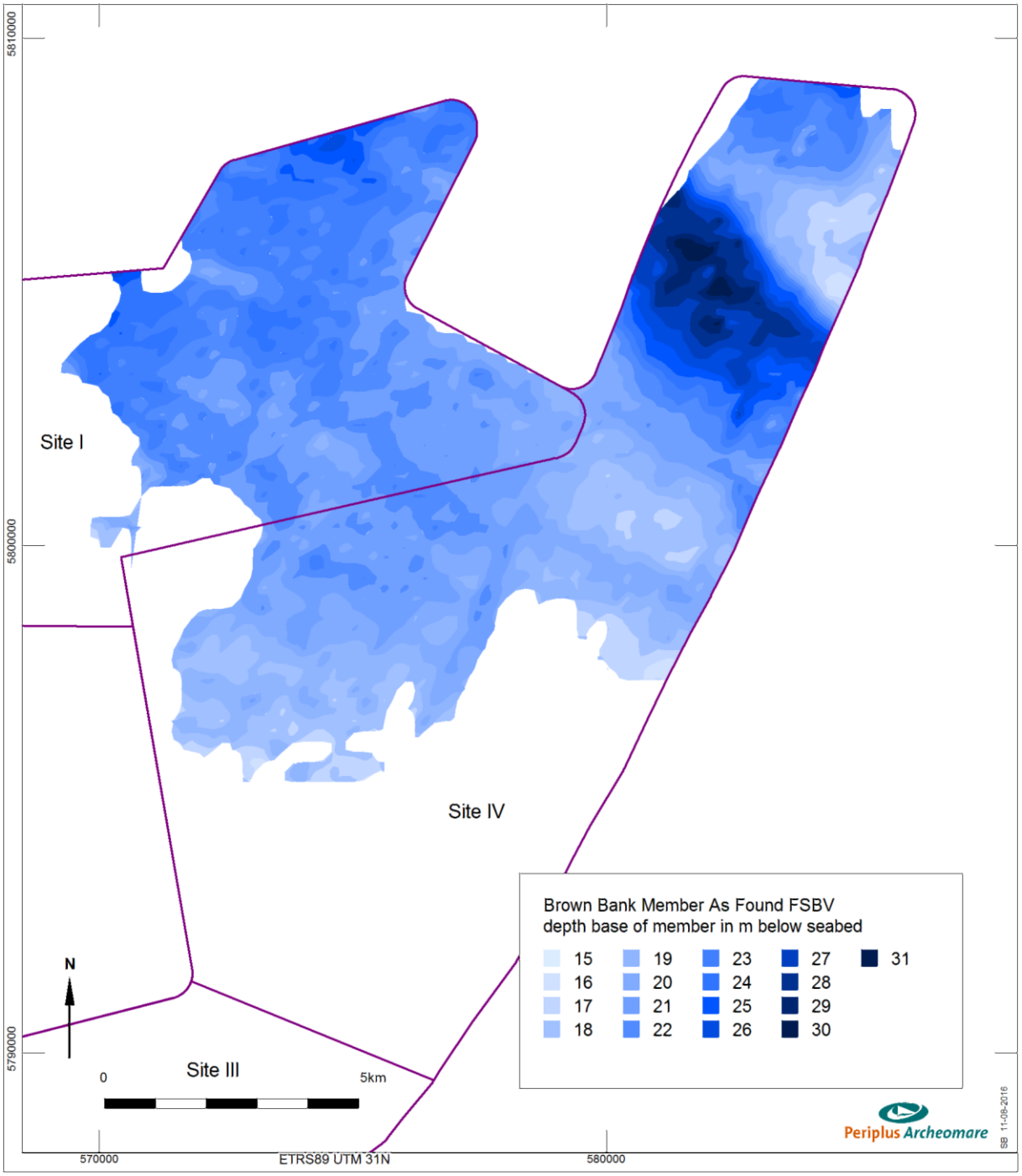

Figure 23. Occurrence of the Brown Bank Member in Site I and IV

The occurrence of the Brown Bank Member as shown in figure 23 is used to zones where Middle Paleolithic camp sites are to be expected in WFS IV (see figure 24).

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4 Synthesis

For this investigation different research questions are defined in the Program of Requirements.[10]
Based on the results of de data analysis the research questions are answered.

primary question:
Are any archaeological remains present within the Area of Interest and to what extent are these remains traceable?
Yes. An archaeological expectation is assigned to a total of 28 objects. Seven known objects and three new objects have been found during this survey campaign, 18 objects were found in the past and are covered with sediments.

with respect to side scan sonar, magnetometer and multibeam survey:

Are there any phenomena visible on the seabed?

Yes. A total of 563 contacts visible at the surface are reported with side scan sonar and multibeam.

A total of 1683 magnetic anomalies cannot be related to known pipelines and cables, or visible objects at the seabed surface. They are related to unknown ferrous objects buried in the seabed, covered by sediments. 245 of these anomalies have an amplitude of 50 nT and more.

	WFS				
General	**I**	**II**	**III**	**IV**	**Total**
Side scan sonar contacts	132 (70)	101(54)	96 (54)	234 (118)	**563 (267)**
Magnetometer contacts	545 (190)	406 (222)	584 (332)	857 (369)	**2392 (1279)**
Overlap sonar magnetometer	8 (3)	3 (3)	7 (4)	14 (7)	**32 (15)**
Unidentified magnetometer > 50nT	**72 (39)**	**72 (46)**	**39 (23)**	**62 (35)**	**245 (102)**
(between brackets: number of contacts within windfarm parcel)					

Table 15. Summary of all contacts

If so:

What is the description of these phenomena?

A summary of the original side scan sonar classification is listed in the table below

Classification	**I**	**II**	**III**	**IV**	**Total**
Suspected debris	121	84	55	113	373
High Backscatter	11	17	35	89	152
Boulders	-	-	4	20	24
Linear debris	-	-	1	8	9
Cable	0	0	0	0	0
Pipeline	0	0	0	0	0
Wrecks	0	0	1	4	5
Total	**132**	**101**	**96**	**234**	**563**

Table 16. Side scan sonar contacts identified in the HKZ WFZ

[10] Van Lil and van den Brenk, 2016.

Do these phenomena have a man-made or natural origin?

None of the assessed contacts smaller than 4 meter has been interpreted as potential archaeological object or structure. After reviewing a selection of 79 contacts larger than four meters in more detail, a number of contacts can be interpreted as natural phenomena such as sedimentary features. A summary is listed in the table below.

Interpretation Periplus	**Number**
Boulder	5
Cable or chain	9
Natural phenomenon	53
Rock dump	1
Unknown object	11
Total	**79**

Table 17. Results of the assessment of selected side scan sonar contacts

Three of the unknown objects were assigned with an archaeological expectation.

If these phenomena can be designated to be man-made:

What classification can be attached?

The man-made phenomena consist of (remains of) shipwreck and loose pieces of cables and chains, which were lost or dumped at sea.

If these phenomena can be classified as archaeological:

Is it possible to interpret the nature of the archaeological objects?

An archaeological expectation is assigned to a total of 28 objects, a summary is listed below.

	WFS				
Objects with an archaeological expectation	**I**	**II**	**III**	**IV**	**Total**
Known object covered with sediments, found by magnetometer	1 (1)	0 (0)	0 (0)	1 (1)	2 (2)
Known object exposed at seabed, found by SSS	0 (0)	0 (0)	1 (1)	4 (2)	5 (3)
Known object covered with sediments	7 (7)	4 (3)	6 (4)	1 (1)	18 (15)
New object exposed at seabed, found by SSS	2 (1)	0 (0)	0 (0)	1 (1)	3 (2)
Total	**10 (9)**	**4 (3)**	**7 (5)**	**7 (5)**	**28 (22)**
(between brackets: number of contacts within windfarm parcel)					

Table 18. Summary of objects from side scan sonar and multibeam with a possible archaeological value

18 known objects found in the past with a possible archaeological expectation have not been found because they probably are covered with sediments.

The resolution of the data is not high enough to discuss details about the found objects with an archaeological expectation. Only in case if operations are planned within 100 meters of the objects, or in case indirect consequences such as scouring because of the installation of infrastructure are to be foreseen within 100 meters of the objects, additional research, e.g. by means of an ROV or divers, is necessary to determine the archaeological value.

If these phenomena can be identified as natural:

What is the nature of these natural phenomena?

The phenomena interpreted as natural consist of sedimentary features.

Based on the acoustic image is it possible to designate zones of high, middle or low activity on the seabed?

The high resolution bathymetry derived from the multibeam recording show that the seabed within all four sites is characterized by very large sand dunes with NW to SE trending crests and height ranging from 2 m to 6 m. The sand dunes are expected to migrate at a rate of 2-4 m per year in a north-easterly direction. This means that any objects present may be at the surface at one moment, while covered with sand at the next moment.

If so:

How can these zones be interpreted?

See the answer to the previous question

General:

What is the relation between the observed objects and the topography of the seabed? Based on this relationship can risk-prone areas be marked selectively?

Larger objects like ship wrecks show clear scouring at the northeast side caused by the dominant currents in a north-easterly direction.

If no acoustic phenomena can be observed:

Are there any clues that this is a consequence of either natural erosion, sedimentation or human interference?

This question is given the results of the investigation not applicable.

<u>with respect to subbottom profiler- and sampling:</u>

Based on seismic profiles and geotechnical data is it possible to map the Pleistocene landscape?

Yes, the data provided by FSBV is fit to map the Pleistocene landscape.

If so:

What is the depth of the Pleistocene landscape compared to the present seabed?

The seabed sediments are part of a mobile top layer in which sedimentary structures such as sand dunes and superposed mega ripples have developed. The mobile top layer is classified as the Bligh Bank Member within the Southern Bight Formation. The top of the underlying Pleistocene landscape consists of fluvial sediments of a braided river system (Rhine). The deposits date from the last ice age (Weichselien) and are part of the Kreftenheye Formation. The As Found depth of the top of the Kreftenheye Formation ranges in all sites from 0.8 meters up until 8.7 meters below the seabed. The variation in depth is closely related to the morphology of the seabed. The Kreftenheye Formation is found at deeper levels beneath sand dune crests and close to the seabed surface beneath the valleys in between the sand dunes.

From Pleistocene to Holocene deposits is the transition gradual or instantaneous (erosive)?

The seismic data indicate that the transition between the Pleistocene Kreftenheye Formation and Holocene Bligh Bank Member is sub horizontal (sheet like) and erosive.

Can zones be identified where prehistoric settlement remains can be expected?

Within the top of Late Pleistocene cover sands (Wierden Member / Boxtel Formation) and river dunes (Delwijnen Member / Boxtel Formation) numerous sites of (pre)historic settlements are known. Based on the desk study and the study from Deltares[11] the Boxtel Formation was expected to occur in Site I and Site II. However, this unit has not been identified in the seismic data.

Another archaeological level for possible *in situ* remains is an organic and matured clay/silt layer which can be present at the top of the Kreftenheye Formation. These deposits are knowns as the Wijchen Layer. The Wijchen Layer has not been identified in the seismic data.

[11] Vonhögen-Peeters et al, 2016

Considering the inferred absence of the Boxtel Formation, Wierden Member and the conclusion that the top of the Kreftenheye Formation was subjected to erosion no *in situ* prehistoric settlement remains are expected at this level. This conclusion applies for all sites.

During the desk study the deeper seated Brown Bank Member has been designated as a potential level for *in situ* Neanderthaler camp sites which are characterized by the occurrence of flint artefacts.

In the north-eastern part of Site IV the Brown Bank Member shows the thickest sequence. At this location a regression at the end of the Eemian interglacial period ultimately could have led to the development of a fresh water lake. This lake environment provides fresh water which presumably results in favourable circumstances for humans to install camp sites and hunt animals which are drawn to the lake side. The top of the Brown Bank Member is in the north-eastern part of the area encountered at 13 up till 22 meters below the seabed.

It should be stressed that at this stage the interpretation is solely based on the seismic data; to date no bore hole data are available which would give a better insight in the deposits present and reconstruction of the actual depositional environment.

The development of the wind farm is an opportunity to learn about the Eemian landscape and related archaeology. The wind farm development is not considered to be a possible threat for these landscapes.

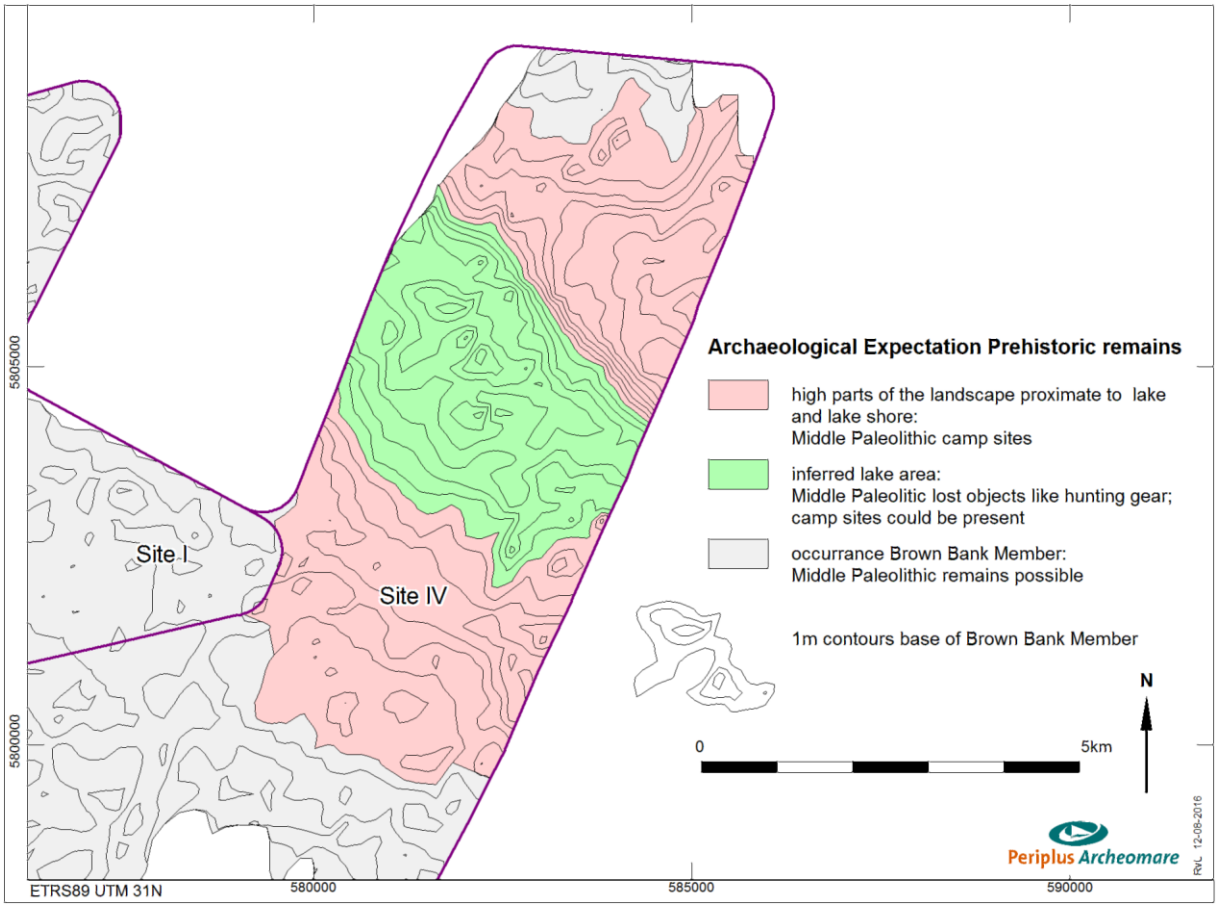

Figure 24. Zones in which Middle Paleolithic remains are expected in Site IV

If so:

Could these expected settlement remains be effected by the installation of the cables based on their vertical position related to the seabed?

No, the installation of cables would not affect potential remains, because the archaeological level is expected to be located at more than 13 meters below the seabed. The installation of monopiles however would penetrate the Brown Bank Member and could affect archaeological remains, if present.

Are there any indications observed on the seismic profiles for the presence of buried (man-made) objects?

No, in none of the sites sub-seabed geohazards have been reported which are expected to comprise archaeological remains. Within the Eem Formation gravel beds have been found in Site I, III, and IV. Distinction between plain gravel and flint artefacts is not possible in seismic data.

If so:

Based on the presence of buried objects and its correlation with side scan sonar, magnetometer en multibeam data can something be said about the nature of these buried objects?

This question is not applicable.

Are there any mitigating measures necessary to avoid disturbance of possible archaeological remains?

In the course of the wind farm development bore hole samples shall be taken. It is advised to look into these samples from an archaeological perspective. This advise especially applies to samples taken from the Brown Bank Member in the zones in which Middle Paleolithic remains are expected in Site IV at 13 – 22 meters below the seabed (refer to figure 24).

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5 Summary and recommendations

A large quantity of survey data (*side scan sonar, magnetometer* and *multibeam* echosounder) recorded within the four wind farm zones (including a safety zone of 500 meters) covering a total area of 389 km^2 were analyzed in order to conduct an archaeological assessment.

The current analysis of geophysical survey results is the second step in the archaeological assessment, following the desk study. The desk study has shown that a total of 52 objects and wrecks are known within the boundaries of the wind farm sites. 27 of these objects consist of small objects, lost cables or chains, and are not considered to be of archaeological importance. For the remaining 25 objects the archaeological value has not been determined.

Five of these objects have been found exposed at the seabed; two objects presumably are marked by a magnetometer anomaly. The other eighteen objects which, based on the findings of the desk study were expected in the area, have not been found. These objects are likely to be covered with sediments due to migration of the sand waves in the area.

Apart from the five known objects found, 558 other contacts were reported with side scan sonar. The analysis of these contacts resulted in a final selection of six unknown objects and structures which may have an archaeological value, based on their shapes and dimensions. From these six contacts the four which have been found proximate to one another in Site IV and are considered to form one site.

A summary of all objects with a possible archaeological expectation is listed in the table below.

Objects with a possible archaeological expectation	**WFS I**	**WFS II**	**WFS III**	**WFS IV**	**Total**
Known objects (NCN) found with SSS exposed at the seabed surface	-	-	-	5	5
Known objects (NCN) found with MAG buried beneath the seabed surface	1	-	-	1	2
Known objects (NCN) not found, probably covered with sediments	7	4	6	1	17
Unknown objects found with side scan sonar	2	-	-	1*	6
Total	**10**	**4**	**6**	**8**	**28**

Table 19. Summary of objects from side scan sonar and multibeam with a possible archaeological value

* cluster of contacts at one site.

A map showing the distribution of the objects is presented in the next figure.

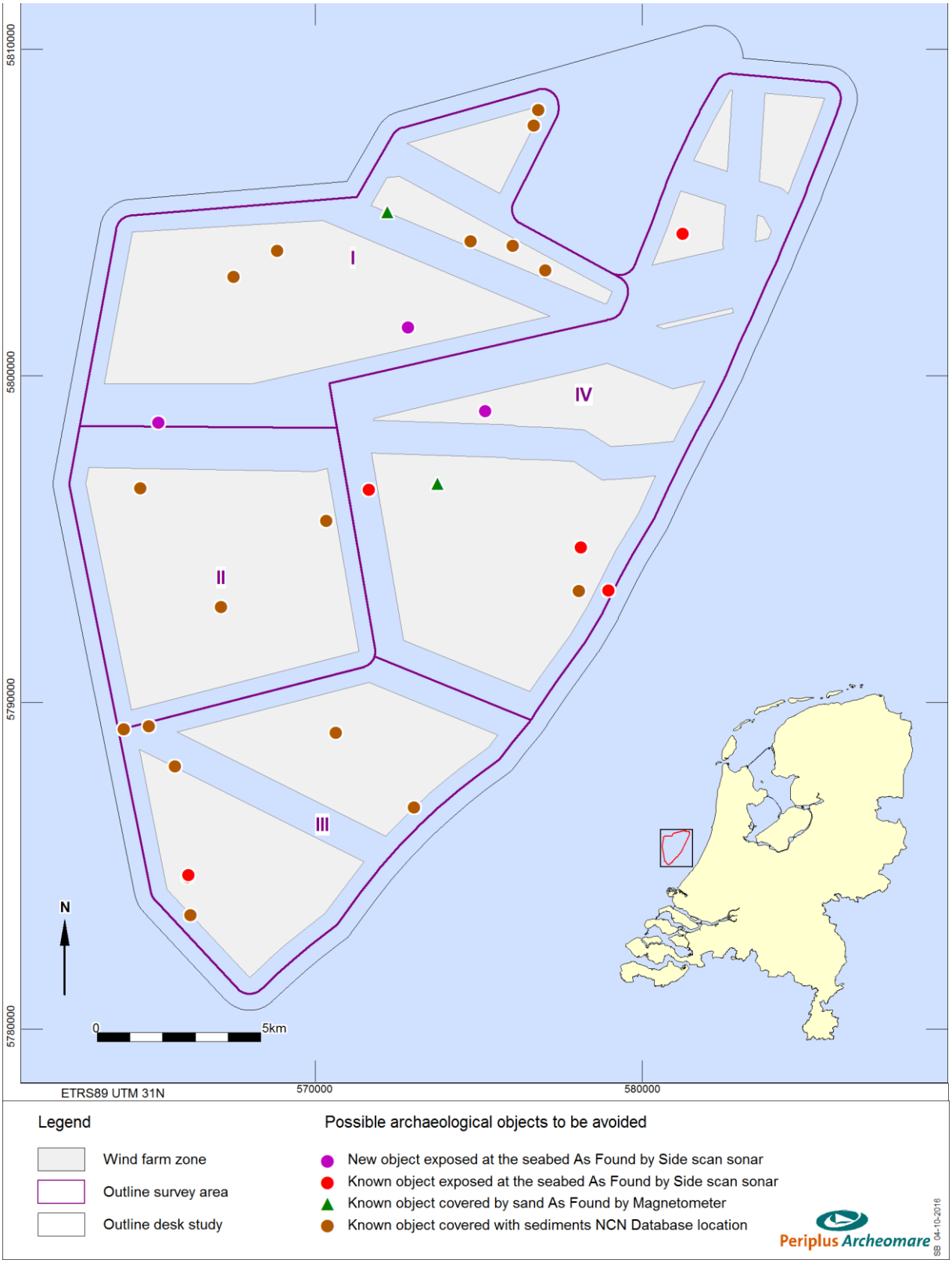

Figure 25. Overview of the potential archaeological objects found with side scan sonar and multibeam

As long as the archaeological value of the objects is not determined, it is advised not to conduct activities which could affect the locations with possible archaeological objects (28 in total) including a buffer zone of 100 meters around. This also applies to cable trenching and anchorages of work vessels.

The buffer zone of 100 meters is a standard that applies to the protection of cultural heritage, this distance may be reduced if it can be substantiated that the applied disturbance has no effect on the archaeological object. For example, when no anchoring is used during cable lay operations the buffer zone can be decreased. Reduction of the distance may be approved by Rijkswaterstaat (RWS). Rijkswaterstaat is the enforcing authority, acting on behalf of the Ministry of Economic Affairs. The Cultural Heritage Agency of the Netherlands (RCE) acts as an advisor to Rijkswaterstaat.

A total of 2394 magnetic anomalies have been observed. 679 of these anomalies can be related to known pipelines or cables. Only 32 can be related to side scan sonar contacts.

A total of 1683 magnetic anomalies cannot be related to known pipelines and cables, or visible objects at the seabed surface. They are related to unknown ferrous objects buried in the seabed, covered by sediments. 245 of these anomalies have an amplitude of 50 nT and more.

Concerning these buried ferrous objects, it is advised to avoid these locations including a buffer zone of 100 meters areas whilst installing wind turbines and the various inner field and export cables. It should be stressed that the origin of the magnetic anomalies is unknown and apart from possible archaeological remains any type of man-made objects can be encountered including unexploded ammunition, anchors, pieces of chains and cables, debris, etcetera.

If it is not feasible to avoid the reported magnetometer locations, additional research is required in order to determine the actual archaeological value of the reported locations. It is advised that the UXO research within 100 meter of the 245 magnetometer anomalies are carried out under onboard archaeological supervision. Depending on the outcome of the UXO research it can be decided if additional research (for instance by means of ROV or dive investigations) is needed. If the UXO research indicates that the object has no archaeological value, the location can be omitted.

Prehistory

From the interpreted seismic data can be concluded that due to the inferred absence of the Boxtel Formation and Wijchen Member and erosion of the top of the Pleistocene sequence at 0 - 8.4 meters below the seabed - at least at this stratigraphical level - no *in situ* remains of prehistoric settlements are expected.

Based on the desk study and the study from Deltares, prehistoric remains were expected to occur in Site I and Site II. However, these archaeological layers have not been identified in the seismic data. Additional research for prehistoric remains within Sites I and II is therefore not considered necessary.

In Site I and IV the Brown Bank Member occurs. Within Site IV zones have been defined which could contain archaeological remains from the Middle Paleolithic. In fact little is known about the actual sediments present and the environment in which these sediments have been deposited. In the course of the wind farm development bore hole samples are being taken. It is advised to look into these samples from an archaeological perspective, following the *AMZ* cycle. This advice applies to samples taken from the Brown Bank Member in the zones in which Middle Paleolithic remains are expected in Site IV.

In general the development of the wind farm is an opportunity to learn about the Eemian landscape and related archaeology. The wind farm development is not considered to be a possible threat for these landscapes.

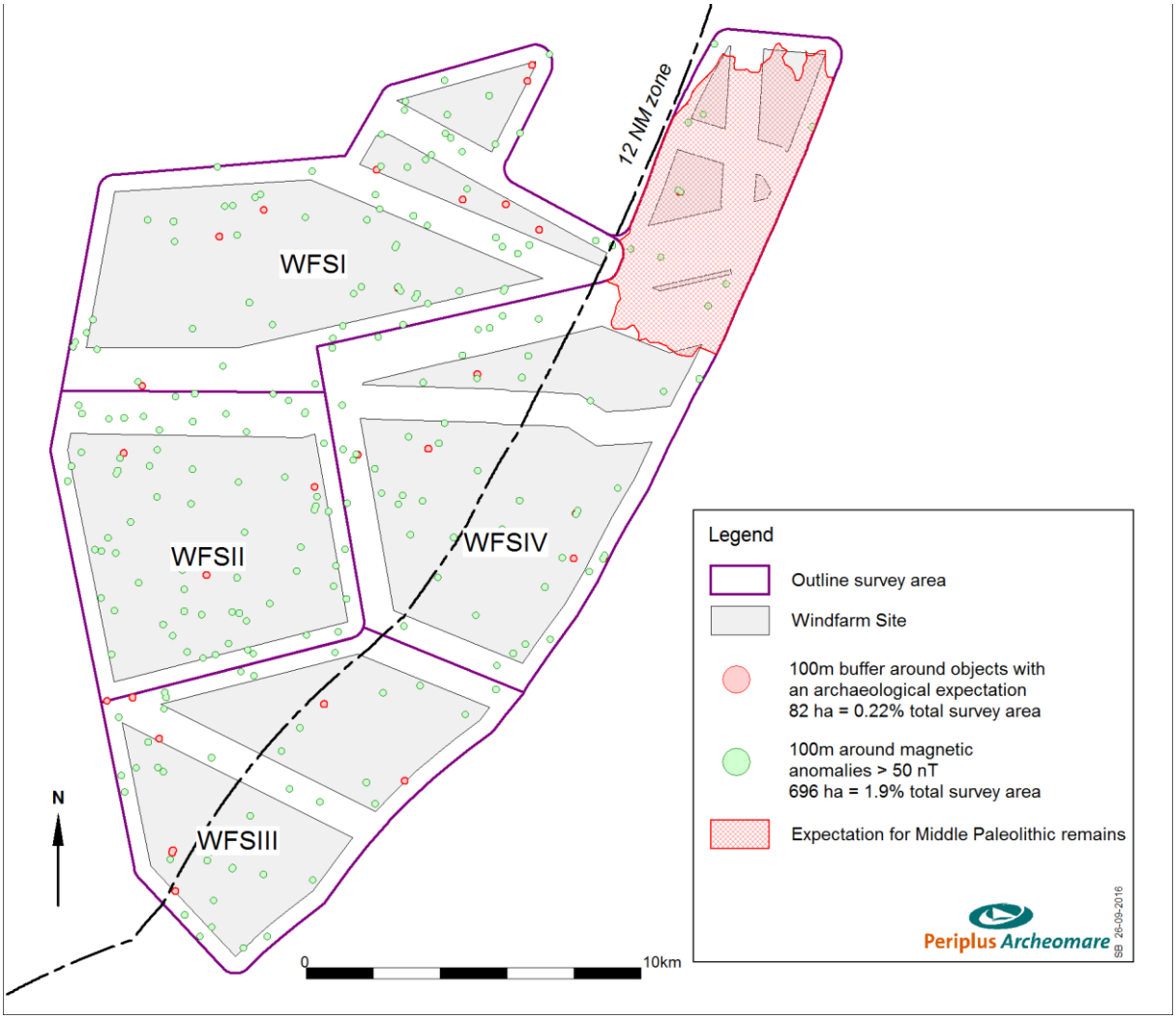

Figure 26. Buffer zones (100m) to scale around contacts and zone with expectancy for prehistoric remains

During the installation of the wind turbines and cable lay operations, archaeological objects may be discovered which were completely buried or not recognized as an archaeological object during the geophysical survey. We recommend passive archaeological supervision based on an approved Program of Requirements. Passive archaeological supervision means that an archaeologist is not present during the execution of the work but always available on call. Following this recommendation would prevent delays during the work when unexpectedly archaeological remains are found. In accordance with the Erfgoedwet, it is required to report those findings to the competent authority. This notification must also be included in the scope of work.

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Glossary and abbreviations

Terminology	Description
AMZ	Archeologische Monumenten Zorg, a description of procedures to ensure the protection of National archaeological Cultural Heritage
CPT	Cone penetration test
Erratic	An (glacial) erratic is a piece of rock that differs from the size and type of rock native to the area in which it rests. These rocks are carried by glacial ice, often over distances of hundreds of kilometres. Erratics can range in size from pebbles to large boulders.
Ferrous	Material which is magnetic or can be magnetized, and well known types are iron and nickel
Holocene	Youngest geological epoch (from the last Ice Age, around 10,000 BC. To the present)
In situ	At the original location in the original condition
KNA	Kwaliteitsnorm Nederlandse Archeologie
Magnetometer	Methodology to measure deviations from the earth's magnetic field (caused by the presence of ferro-magnetic = ferrous objects)
Multibeam	Acoustic instrument that uses different bundles or beams to measure the depth in order to create a detailed topographic model
Pleistocene	Geological era that began about 2 million years ago. The era of the ice ages but also moderately warm periods. The Pleistocene ends with the beginning of the Holocene
PvE	Program of Requirements (Dutch: Programma van Eisen)
RCE	Ministry of Cultural Heritage (Dutch: Rijksdienst voor het Cultureel Erfgoed)
ROV	Remotely Operated Vehicle
Side scan sonar	Acoustic instrument that registers the amplitude of reflections of the seabed. The resulting images are similar to a black / white photograph. The technique is used to detect objects and to classify the morphology and type of soil
Current ripples	Asymmetrical wave pattern at the seabed caused by currents. The steep sides of the ripples are always on the downstream side.
Subbottom profiler	Acoustic system used to create seismic profiles of the subsurface.
Trenching	Construction of a trench for the purpose of burying a cable or pipeline
Vibrocore	Vibrocore bore is a special drilling technique where a core tube is driven by means of vibration energy in the seabed. In addition, the core tube is provided with a piston so that the bottom material in the core tube remains in place.

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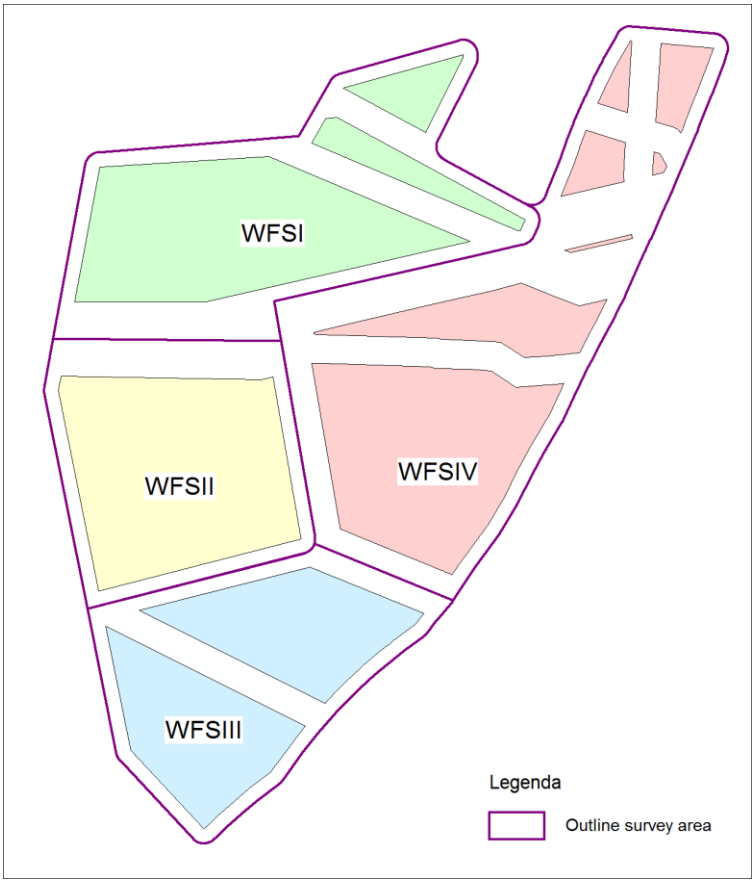
- KNA Waterbodems 3.2
- Nationaal Contactnummer Nederland (NCN)
- SonarReg92, objectendatabase Rijkswaterstaat Noordzee en Delta

Appendix 1. Summary of contacts and known objects



General	I	II	III	IV	Total
Side scan sonar contacts	132 (70)	101(54)	96 (54)	234 (118)	**563 (267)**
Magnetometer contacts	545 (190)	406 (222)	584 (332)	857 (369)	**2392 (1279)**
Overlap sonar magnetometer	8 (3)	3 (3)	7 (4)	14 (7)	**32 (15)**
Unidentified magnetometer > 50nT	**72 (39)**	**72 (46)**	**39 (23)**	**62 (35)**	**245 (102)**

Known Objects	I	II	III	IV	Total
Total known objects	20 (19)	14 (9)	11 (6)	7 (5)	**52 (39)**
Known objects with an archaeological expectation	7 (7)	4 (3)	7 (5)	6 (4)	**24 (19)**
Known objects with an archaeological expectation found	1 (1)	0 (0)	1 (1)	5 (3)	**7 (5)**

Objects with an archaeological expectation	I	II	III	IV	Total
Known object covered with sediments, found by magnetometer	1 (1)	0 (0)	0 (0)	1 (1)	**2 (2)**
Known object exposed at seabed, found by SSS	0 (0)	0 (0)	1 (1)	4 (2)	**5 (3)**
Known object covered with sediments	7 (7)	4 (3)	6 (4)	1 (1)	**18 (15)**
New object exposed at seabed, found by SSS	2 (1)	0 (0)	0 (0)	1 (1)	**3 (2)**
Total	**10 (9)**	**4 (3)**	**7 (5)**	**7 (5)**	**28 (22)**

Values refer to the total number within the surveyed areas, including the safety zone of 500 meters. The values between the brackets are the number within the Wind farm parcels).

Appendix 2. Listing of unidentified magnetic anomalies

> 50 nT and not related to known objects or side scan sonar contacts

Annotation	Area	Line	Vessel	ETRS89 UTM31N		Anomaly type	Amplitude (nT)	Anomaly width (m)
				Easting	Northing			
M_FP_0045	I	FPMainNorth22	FP	576036	5801508	M-	181	33
M_FP_0046	I	FPMainNorth22	FP	575998	5801425	D	79	19
M_FP_0047	I	FPMainNorth21	FP	576418	5802547	D	70	37
M_FP_0053	I	FPMainNorth18	FP	575963	5802753	D	522	5
M_FP_0056	I	FPMainNorth16	FP	575768	5803028	D	109	21
M_FP_0060	I	FPMainNorth14	FP	574674	5801427	D	421	21
M_FP_0066	I	FPMainNorth11	FP	576490	5806139	D	123	28
M_FP_0074	I	FPMainNorth10	FP	577371	5808497	D	592	38
M_FP_0076	I	FPMainNorth09	FP	573735	5801062	D	62	41
M_FP_0083	I	FPMainNorth08A	FP	575752	5805808	D	101	35
M_FP_0101	I	FPMain43	FP	569096	5800428	M+	59	19
M_FP_0115	I	FPMain40	FP	570076	5803628	M-	55	22
M_FP_0120	I	FPMain38	FP	567626	5799189	M+	79	15
M_FP_0128	I	FPMain37	FP	568410	5801088	D	117	38
M_FP_0129	I	FPMain37	FP	570288	5805006	D	75	27
M_FP_0153	I	FPMain30	FP	568740	5804314	M+	1845	19
M_FP_0156	I	FPMain29	FP	568581	5804228	M+	86	25
M_FP_0157	I	FPMain29	FP	568047	5803103	M-	62	19
M_FP_0158	I	FPMain29	FP	566720	5800309	M+	79	34
M_FP_0168	I	FPMain26	FP	567917	5803981	D	1048	55
M_FP_0183	I	FPMain20	FP	567453	5805133	M+	79	20
M_FP_0198	I	FPMain14	FP	563864	5799686	D	99	27
M_FP_0207	I	FPMain12	FP	565374	5803551	D	469	43
M_FP_0218	I	FPMain09	FP	563153	5799769	M-	673	13
M_FP_0219	I	FPMain09	FP	563224	5799910	D	97	23
M_FP_0230	I	FPSeis06	FP	563745	5800583	M-	339	12
M_FP_0232	I	FPSeis06	FP	563560	5800194	D	67	15
M_FP_0233	I	FPSeis06	FP	563560	5800194	D	66	11
M_FP_0240	I	FPSeis09	FP	566149	5803506	M-	69	20
M_FP_0241	I	FPSeis10	FP	566181	5802909	D	73	25
M_FP_0251	I	FPSeis13	FP	567678	5803958	D	108	25
M_FP_0267	I	FPSeis32	FP	572843	5801547	M-	64	35
M_FP_0268	I	FPSeis32	FP	573721	5803385	D	57	20
M_FP_0279	I	FPSeis34	FP	572996	5800432	D	217	29
M_FP_0314	I	FPMain48	FP	573067	5807091	D	105	29
M_FP_0331	I	FPMain49	FP	572342	5805151	M+	129	24
M_FP_0355	I	FPMain51	FP	571916	5803556	D	99	38
M_FP_0394	I	FPMain53	FP	574231	5807711	D	183	51
M_FP_0397	I	FPMain54	FP	573123	5805129	M-	50	26

Annotation	Area	Line	Vessel	ETRS89 UTM31N		Anomaly type	Amplitude (nT)	Anomaly width (m)
				Easting	Northing			
M_FP_0419	I	FPMain55	FP	570901	5800018	D	136	30
M_FP_0437	I	FPMain56M	FP	571756	5801554	D	85	18
M_FP_0439	I	FPMain56M	FP	571200	5800389	D	166	14
M_FP_0443	I	FPMain56M	FP	570375	5798663	M+	179	23
M_FP_0459	I	FPMain57	FP	573845	5805491	D	51	26
M_FP_0474	I	FPMain58	FP	574263	5806134	D	201	34
M_FP_0489	I	FPMain59	FP	573305	5803676	D	60	33
M_FP_0493	I	FPMain59	FP	574416	5806003	M-	110	26
M_FP_0530	I	FPMainNorth03AM	FP	572925	5801433	D	56	6
M_FP_0545	I	FPMainNorthXL4	FP	578743	5802934	M+	211	13
M_FP_0548	I	FPMainNorthXL5	FP	579244	5802787	M-	98	30
M_FP_0633	I	FPSeis21	FP	569647	5802471	D	57	36
M_FP_0641	I	FPSeis23	FP	570171	5802184	M+	151	20
M_FP_0650	I	FPSeis24	FP	572359	5806101	D	53	24
M_FP_0655	I	FPSeis25	FP	570892	5802315	D	100	28
M_FP_0664	I	FPSeis26	FP	572170	5804302	M-	478	23
M_FP_0666	I	FPSeis29	FP	574313	5806692	D	129	29
M_FP_0668	I	FPSeis29	FP	573670	5805349	M-	180	25
M_FP_0694	I	FPSeis30	FP	572759	5802735	M-	72	12
M_FP_0695	I	FPSeis30	FP	572797	5802813	D	108	18
M_FP_0739	I	FPMain51A	FP	571918	5803556	D	76	36
M_FP_0774	I	FPMain55A	FP	571523	5801349	D	59	27
M_FP_1152	I	FPSeis42	FP	576766	5802803	D	270	28
M_FP_1211	I	FPSeis34A	FP	573357	5801224	D	81	12
M_FP_1212	I	FPSeis34A	FP	573418	5801345	D	847	11
M_FP_1215	I	FPSeis34A	FP	574908	5804474	D	51	7
M_FP_1222	I	FPSeis27	FP	572300	5803878	D	96	32
M_FP_1603	I	FPSeis32A	FP	572851	5801556	D	103	38
M_FP_1606	I	FPSeis32A	FP	574764	5805584	D	52	27
M_FP_1608	I	FPSeis32A	FP	575563	5807260	D	87	30
M_FP_1621	I	FPSeis25A	FP	573040	5806828	D	52	15
M_FP_1624	I	FPSeis25A	FP	570894	5802315	D	180	30
M_FP_1872	I	FPMain24	FP	565089	5798728	D	114	63
M_FP_0037	II	FPMain27	FP	564552	5796444	D	113	57
M_FP_0110	II	FPMain41	FP	565109	5792727	M+	70	11
M_FP_0112	II	FPMain41	FP	566712	5796115	M+	82	13
M_FP_0119	II	FPMain39	FP	564382	5791897	D	80	22
M_FP_0124	II	FPMain37	FP	565654	5795285	D	93	21
M_FP_0126	II	FPMain37	FP	566722	5797536	D	119	38
M_FP_0132	II	FPMain36	FP	563990	5792271	D	111	16
M_FP_0134	II	FPMain35	FP	566784	5798367	D	72	47
M_FP_0142	II	FPMain33	FP	565664	5796697	M-	53	9

Annotation	Area	Line	Vessel	ETRS89 UTM31N		Anomaly type	Amplitude (nT)	Anomaly width (m)
				Easting	Northing			
M_FP_0143	II	FPMain33	FP	565431	5796213	D	50	29
M_FP_0147	II	FPMain32	FP	566207	5798289	D	429	19
M_FP_0148	II	FPMain32	FP	565730	5797291	D	62	17
M_FP_0150	II	FPMain32	FP	563995	5793672	M-	84	11
M_FP_0152	II	FPMain32	FP	564195	5794074	D	64	22
M_FP_0161	II	FPMain28	FP	564438	5795975	D	103	18
M_FP_0162	II	FPMain28	FP	564485	5796074	D	160	19
M_FP_0163	II	FPMain28	FP	565257	5797691	M+	53	11
M_FP_0178	II	FPMain22	FP	564216	5797614	D	79	22
M_FP_0184	II	FPMain20	FP	563400	5796616	D	261	42
M_FP_0185	II	FPMain20	FP	562993	5795759	D	109	26
M_FP_0189	II	FPMain19	FP	563103	5796203	D	81	28
M_FP_0194	II	FPMain15	FP	563320	5798024	M-	621	38
M_FP_0239	II	FPSeis09	FP	563418	5797778	D	110	25
M_FP_0248	II	FPSeis13	FP	564673	5797648	M-	122	42
M_FP_0264	II	FPSeis32	FP	567786	5790916	D	92	41
M_FP_0265	II	FPSeis32	FP	570634	5796890	D	118	21
M_FP_0278	II	FPSeis34	FP	569021	5792108	D	111	30
M_FP_0283	II	FPSeis35	FP	569818	5793081	M+	2761	128
M_FP_0322	II	FPMain48	FP	566410	5793115	D	62	33
M_FP_0325	II	FPMain49	FP	565840	5791486	M-	142	182
M_FP_0330	II	FPMain49	FP	569119	5798364	M-	58	7
M_FP_0344	II	FPMain50	FP	566465	5792539	D	89	41
M_FP_0375	II	FPMain52	FP	566467	5791879	D	62	31
M_FP_0376	II	FPMain52	FP	566126	5791147	D	90	29
M_FP_0429	II	FPMain55I	FP	567766	5793424	M-	61	16
M_FP_0446	II	FPMain56M	FP	568266	5794235	D	68	17
M_FP_0447	II	FPMain56M	FP	566557	5790666	M+	52	25
M_FP_0496	II	FPMain59A	FP	567028	5790484	D	241	49
M_FP_0556	II	FPMainSouth01	FP	567404	5790584	D	60	34
M_FP_0558	II	FPMainSouth02	FP	568109	5791821	D	75	19
M_FP_0563	II	FPMainSouth04	FP	568328	5791589	D	115	29
M_FP_0570	II	FPMainSouth06	FP	570428	5795299	D	71	25
M_FP_0572	II	FPMainSouth07	FP	569945	5793797	D	115	76
M_FP_0577	II	FPMainSouth08	FP	568532	5790615	D	82	12
M_FP_0581	II	FPMainSouth09	FP	570774	5794857	D	87	29
M_FP_0598	II	FPMainSouth15	FP	571267	5793726	D	76	24
M_FP_0599	II	FPMainSouth15	FP	570998	5793242	D	83	9
M_FP_0603	II	FPMainSouth16	FP	570115	5791161	D	109	42
M_FP_0622	II	FPSeis18	FP	564867	5794540	D	104	27
M_FP_0623	II	FPSeis18	FP	564427	5793613	D	56	22
M_FP_0636	II	FPSeis22	FP	564300	5790598	D	69	18

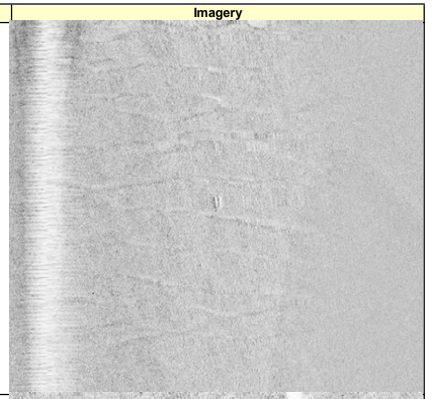
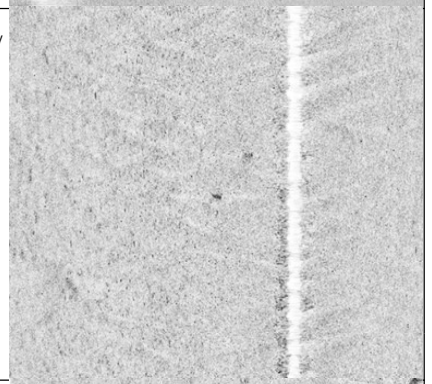
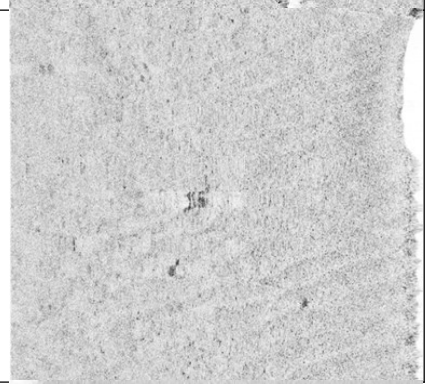
Annotation	Area	Line	Vessel	ETRS89 UTM31N		Anomaly type	Amplitude (nT)	Anomaly width (m)
				Easting	Northing			
M_FP_0639	II	FPSeis22	FP	567716	5797762	M-	110	20
M_FP_0662	II	FPSeis26	FP	568087	5795732	M-	248	17
M_FP_0671	II	FPSeis29	FP	570084	5797824	M-	110	12
M_FP_0672	II	FPSeis29	FP	570062	5797777	D	195	22
M_FP_0689	II	FPSeis30	FP	568042	5792879	D	96	24
M_FP_0691	II	FPSeis30	FP	569472	5795884	D	56	28
M_FP_0704	II	FPX20	FP	568323	5797232	M+	75	21
M_FP_0765	II	FPMain55A	FP	566988	5791780	D	151	18
M_FP_0915	II	FPSeis09A	FP	563414	5797778	D	51	34
M_FP_0924	II	FPSeis13B	FP	564683	5797646	M-	126	45
M_FP_1176	II	FPSeis39	FP	570926	5792623	D	307	36
M_FP_1189	II	FPSeis31A	FP	567902	5791857	D	163	47
M_FP_1199	II	FPSeis34A	FP	568362	5790724	D	66	16
M_FP_1202	II	FPSeis34A	FP	570349	5794899	D	67	29
M_FP_1203	II	FPSeis34A	FP	570401	5795018	D	78	43
M_FP_1226	II	FPSeis27	FP	569583	5798165	D	79	37
M_FP_1292	II	FPSeis16A	FP	563803	5793719	M+	53	131
M_FP_1588	II	FPMain44	FP	566673	5795081	D	56	28
M_FP_1614	II	FPSeis28A	FP	567825	5793783	M-	99	30
M_VH_0853	II	VHMain45	VH	571062	5791269	D	244	22
M_VH_1682	II	VHMain46	VH	571309	5792246	D	77	21
M_FP_0287	III	FPSeis36M	FP	566055	5784478	M-	114	13
M_FP_0677	III	FPSeis29	FP	565865	5788962	D	155	24
M_FP_0681	III	FPSeis29	FP	565394	5787975	D	63	20
M_FP_0682	III	FPSeis29	FP	565034	5787211	D	233	25
M_FP_0684	III	FPSeis29	FP	564690	5786491	D	90	19
M_FP_0763	III	FPMain55A	FP	565891	5789454	D	69	27
M_FP_1010	III	FPSeis48	FP	568944	5782180	D	59	29
M_FP_1018	III	FPSeis48	FP	572400	5789442	M+	79	29
M_FP_1068	III	FPSeis45	FP	568831	5784023	D	88	22
M_FP_1121	III	FPSeis42	FP	566942	5782180	D	94	36
M_FP_1124	III	FPSeis42	FP	567901	5784199	D	164	27
M_FP_1126	III	FPSeis42	FP	567915	5784228	D	230	31
M_FP_1131	III	FPSeis42	FP	569911	5788399	D	333	19
M_FP_1132	III	FPSeis42	FP	570974	5790646	M+	85	31
M_FP_1195	III	FPSeis31A	FP	565683	5787219	D	59	43
M_FP_1287	III	FPSeis52	FP	572164	5786131	M+	59	27
M_FP_1330	III	FPSeis47	FP	570515	5786189	D	122	109
M_FP_1456	III	FPSeis58	FP	575770	5789547	D	267	41
M_FP_1611	III	FPSeis28A	FP	564587	5786980	D	76	21
M_FP_1820	III	FPSeis51A	FP	573502	5789662	M+	4018	224
M_VH_0189	III	VHMain15	VH	574856	5788802	D	50	18

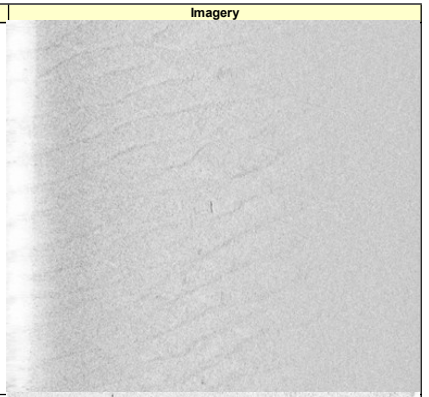
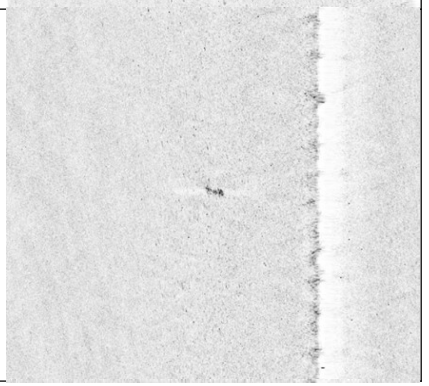
Annotation	Area	Line	Vessel	ETRS89 UTM31N		Anomaly type	Amplitude (nT)	Anomaly width (m)
				Easting	Northing			
M_VH_0368	III	VHMain27	VH	571901	5786772	D	56	50
M_VH_0377	III	VHMain28	VH	570303	5783860	D	80	73
M_VH_0532	III	VHMain35	VH	568232	5781838	D	75	60
M_VH_0557	III	VHMain40	VH	569610	5786585	M+	241	35
M_VH_0846	III	VHMain45	VH	568106	5785068	M+	132	13
M_VH_0848	III	VHMain45	VH	568441	5785775	D	165	14
M_VH_0851	III	VHMain45	VH	569369	5787712	D	145	17
M_VH_0873	III	VHMain42	VH	567290	5782458	D	241	50
M_VH_1560	III	VHMain44	VH	567342	5783257	D	54	23
M_VH_1665	III	VHMainSouth02B	VH	567153	5784445	D	180	27
M_VH_1666	III	VHMainSouth02B	VH	567268	5784691	M-	78	28
M_VH_1678	III	VHMainSouth01A	VH	566482	5782820	M+	51	23
M_VH_1700	III	VHMainSouth09	VH	568543	5789955	M-	55	42
M_VH_1706	III	VHMainSouth17	VH	565844	5787091	D	125	50
M_VH_1712	III	VHMainSouth23	VH	565928	5789309	D	57	29
M_VH_1746	III	VHMainSouth10	VH	567283	5787512	D	87	47
M_VH_1758	III	VHMainSouth12	VH	568159	5790080	D	301	33
M_VH_1785	III	VHMainSouth30	VH	564512	5788713	D	56	42
M_FP_0266	IV	FPSeis32	FP	571179	5798028	D	80	19
M_FP_0441	IV	FPMain56M	FP	570887	5799738	D	51	14
M_FP_0517	IV	FPMainNorth03	FP	572255	5800063	D	69	14
M_FP_0553	IV	FPMainNorthXL7	FP	579786	5802686	D	388	19
M_FP_0590	IV	FPMainSouth12	FP	571330	5795099	D	110	43
M_FP_0707	IV	FPX20	FP	572850	5795077	D	51	23
M_FP_0710	IV	FPX27	FP	578582	5798154	D	78	41
M_FP_0965	IV	FPSeis46	FP	577040	5800593	D	230	41
M_FP_0977	IV	FPSeis41	FP	575238	5800278	D	55	21
M_FP_1022	IV	FPSeis48	FP	574035	5792881	D	63	34
M_FP_1037	IV	FPSeis43	FP	575204	5798822	D	78	21
M_FP_1143	IV	FPSeis42	FP	574233	5797487	D	98	15
M_FP_1147	IV	FPSeis42	FP	575583	5800331	D	138	11
M_FP_1205	IV	FPSeis34A	FP	571208	5796706	M-	157	17
M_FP_1244	IV	FPSeis53	FP	575170	5791763	D	109	36
M_FP_1250	IV	FPSeis53	FP	581203	5804441	D	54	259
M_FP_1267	IV	FPSeis52	FP	581951	5806703	D	413	28
M_FP_1277	IV	FPSeis52	FP	575938	5794046	M+	189	26
M_FP_1278	IV	FPSeis52	FP	575770	5793692	D	76	25
M_FP_1335	IV	FPSeis47	FP	573017	5791437	M-	54	18
M_FP_1341	IV	FPSeis47	FP	575218	5796074	D	118	22
M_FP_1346	IV	FPSeis47	FP	576542	5798852	D	63	16
M_FP_1372	IV	FPSeis63	FP	581835	5798810	D	54	22
M_FP_1388	IV	FPSeis62	FP	578964	5793446	D	3017	92

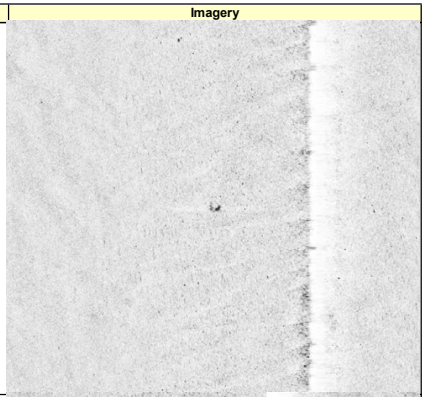
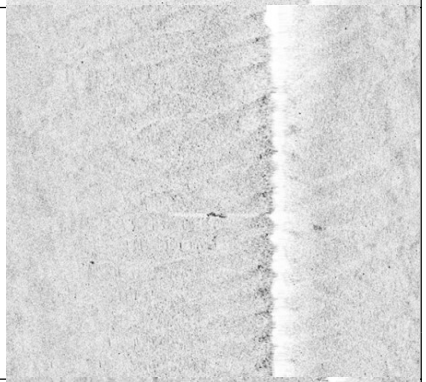
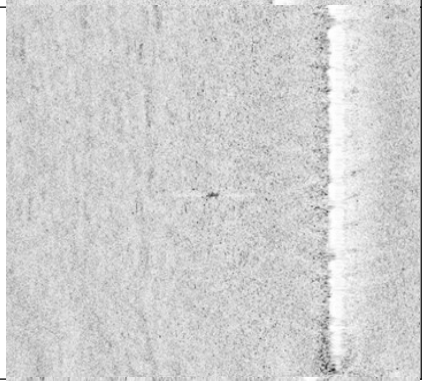
Annotation	Area	Line	Vessel	ETRS89 UTM31N		Anomaly type	Amplitude (nT)	Anomaly width (m)
				Easting	Northing			
M_FP_1389	IV	FPSeis62	FP	579011	5793544	M+	129	23
M_FP_1435	IV	FPSeis57	FP	575795	5790260	D	84	26
M_FP_1457	IV	FPSeis58	FP	576283	5790622	D	60	35
M_FP_1458	IV	FPSeis58	FP	577225	5792602	D	192	34
M_FP_1575	IV	FPSeis50A	FP	582283	5808799	D	63	59
M_FP_1799	IV	FPSeis52I	FP	576472	5795184	D	66	31
M_FP_1801	IV	FPSeis52I	FP	575931	5794047	M+	70	35
M_FP_1824	IV	FPSeis51A	FP	581502	5806463	D	52	28
M_VH_0014	IV	VHMain03A	VH	585196	5806315	D	57	46
M_VH_0015	IV	VHMain03A	VH	585206	5806337	D	79	27
M_VH_0032	IV	VHMain05	VH	578550	5793062	D	64	53
M_VH_0037	IV	VHMain05A	VH	582640	5801644	D	111	30
M_VH_0042	IV	VHMain06A	VH	577384	5791042	D	52	62
M_VH_0049	IV	VHMain06A	VH	582103	5800979	D	124	65
M_VH_0062	IV	VHMain07	VH	579398	5795549	D	56	64
M_VH_0064	IV	VHMain07	VH	580774	5798433	M+	99	44
M_VH_0089	IV	VHMain10	VH	576648	5790899	D	83	36
M_VH_0110	IV	VHMain11	VH	577749	5793478	M-	52	32
M_VH_0137	IV	VHMain12a	VH	578155	5794772	D	11235	169
M_VH_0139	IV	VHMain12a	VH	578207	5794881	D	108	24
M_VH_0276	IV	VHMain19	VH	580686	5802445	M+	84	28
M_VH_0289	IV	VHMain21	VH	581283	5804388	D	7514	165
M_VH_0335	IV	VHMain24A	VH	575951	5794326	D	109	86
M_VH_0443	IV	VHMain32	VH	574508	5794080	D	64	44
M_VH_0551	IV	VHMain34	VH	576731	5799495	M-	51	27
M_VH_0558	IV	VHMain40	VH	573213	5794161	M+	94	36
M_VH_0573	IV	VHMain41B	VH	573575	5795169	M+	123	41
M_VH_0574	IV	VHMain41D	VH	573577	5795170	M-	249	41
M_VH_0783	IV	VHMainNorth02	VH	573159	5797079	D	178	39
M_VH_0785	IV	VHMainNorth02	VH	572354	5795402	D	70	25
M_VH_0796	IV	VHMainNorth05	VH	572158	5796131	D	87	33
M_VH_0805	IV	VHMainNorth04	VH	573595	5798703	M-	77	29
M_VH_0827	IV	VHMainNorth10	VH	571594	5796569	M+	1282	19
M_VH_0828	IV	VHMainNorth10	VH	571506	5796388	M-	63	7
M_VH_0854	IV	VHMain45	VH	572988	5795334	D	65	21
M_VH_0861	IV	VHMain43	VH	574064	5796888	D	56	21
M_VH_0892	IV	VHMain42	VH	575968	5800684	D	73	28
M_VH_1684	IV	VHMain46	VH	574770	5799514	D	54	20

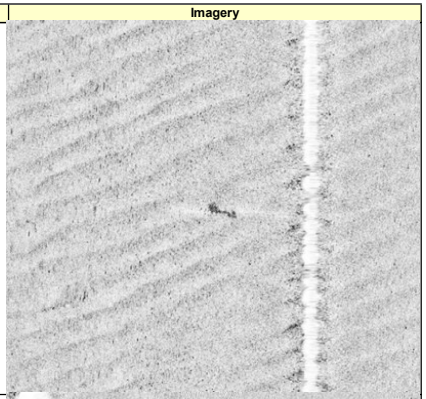
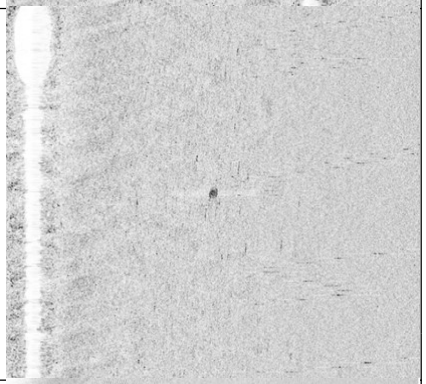
Appendix 3. Listing of selected side scan sonar contacts

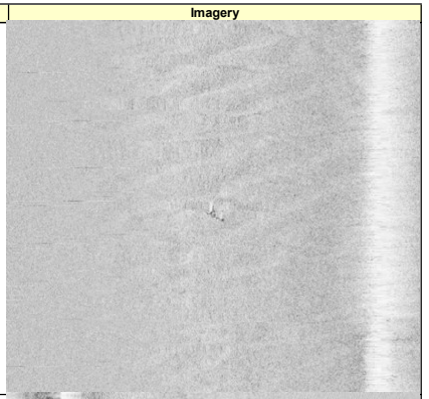
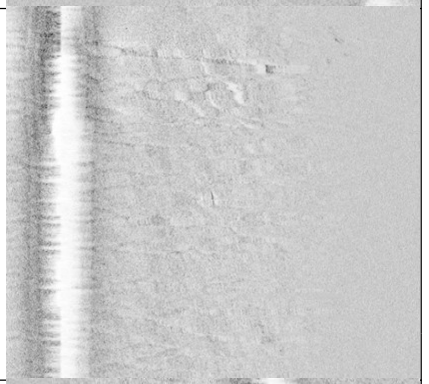
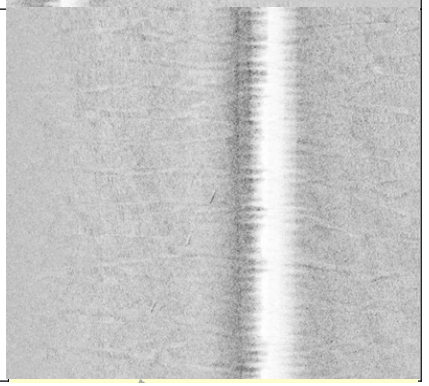
Contains a selection of 79 out of a total of 563 side scan sonar contacts with a possible Archaeological expectation, based on their size (larger than four meters) and characteristics.

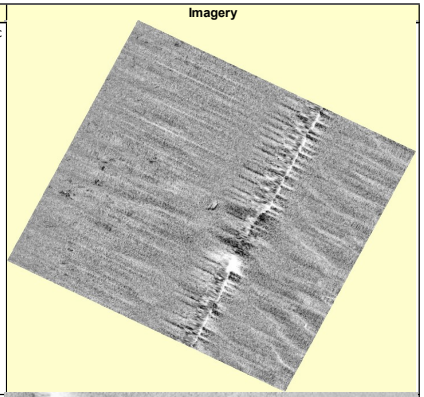
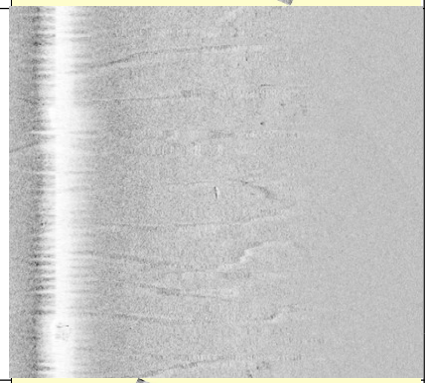
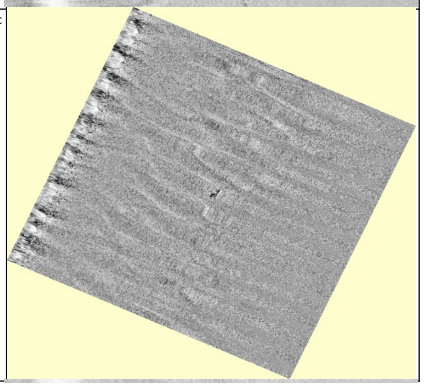
Name	Area	Line	Vessel	Easting	Northing	L	W	H	Description raw sonar	Description mbeam	Interpretation PP	Remarks	Imagery
S_FP_0011	II	FPMain34_SH_706.01	FP	565250	5795690	4.1	0.6	0.3	two cylindrical objects in the seabed; shadow and reflection	not visible on MBES-data	sunken tubular objects	possible arch. value	
S_FP_0031	I	FPMain07_SL_501.01	FP	563439	5801150	4.8	2.2	1.1	elongated object; strong reflective; no shadow	object not visible; small scourmark	boulder or metallic material such as an anchor or scaffold pole.	reported shadow is not visible, object lays seemingly flat on the seabed	
S_FP_0033	I	FPMain07_SL_502.01	FP	564965	5804460	5.6	4.6	0.8	rectangular object(s) with difference in reflectiveness;	not visible on MBES-data	possible cable with multiple reflections;	neither one of the data sources are clear enough to determine this correctly	

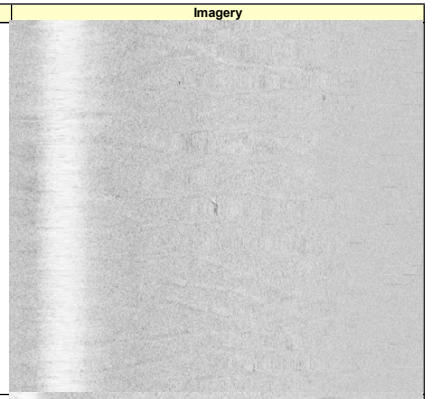
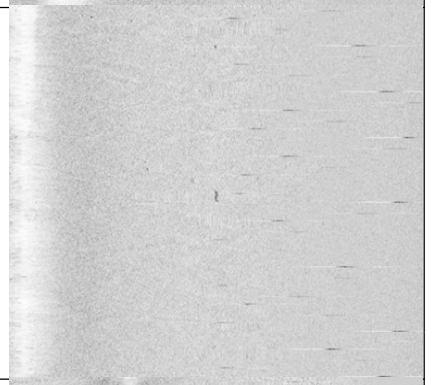
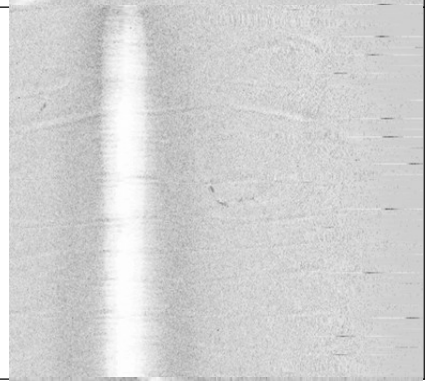
Name	Area	Line	Vessel	Easting	Northing	L	W	H	Description raw sonar	Description mbeam	Interpretation PP	Remarks	Imagery
S_FP_0037	I	FPMain08_SH_703.01	FP	563212	5800500	4.2	0.6	0.2	elongated object; small shadow; reflective	object not visible on the bathymet	possible wooden/plastic/rubber object because of relative low reflectivity		
S_FP_0048	I	FPSeis05_SL_502.01	FP	563839	5801280	4.0	2.9	1.1	elongated object; strong reflection; shadow	object not visible on the bathymet	possible piece of cable or chain		
S_FP_0055	I	FPMain10_SL_501.01	FP	564381	5802060	4.6	2.4	2.0	spherical object; strong reflection; shadow	possible related scourmarks to the	boulder with gravel revealing scour	natural phenomenon	

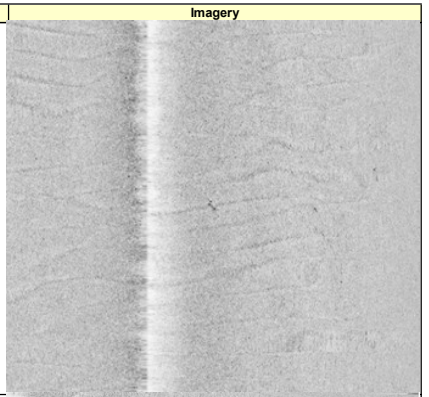
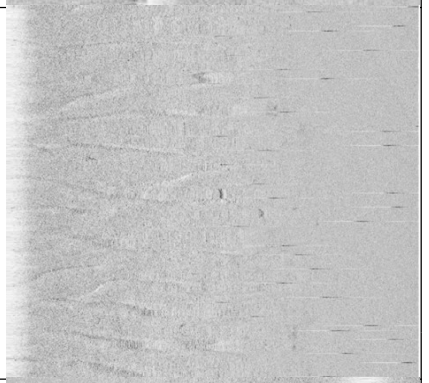
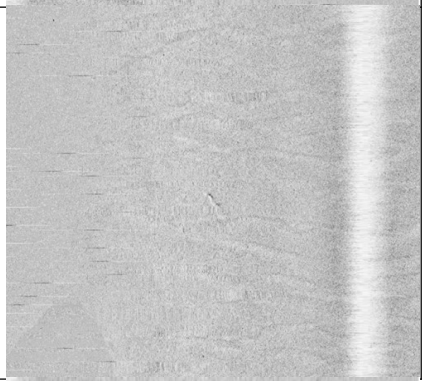
Name	Area	Line	Vessel	Easting	Northing	L	W	H	Description raw sonar	Description mbeam	Interpretation PP	Remarks	Imagery
S_FP_0056	I	FPMain10_SL_502.01	FP	563419	5800050	5.0	2.9	2.1	strong reflective horseshoe-like object;	visible scourmarks around the obj	possible boulder		
S_FP_0063	I	FPMain11_SL_501.01	FP	564193	5801320	4.8	2.7	2.6	strong reflective elongated object; shadow	possbile scourmarks on bathy	possible desposed cable/chain	slightly visible on mbes-data	
S_FP_0070	I	FPMain14_SL_501.01	FP	565526	5803070	4.7	2.0	0.3	strong reflective irregular object; possible shadow	object are visible as small elevatio	possible boulder	probably natural phenomenon	

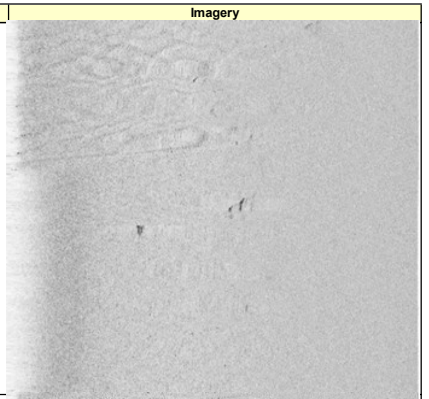
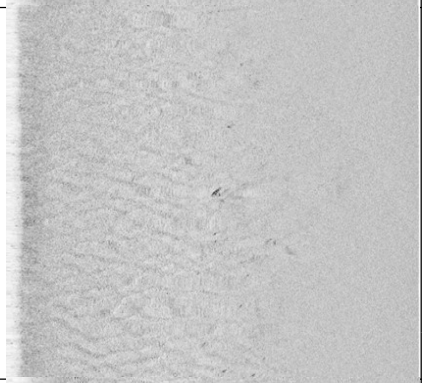
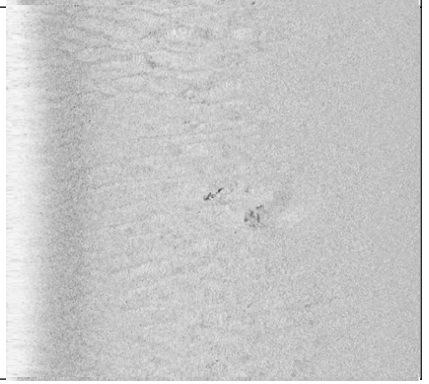
Name	Area	Line	Vessel	Easting	Northing	L	W	H	Description raw sonar	Description mbeam	Interpretation PP	Remarks	Imagery
S_FP_0079	II	FPSeis08_SL_501.01	FP	563255	5798210	10.1	3.8	1.7	irregular feature; clear shadow; reflection`	not visible on MBES-data	gravel/shell beds	natural phenomenon	
S_FP_0080	I	FPSeis08_SL_501.01	FP	563945	5799470	4.6	3.3	1.3	rectangular low reflective feature; no shadow	not visible on MBES-data	possible clayey/peat bed	natural phenomenon	
S_FP_0082	II	FPSeis08_SH_702.01	FP	563338	5798180	9.1	2.1	0.3	irregular feature; no shadow;	not visible on MBES-data	gravel/shell beds, no shadow but stronger reflection than surroundings	natural phenomenon	

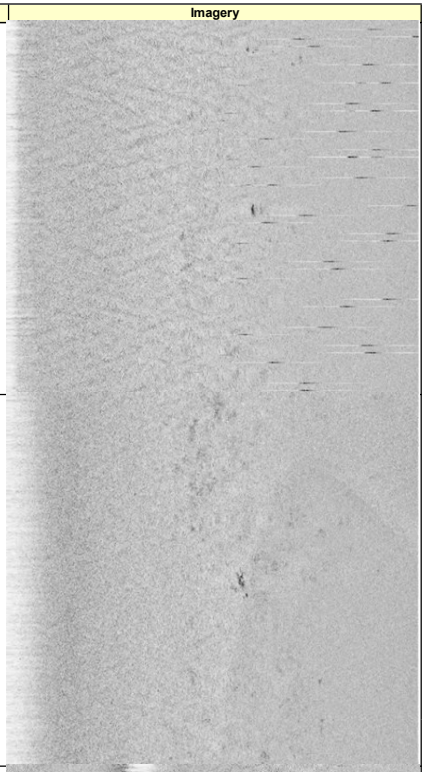
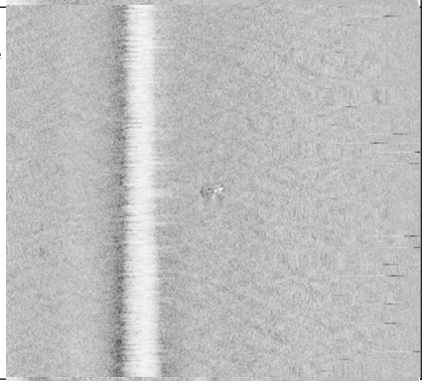
Name	Area	Line	Vessel	Easting	Northing	L	W	H	Description raw sonar	Description mbeam	Interpretation PP	Remarks	Imagery
S_FP_0095	I	FPSeis11_SH_703.01	FP	565585	5800800	4.7	1.6	0.2	elongated object; shadow;	not visible on MBES-data	elevated above seabed with ridge/chain; boulder or anchor	natural phenomenon	
S_FP_0104	II	FPMain24M_SH_701.01	FP	564696	5798020	4.9	0.4	0.2	no object; shadow is on the wrong side	not visible on MBES-data	possible seabed depression	natural phenomenon	
S_FP_0105	II	FPMain24M_SH_701.01	FP	564690	5797860	4.3	0.6	0.2	elongated objects; shadow; reflective	not visible on MBES-data	possible partly buried cable		

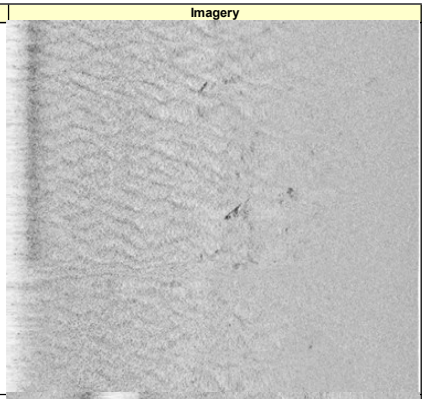
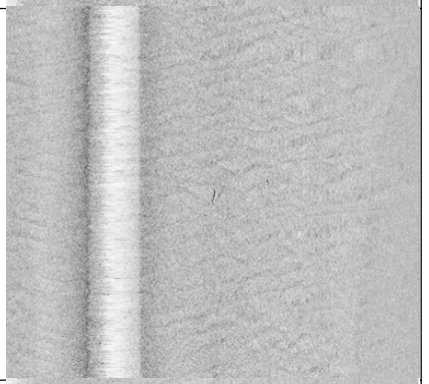
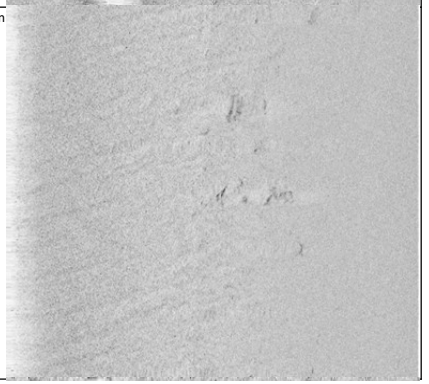
Name	Area	Line	Vessel	Easting	Northing	L	W	H	Description raw sonar	Description mbeam	Interpretation PP	Remarks	Imagery
S_FP_0112	I	FPMain25M_SH_701.01	FP	565220	5798600	5.5	1.3	0.5	cylindrical objects; strong reflection; shadow	visible on on top of sand ridge MB	may be piece of pipe or UXO; object is of interest for further research	may be something of metallic nature but this can not be validated. Possible archaeological value	
S_FP_0113	II	FPMain26_SH_701.01	FP	563098	5793760	4.1	1.0	0.2	elongated feature; shadow; reflective	not visible on MBES-data	sand ridge;	natural phenomenon	
S_FP_0115	I	FPSeis14_SH_705.01	FP	565483	5798490	5.3	0.7	0.2	elongated and spherical object; shadow; strong reflection	not visible on MBES-data	a piece of pipe/ gravel patch with boulder	may be something of metallic nature but this can not be validated	

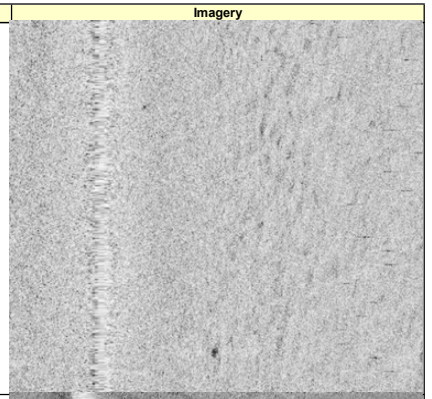
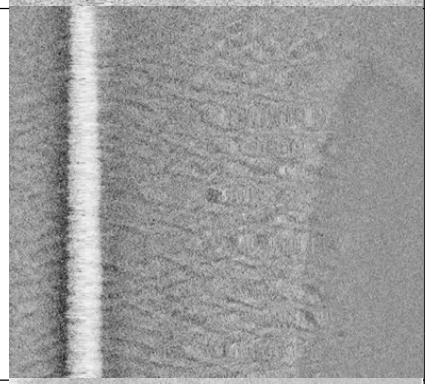
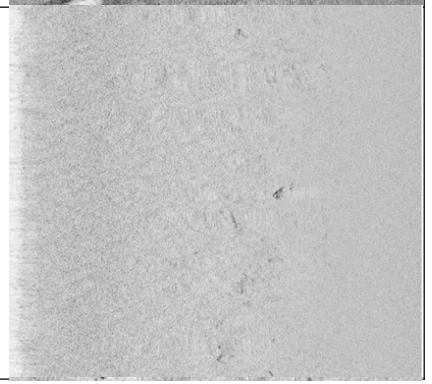
Name	Area	Line	Vessel	Easting	Northing	L	W	H	Description raw sonar	Description mbeam	Interpretation PP	Remarks	Imagery
S_FP_0116	II	FPSeis14_SH_705.01	FP	564953	5797610	5.1	0.6	0.2	elongated object with an angle; shadow; reflection	not visible on MBES-data	possible wooden feature; maybe clayey bank		
S_FP_0121	II	FPMain28_SH_705.01	FP	565092	5797480	4.0	1.9	0.2	no shadow; reflective feature on seabed	not visible on MBES-data	gravelly or clayey sand ridge	natural phenomenon	
S_FP_0122	II	FPMain28_SH_707.01	FP	563236	5793520	8.5	1.3	0.3	no shadow; weak reflection	sand ridge is visible on MBES-data	boulders; sand ridges	natural phenomenon	

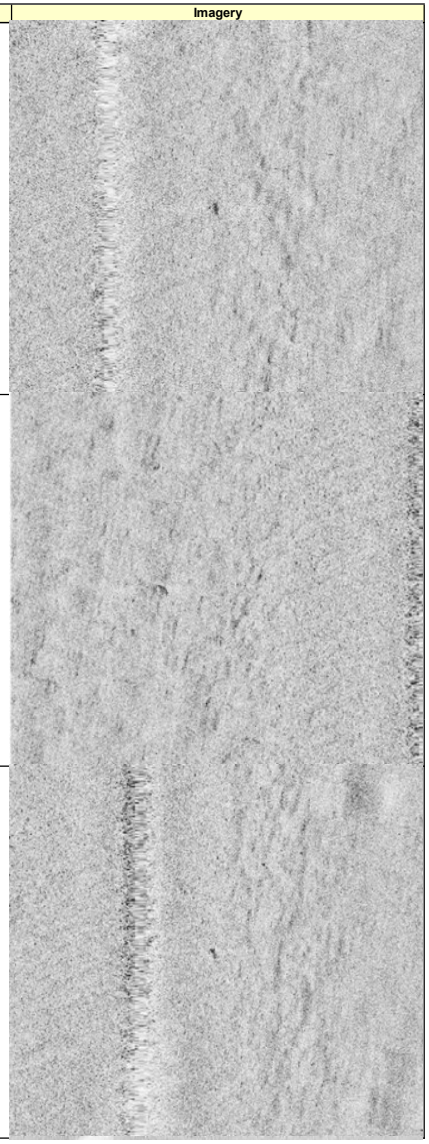
Name	Area	Line	Vessel	Easting	Northing	L	W	H	Description raw sonar	Description mbeam	Interpretation PP	Remarks	Imagery
S_FP_0126	II	FPMain29_SH_705.01	FP	564736	5796200	4.2	1.9	0.4	no shadow; weak reflection; no clear object	not visible on MBES-data	disturbance seabed	natural phenomenon	
S_FP_0129	II	FPSeis16_SH_701.01	FP	563673	5793290	4.3	1.0	0.2	reflection; shadow; spherical object	not visible on MBES-data	boulder or tire		
S_FP_0131	II	FPSeis16_SH_704.01	FP	565693	5797800	5.1	0.6	0.2	shadow; weak reflection; elongated feature	not visible on MBES-data	possible sand ridge	natural phenomenon	

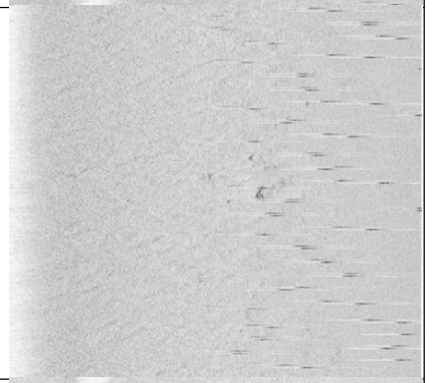
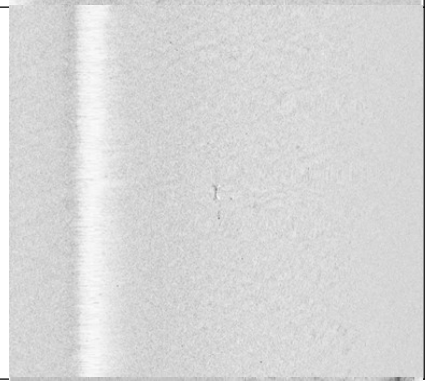
Name	Area	Line	Vessel	Easting	Northing	L	W	H	Description raw sonar	Description mbeam	Interpretation PP	Remarks	Imagery
S_FP_0143	I	FPMainNorth21_SH_701.02	FP	575878	5801250	4.7	0.7	0.2	irregular shaped objects; weak reflection; no shadow	not visible on MBES-data	possible peat patches or wood	organic material	
S_FP_0153	I	FPMainNorth12_SH_702.02	FP	575220	5803140	4.3	1.1	0.2	XTF MISSING				
S_FP_0157	I	FPMainNorth11I_SH_703.02	FP	575502	5803970	7.1	1.5	0.3	irregular object; strong reflection; small shadow	not visible on MBES-data	possbile gravel; circular 'patch below' does seem to be of unnatural origin	probably natural phenomenon	

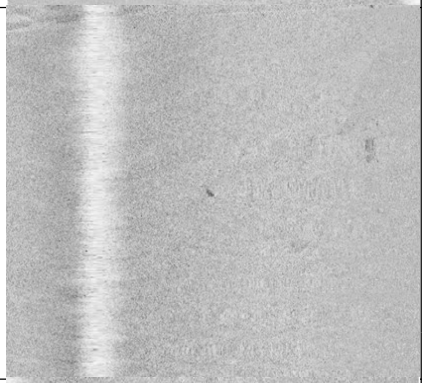
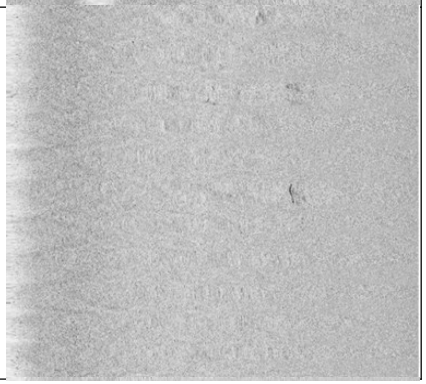
Name	Area	Line	Vessel	Easting	Northing	L	W	H	Description raw sonar	Description mbeam	Interpretation PP	Remarks	Imagery
S_FP_0164	I	FPSeis31_SH_702.01	FP	574516	5805900	5.0	1.1	0.1	cylindrical object; no shadow; weak reflection	not visible on MBES-data	possible peat layer	natural phenomenon	
S_FP_0174	I	FPMainNorth02_SH_704.01	FP	572944	5802120	5.2	0.8	0.3	no object visible;		patch of gravel	natural phenomenon	
S_FP_0178	I	FPSeis32_SH_709.01	FP	572850	5801510	5.8	1.0	0.6	elongated object; shadow; strong reflection	visible on MBES-data; scourmarks	possible piece of a pipe line	can be correlated with m_FP_0267 Possible archaeological value	

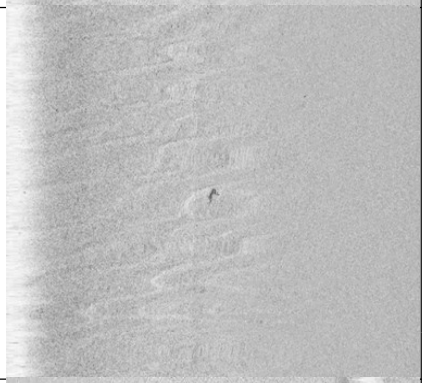
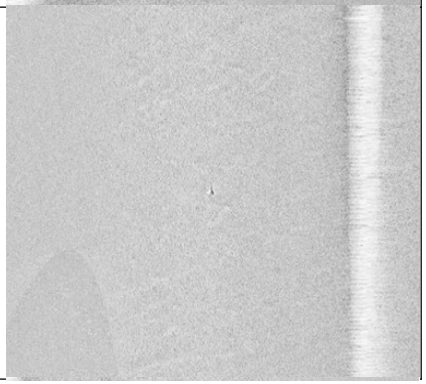
Name	Area	Line	Vessel	Easting	Northing	L	W	H	Description raw sonar	Description mbeam	Interpretation PP	Remarks	Imagery
S_FP_0186	I	FPMainNorth04_SH_704.01	FP	573028	5801610	6.6	1.8	0.2	irregular shaped object; strong reflection; no shadow	not visible on MBES-data	gravel/shell beds	natural phenomenon	
S_FP_0198	I	FPMainNorth06A_SH_702.01	FP	576066	5807160	4.9	0.6	0.2	elongated object; with shadow and strong reflection	not visible on MBES-data	deposited on seabed	probably natural phenomenon	
S_FP_0209	II	FPMainSouth03_SH_702.01	FP	569622	5794670	4.1	1.4	0.3	some shadow; reflection; irregular features	on the side of a trawlertrack	seabed disturbance due fishing	induced natural phenomenon	

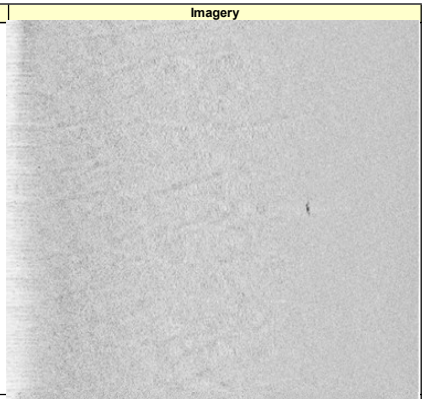
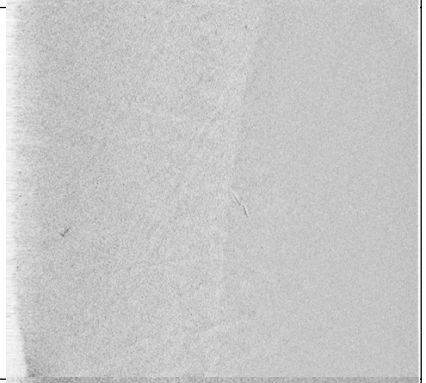
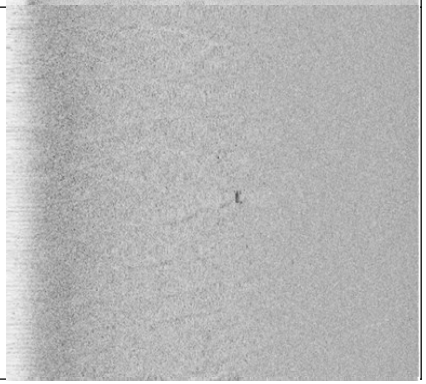
Name	Area	Line	Vessel	Easting	Northing	L	W	H	Description raw sonar	Description mbeam	Interpretation PP	Remarks	Imagery
S_FP_0221	IV	FPMainNorth07_SL_503.01	FP	572955	5800200	4.0	2.3	0.4	spherical object; reflective; no shadow	elongated feature visible on MBES	spherical object is natural; elongated object could be a piece of cable	no arch. value	
S_FP_0222	I	FPMainNorth08A_SH_702.01	FP	574453	5802970	5.9	6.2	0.4	no object visible; no shadow; reflection	not visible on MBES-data	scourpatch	natural phenomenon	
S_FP_0224	II	FPMainSouth07_SH_702.01	FP	569585	5793240	4.9	2.4	0.2	reflection on seabed; no shadow; irregular feature	not visible on MBES-data	seabed disturbance; gravel/shellbed	natural phenomenon	

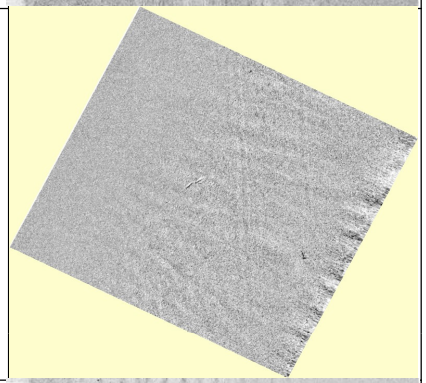
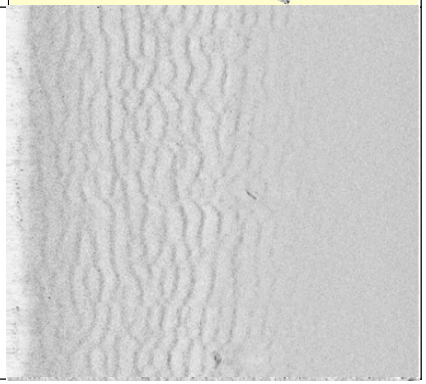
Name	Area	Line	Vessel	Easting	Northing	L	W	H	Description raw sonar	Description mbeam	Interpretation PP	Remarks	Imagery
S_FP_0227	III	FPSeis35_SL_502.01	FP	567682	5788540	4.9	1.5	0.1	elongatd feature; no shadow; reflective	not visible on MBES-data	sand ridge	natural phenomenon	
S_FP_0228	IV	FPSeis35_SL_504.01	FP	572322	5798630	4.3	2.8	0.2	XTF MISSING;				
S_FP_0229	IV	FPSeis35_SL_504.01	FP	572640	5799040	4.1	1.7	0.6	XTF MISSING;				

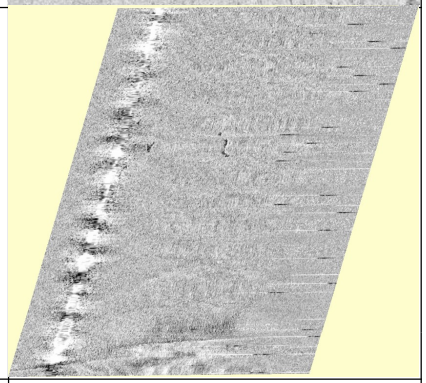
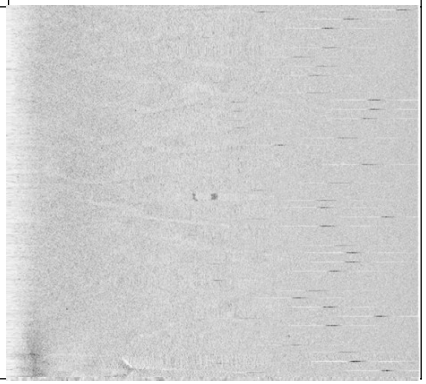
Name	Area	Line	Vessel	Easting	Northing	L	W	H	Description raw sonar	Description mbeam	Interpretation PP	Remarks	Imagery
S_FP_0244	III	FPSeis36M_SH_710.01	FP	566137	5784740	7.3	4.0	1.8	within 50m NCN14632; large spherical object; clear shadow; strong reflection; visible scourpatterns	visible on MBES-data; scourmarks	large 3x3 spherical object already reported as obstruction	arch .value	
S_FP_0245	III	FPSeis36M_SH_710.01	FP	565909	5784350	4.3	2.8	0.1	irregular shaped seabed feature; low reflection; no clear shadow	not visible on MBES-data	seabed feature	natural phenomenon	
S_FP_0253	II	FPMainSouth17_SH_701.01	FP	570931	5792480	5.6	1.5	0.2	probably shadow; strong reflection; elongated object	scourmarks visible on MEBS	possible object; unclear what the origin might be	may have arch .value	

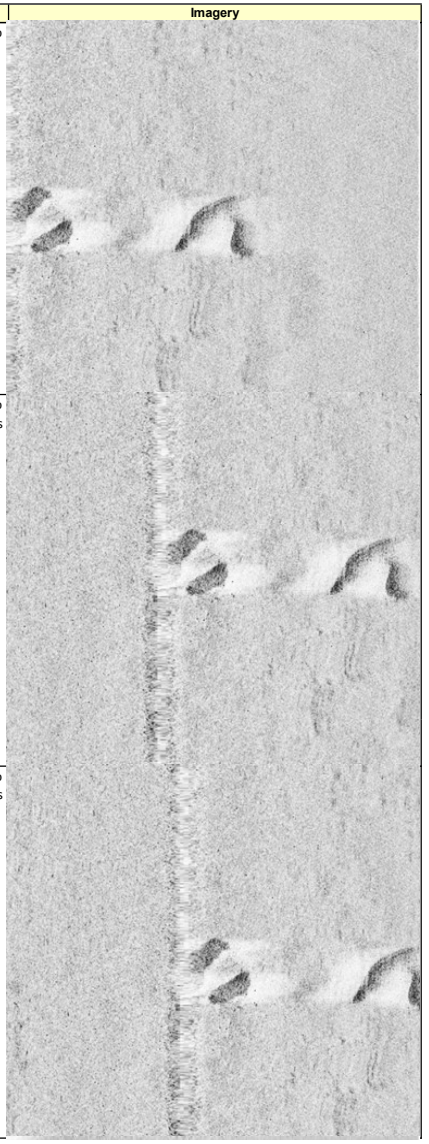
Name	Area	Line	Vessel	Easting	Northing	L	W	H	Description raw sonar	Description mbeam	Interpretation PP	Remarks	Imagery
S_FP_0263	II	FPMain57_SH_703.01	FP	568591	5794600	5.0	4.0	0.6	reflective rectangular seabed feature; shadow;	not visible on MBES-data	block ofclay or peat not assumed to have arh. Value	natural phenomenon	
S_FP_0270	II	FPMain53_SH_702.01	FP	566635	5791680	4.1	2.2	0.5	reflective spherical object or seabed feature; no shadow;	possible small scourmarks on MBE	possible recflection due to sand ridge next o scour	natural phenomenon	
S_FP_0271	I	FPMain53_SH_706.01	FP	570235	5799110	7.0	0.4	0.0	no shadow; low reflection	not visible on MBES-data	possible clayey sand ridge	natural phenomenon	

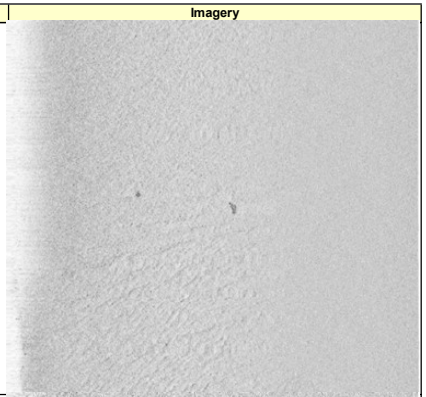
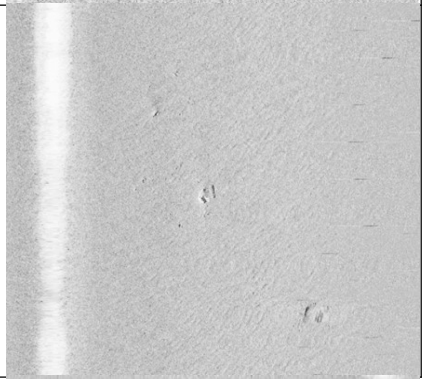
Name	Area	Line	Vessel	Easting	Northing	L	W	H	Description raw sonar	Description mbeam	Interpretation PP	Remarks	Imagery
S_FP_0279	I	FPMain51_SH_709.01	FP	572271	5804150	5.0	1.0	0.1	shadow in front; reflection	not visible on MBES-data	seabed depression	natural phenomenon	
S_FP_0286	II	FPMain55I_SH_701.01	FP	566311	5790230	4.9	1.4	0.2	irregular object in seabed; reflective; small shadow	not visible on MBES-data	sand ridge	natural phenomenon	
S_FP_0292	II	FPMain46_SH_708.01	FP	566068	5793000	4.0	1.3	0.3	elongated object on the seabed; small shadow; reflective	some elevation visible on seabed	boulder or sand ridge	no arch. value	

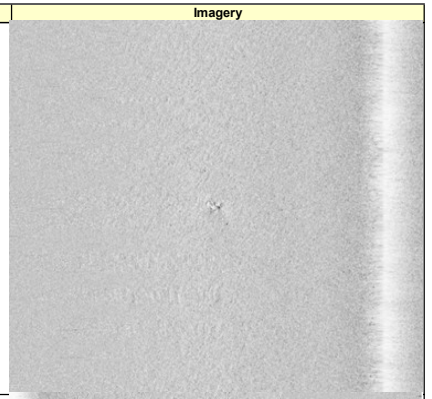
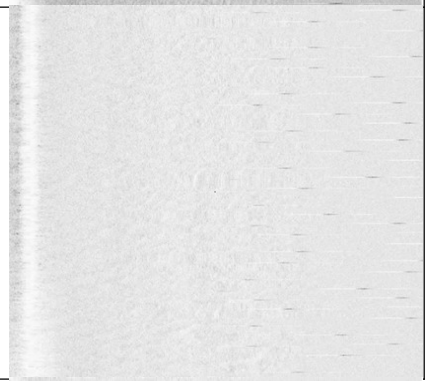
Name	Area	Line	Vessel	Easting	Northing	L	W	H	Description raw sonar	Description mbeam	Interpretation PP	Remarks	Imagery
S_FP_0294	II	FPMain46_SH_710.01	FP	564172	5789330	4.5	1.5	0.2	shadow in front of feature	not visible on MBES-data	sand ridge	natural phenomenon	
S_FP_0302	II	FPMain43_SH_717.01	FP	567892	5797820	4.2	1.2	0.1	elongated object on seabed; reflective; clear shadow	not visible on MBES-data	may be anchor chain, piece of cable	may have arch .value	
S_FP_0307	II	FPMain42_SH_705.01	FP	567632	5797970	4.2	1.9	0.2	shperical object; some reflection; small shadow	not visible on MBES-data	in line with seabed ripples; interpreted as a boulder with possible gravel surounding	natural phenomenon	

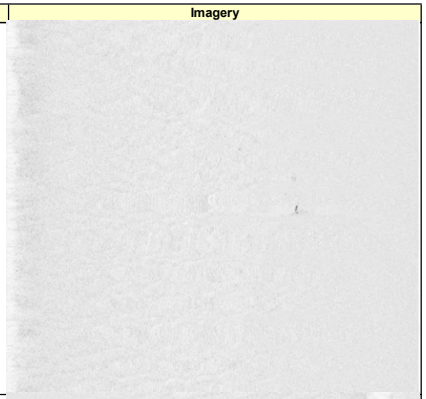
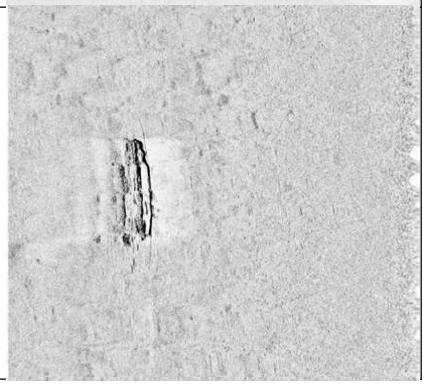
Name	Area	Line	Vessel	Easting	Northing	L	W	H	Description raw sonar	Description mbeam	Interpretation PP	Remarks	Imagery
S_FP_0308	II	FPMain41_SH_705.01	FP	567551	5797670	6.6	1.0	0.1	elongated feature; no shadow; small reflection	not visible on MBES-data	sandrigde;	natural phenomenon	
S_FP_0309	I	FPMain41_SH_707.01	FP	569217	5801490	5.1	0.9	0.3	small shadow; reflection	not visible on MBES-data	sand ridge;	natural phenomenon	
S_FP_0318	I	FPMainNorthXL7_SH_702.01	FP	576243	5804530	4.5	1.1	0.1	shadow in front; reflection	not visible on MBES-data	sand ridge;	natural phenomenon	

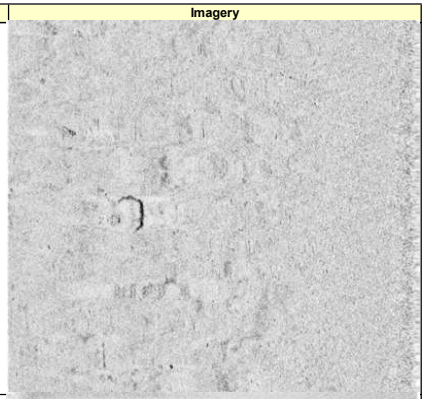
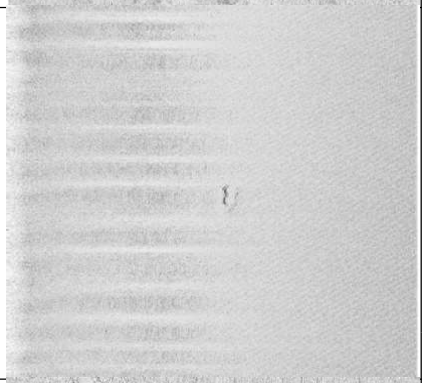
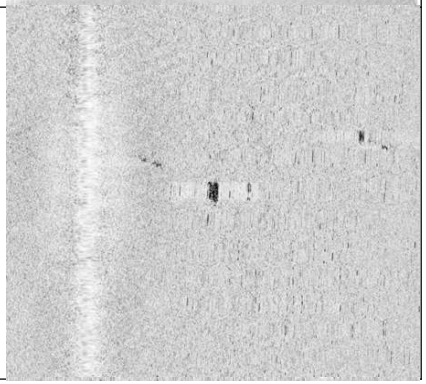
Name	Area	Line	Vessel	Easting	Northing	L	W	H	Description raw sonar	Description mbeam	Interpretation PP	Remarks	Imagery
S_FP_0320	I	FPMainNorthXL3_SL_501.01	FP	578398	5803110	6.5	1.4	0.2	small shadow; reflection	not visible on MBES-data	probably sand ridge	natural phenomenon occurs more in this region	
S_FP_0321	II	FPSeis30_SH_703.01	FP	566749	5790050	7.6	1.1	0.1	elongated object on the seabed; clear shadow; reflective	straigth elongated object visible o	possible part of chain or cable;	may have arch .value	
S_FP_0328	III	FPSeis29_SH_712.01	FP	564948	5787180	6.4	0.6	0.1	linear object; no shadow; reflection	not visible on MBES-data	possible scaffold pole; seems unnaturally straight	no arch. value	
S_FP_0333	II	FPMain34_SL_503.01	FP	565427	5795800	5.7	2.6	0.3	irreglar features; low reflection; small shadow	not visible on MBES-data	clay/peat patches	natural phenomenon	

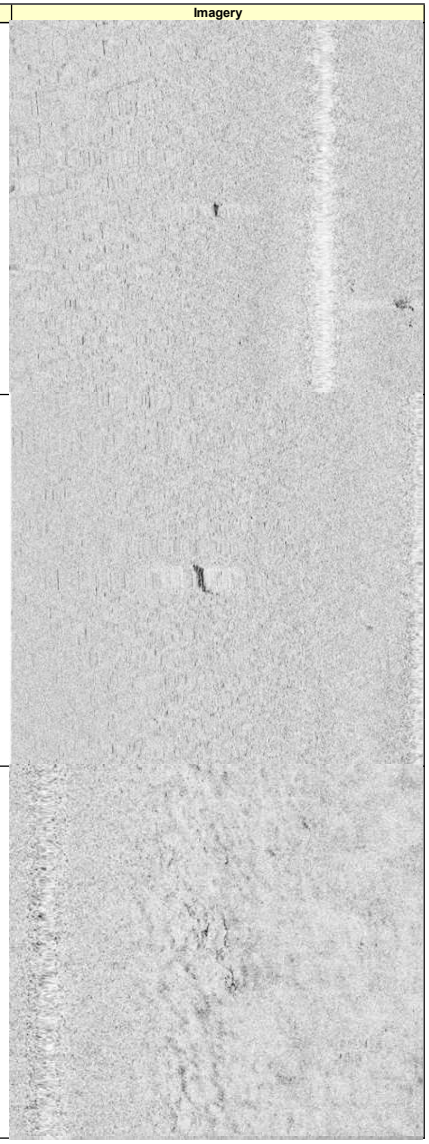
Name	Area	Line	Vessel	Easting	Northing	L	W	H	Description raw sonar	Description mbeam	Interpretation PP	Remarks	Imagery
S_FP_0342	IV	VHMainNorth10_SL_501.01	FP	571650	5796540	26.1	5.8	1.0	within 50m NCN 1942; large object partly buried; clear shadows and reflection	clearly visible on MBES-data; large	related to NCN 1942; wreck	arch .value; can be related to M_VH_0832;	
S_FP_0343	IV	VHMainNorth10_SL_501.01	FP	571608	5796570	15.0	7.1	0.5	with in range of NCN 1942; large objects; partly buried; clear shadows and reflection	clearly visible on MBES-data; large	related to NCN 1942; wreck	arch .value; can be related to M_VH_0832; same picture as 342	
S_FP_0344	IV	VHMainNorth10_SL_501.01	FP	571595	5796560	14.7	6.1	0.5	with in range of NCN 1942; large objects; partly buried; clear shadows and reflection	clearly visible on MBES-data; large	related to NCN 1942; wreck	arch .value; can be related to M_VH_0832; same picture as 342	

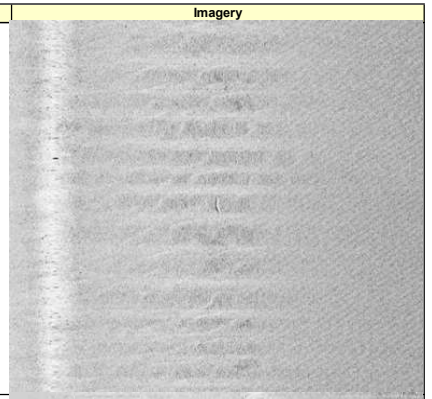
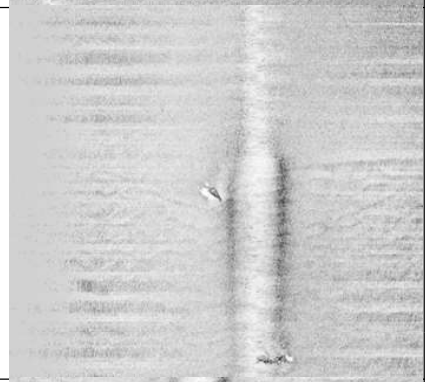
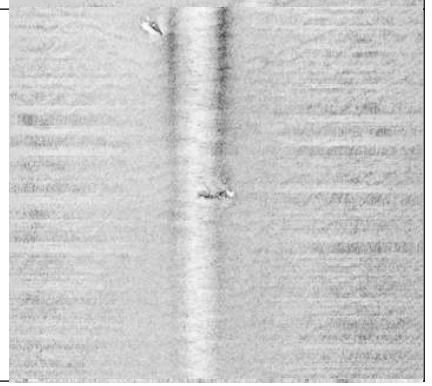
Name	Area	Line	Vessel	Easting	Northing	L	W	H	Description raw sonar	Description mbeam	Interpretation PP	Remarks	Imagery
S_FP_0348	IV	VHMainNorth07_SH_701.01	FP	573164	5799090	4.3	0.8	0.1	irregular feature in seabed; shadow on the wrong side	not visible on MBES-data	seabed depression	natural phenomenon	
S_FP_0350	IV	VHMainNorth06_SL_501.01	FP	571602	5795000	7.6	1.9	0.3	irregular feature in seabed; no shadow	not visible on MBES-data	gravel/shell beds	natural phenomenon	
S_FP_0389	IV	FPSeis43_SH_703.01	FP	575216	5798950	4.3	0.7	0.2	multiple features; strong reflection and clear shadow	related elevation visible on MBES-	possibly related to 391- 388. seems unnatural deposition	possible arch. value	

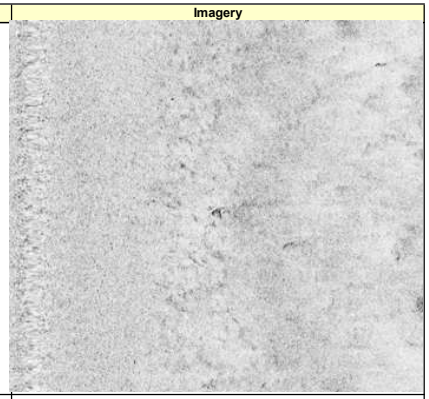
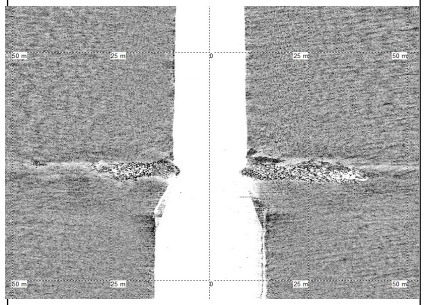
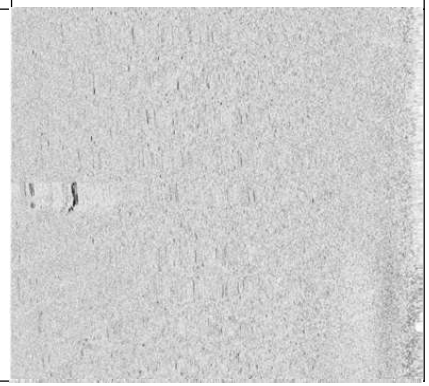
Name	Area	Line	Vessel	Easting	Northing	L	W	H	Description raw sonar	Description mbeam	Interpretation PP	Remarks	Imagery
S_FP_0395	III	FPSeis44_SH_708.01	FP	571763	5791010	4.9	1.5	0.2	Irregular seabed feature; weak reflection and shadow	not visible on MBES-data	seabed feature	natural phenomenon	
S_FP_0397	IV	FPSeis46_SH_709.01	FP	573629	5793340	70.0	0.3	0.1	elongated object on top of seabed; reflective; clear shodaw	not visible on MBES-data	chain or fishing net; possibly related to surrounding trawlertrack	no arch. value	
S_FP_0417	IV	FPSeis49_SL_502.01	FP	577292	5799120	4.7	1.2	0.2	no object visible	not visible on MBES-data			

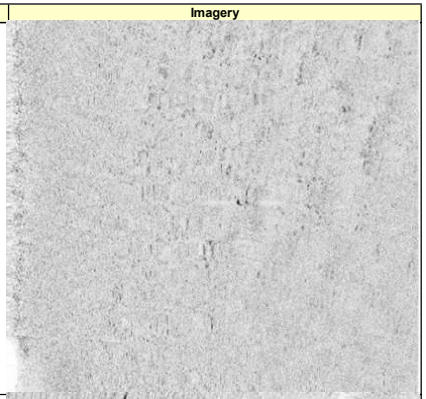
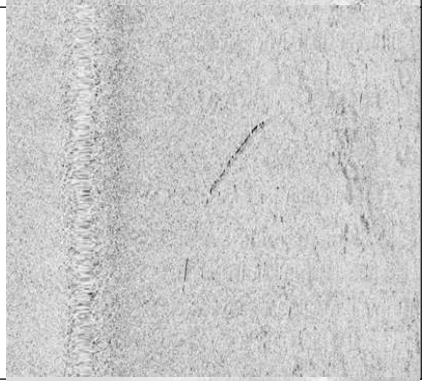
Name	Area	Line	Vessel	Easting	Northing	L	W	H	Description raw sonar	Description mbeam	Interpretation PP	Remarks	Imagery
S_FP_0481	IV	FPSeis58_SL_502.01	FP	578196	5794830	6.6	1.5	0.0	XTF-data is poor; large object is distinguishable with reflection	visible scourmarks patterns aroun	in this area the large scour pattern mostly indicate something buried; also magnometer anomalies are close; possible related to NCN 1934	possible arch. value	
S_FP_0482	IV	FPSeis58_SH_703.01	FP	576739	5791460	5.0	0.5	0.1	elongated feature on seabed; reflection with clear shadow	not visible on MEBS	sand ridge	natural phenomenon	
S_VH_0001	IV	VHMain03_S_501.01	VH	578977	5793440	34.4	10.3	1.2	within 50m NCN 253	clearly visible on MBES-data; wrec	definitely NCN 253; related to magnetometer contact 1388	arch. Value (image from database)	

Name	Area	Line	Vessel	Easting	Northing	L	W	H	Description raw sonar	Description mbeam	Interpretation PP	Remarks	Imagery
S_VH_0002	IV	VHMain03_S_501.01	VH	579876	5795340	12.3	1.4	0.2	circular feature; shadow before feature; reflective	not visible on MBES-data	clayey bed or sand ridge	natural phenomenon	
S_VH_0006	IV	VHMain05A_S_701.01	VH	578985	5793810	7.0	2.5	0.1	elongated reflective feature; shadow in front	feature is visible on MBES-data; sc	natural scour ridge cannot be related to an object	natural phenomenon	
S_VH_0015	IV	VHMain07_S_501.01	VH	577446	5791340	6.9	3.2	0.5	strong reflective feature with no clear shadow	not visible on MBES-data	gravel bed	natural phenomenon	

Name	Area	Line	Vessel	Easting	Northing	L	W	H	Description raw sonar	Description mbeam	Interpretation PP	Remarks	Imagery
S_VH_0019	IV	VHMain07_S_504.01	VH	581294	5799590	4.3	1.3	0.3	reflective feature of the seabed; shadow possibly in the front	not visible on MBES-data	sand ridge	natural phenomenon	
S_VH_0020	IV	VHMain08A_S_501.01	VH	581224	5799650	8.2	2.2	0.3	reflective feature of the seabed; shadow in the front	not visible on MBES-data	sand ridge	natural phenomenon	
S_VH_0034	IV	VHMain11_S_504.01	VH	581044	5800270	25.0	0.0	0.0	weak reflective feature of the seabed; shadow in the front	not visible on MBES-data	sand ridge	natural phenomenon	

Name	Area	Line	Vessel	Easting	Northing	L	W	H	Description raw sonar	Description mbeam	Interpretation PP	Remarks	Imagery
S_VH_0036	IV	VHMain11_S_710.01	VH	583855	5806170	5.8	0.4	0.1	reflective elongated feature; with shadow	not visible on MBES-data	sand ridge	natural phenomenon	
S_VH_0041	IV	VHMain12_S_708.01	VH	578198	5794830	5.0	1.3	1.2	within 50m NCN 1934; XTF-data is poor; large object is distinguishable with refelction	visible scourmarks patterns aroun	in this area the large scour pattern mostly indicate something buried; also magnometer anomalies are close; possible related to NCN 1934	arch. Value	
S_VH_0042	IV	VHMain12_S_708.01	VH	578157	5794790	8.2	2.1	1.0	within 50m NCN 1934; XTF-data is poor; large object is distinguishable with refelction	visible scourmarks patterns aroun	in this area the large scour pattern mostly indicate something buried; also magnometer anomalies are close; possible related to NCN 1934	arch. Value	

Name	Area	Line	Vessel	Easting	Northing	L	W	H	Description raw sonar	Description mbeam	Interpretation PP	Remarks	Imagery
S_VH_0043	IV	VHMain12_S_504.01	VH	578057	5794700	4.1	3.3	0.1	strong reflective circular object; partly buried; some shadow	not visible on MBES-data	possible oil drum or tyre; can be debris related to NCN 1934	possible arch. value	
S_VH_0049	IV	FPSeis57	VH	538090	5805590	63	14	-	large structure; strong reflection; below fish almost no shadow	Clearly visible	dumped cargo; wreck remains; rockdump (unlikely location)	possible arch. value	
S_VH_0054	IV	VHMain12A_S_504.01	VH	578032	5794260	10.4	2.5	0.2	strong reflective elongated object; with shadow and possible double reflection	not visible on MBES-data	may be sand ridge or part of chain/cable	no arch. value	

Name	Area	Line	Vessel	Easting	Northing	L	W	H	Description raw sonar	Description mbeam	Interpretation PP	Remarks	Imagery
S_VH_0056	IV	VHMain13B_S_502.01	VH	577173	5792800	4.9	3.0	0.2	no object; shadow in front of object	not visible on MBES-data	sand ridge	natural phenomenon	
S_VH_0062	IV	VHMain16A_S_505	VH	580534	5801270	5.1	1.1	0.2	reflective feature of seabed	not visible on MBES-data	sand ridge	natural phenomenon	
S_VH_0079	IV	VHMain15A_S_502.01	VH	576278	5791680	68.0	0.0	0.0	thin reflection for 68m; n clear shadow; partly buried	possible elongated feature in MBE	possible chain or cable; sand ridge	no arch. value	

Name	Area	Line	Vessel	Easting	Northing	L	W	H	Description raw sonar	Description mbeam	Interpretation PP	Remarks	Imagery
S_VH_0091	III	VHMain18_S_712.01	VH	573265	5786550	8.8	0.5	0.4	XTF MISSING; elongated, linear object; reflective with shadow	object visible on MBeS-data includ	possible piece of cable or pipe	no arch. value	
S_VH_0093	IV	VHMain21_S_506.01	VH	581269	5804400	44.0	14.7	1.8	within 50m NCN 1959; clear reflective features; wreck	elevation and scourmarks associat	wreck	arch. value	
S_VH_0094	IV	VHMain21_S_506.01	VH	581855	5805310	7.2	0.9	0.1	elongated reflective feature; no shadow	not visible on MBES-data	sand ridge	natural phenomenon	

Appendix 4. Phases of maritime archaeological research

The care for cultural heritage is legally required according to Dutch law. In order to comply with the requirements, all procedures and requirements for the archaeological research process haven been incorporated in the Dutch Quality Standard for Archaeology (KNA waterbodems, version 3.2). Below a brief description of the steps involved:

1. **Desk study**
   The purpose of a desk study is to collect and report all available historical data, geological information and information about disturbances in the past. The result is an archaeological expectation map or model.
   The desk study may be expanded with an analysis of sonar and multibeam data, if available.

   IF the outcome of the desk study shows that there is a risk of occurrence of Archaeology, then the next phase must be carried out:

2. **Exploratory field research (opwaterfase)**
   In order to test the archaeological expectation, a geophysical survey is carried out. The type of survey depends on the type of expected objects, local geology and expected depth of the objects below the seafloor. In practice, the research usually consists of a side scan sonar survey, if necessary, supplemented with multibeam echosounder recordings, subbottom profiling and magnetometer measurements. The requirements of the survey are based on the desk study and should be included in a program of requirements which must be approved by the competent authorities.

   IF potential archaeological objects are found, then the next phase must be carried out:

3. **Exploratory field research (onderwaterfase verkennend)**
   The suspected sites are investigated by specialized divers in order to identify the objects. The requirements of the underwater research are included in a program of requirements which must be approved by the competent authorities.

   IF as site is identified as an archaeological object or structure then the next phase must be carried out:

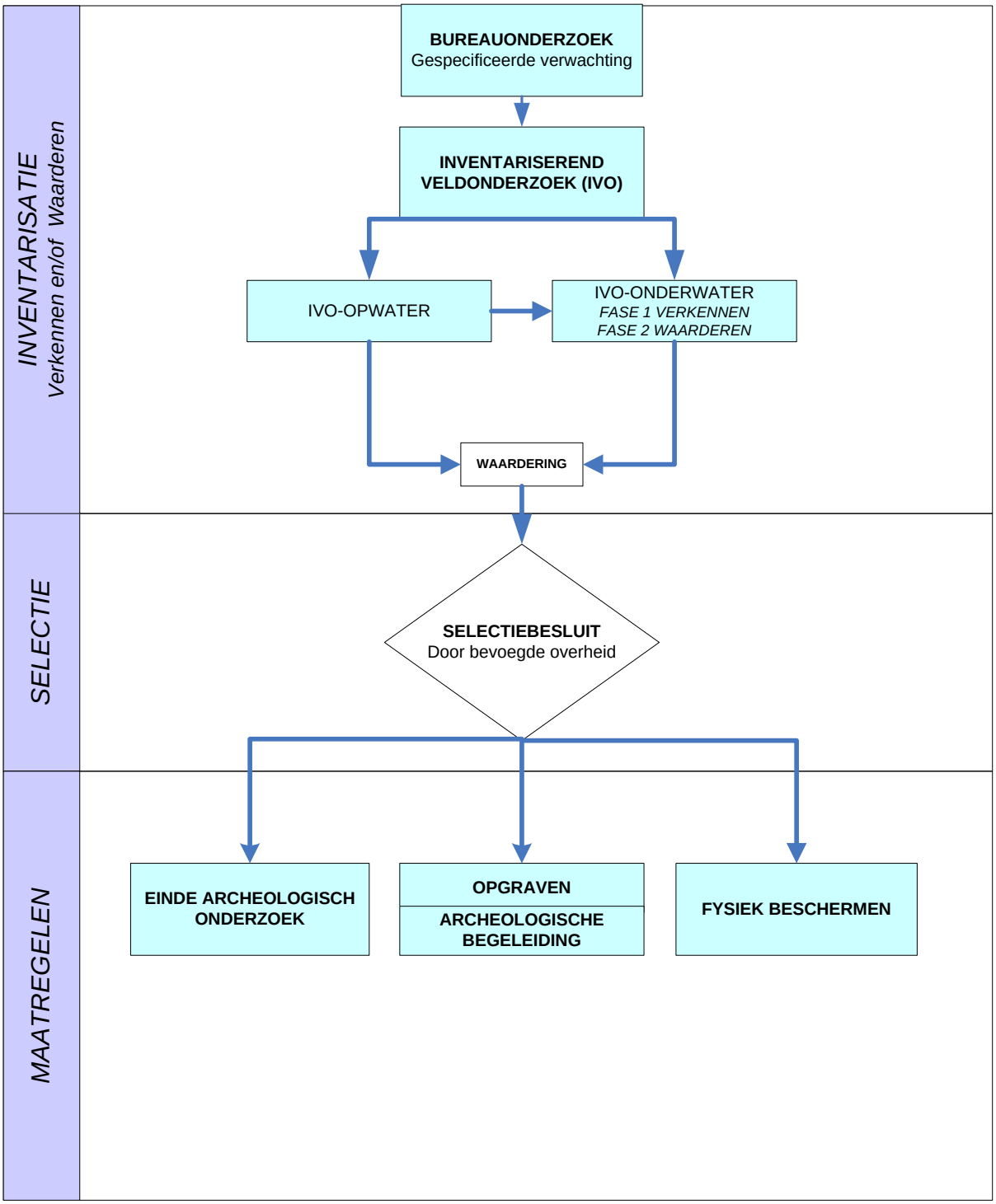
4. **Appreciative field research (onderwaterfase waarderend)**
   The archaeological remains at the site are thoroughly investigated and mapped by a specialized archaeological diving team and samples are collected for additional research. Then a decision will be made whether the archaeological remains are worth preserving. If the latter is the case, then there are two possibilities: either the remains can be preserved in situ (adjustment of plans) or the next phase will be conducted:

5. **Archaeological excavation**
   The archaeological remains are excavated under supervision of a senior maritime archaeologist. All remains need to be documented, registered and conserved. The requirements of the underwater research are included in a program of requirements which must be approved by the competent authorities.

The phases described above contain a number of decision points that are dependent on the detected archaeological objects. The figure on the next page shows these moments schematically.

Schematic overview KNA Waterbodems version 3.2

(AMZ cycle in Dutch)



Contacts
Netherlands Enterprise Agency (RVO.nl)
Croeselaan 15 | 3521 BJ | Utrecht
P.O. Box 8242 | 3503 RE | Utrecht
www.rvo.nl / http://english.rvo.nl

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