Netherlands Enterprise Agency

Archaeological Desk Study

Hollandse Kust (noord) Wind Farm Zone

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Author: Periplus Archeomare

Periplus Archeomare

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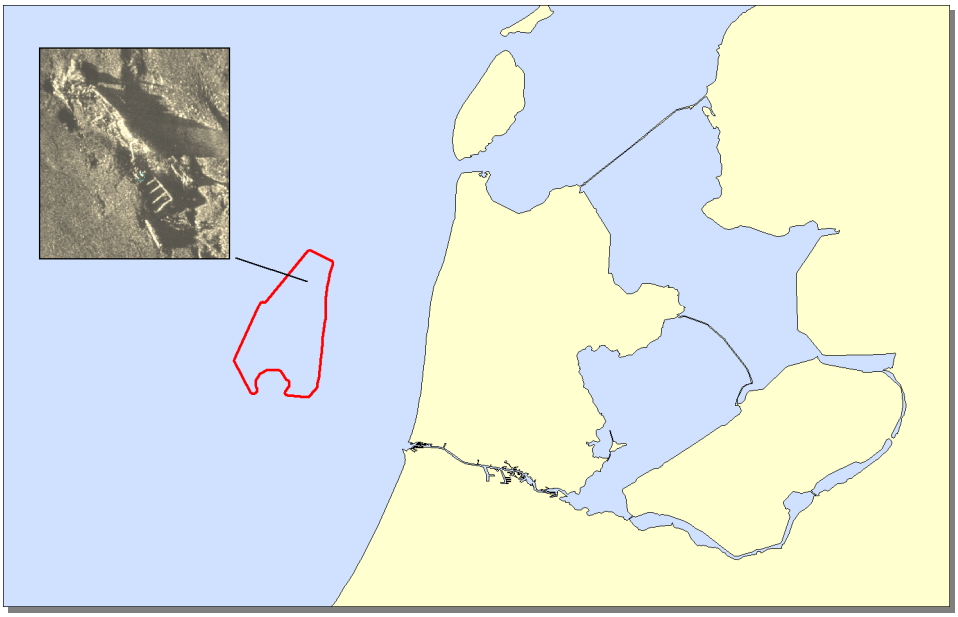
Hollandse Kust (noord)
Wind Farm Zone



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At the request of

Rijksdienst voor Ondernemend Nederland (RVO.nl)
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Periplus Archeomare Report 17A007-01

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At the request of: Rijksdienst voor Ondernemend Nederland (RVO.nl)
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Contents

Table 1. Dutch archeological 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 (noord)	
Chart:	1801-01	
Coordinates		ETRS89 UTM31N
Geodetic datum: ETRS89	Centre	E 584 846, N 5 838 982
Projection: UTM31N	NW	E 589 059, N 5 853 752
	NE	E 593 530, N 5 851 538
	SW	E 576 176, N 5 831 691
	SE	E 589 268, N 5 824 065
Depth (LAT):	15.0 to 34.5 meter, average 22.6 meter	
Surface area	304 square km	
Surface investigation area (buffer 1km)	393 square km	
Environment:	Tidal currents, salt water	
Area use:	Shipping lane, fishing and recreation, sand extraction	
Area administrator:	Rijkswaterstaat Zee en Delta	
ARCHIS-research report (CIS-code):	4040290100	
Periplus-project reference:	17A007-01	
Period	April - May 2017	

Samenvatting (in Dutch)

In opdracht van de Rijksdienst voor Ondernemend Nederland (RVO.nl) heeft Periplus Archeomare B.V. een archeologisch bureauonderzoek uitgevoerd voor het toekomstige windpark Hollandse Kust (noord). Het onderzoeksgebied heeft een oppervlakte van 304 km^2 en ligt in de Noordzee, 18.5 km uit de kust bij IJmuiden.

Voor het onderzoeksgebied bestaat een hoge verwachting voor de aanwezigheid van (resten van) scheepswrakken en vliegtuigwrakken uit de Tweede Wereldoorlog. Daarnaast is het aannemelijk dat vanwege de post-glaciale zeespiegelstijging *in situ* resten van kampementen van jagers/verzamelaars uit het Late-Paleolithicum en het Vroege-Mesolithicum kunnen worden aangetroffen.

Delen van het onderzoeksgebied zijn in het verleden al vlakdekkend onderzocht met geofysische technieken.

Tijdens de geofysische survey voor zandwindgebied Q05 is aan twee locaties een mogelijke archeologische waarde toegekend.

Meer dan 90 % van het windgebied is nog niet in detail onderzocht door middel van een geofysische survey. Het is mogelijk dat onbekende (resten van) wrakken aanwezig zijn.

Scheepswrakken
Binnen het onderzoeksgebied zijn in totaal veertien scheepswrakken bekend. Vier wrakken zijn geïdentificeerd en hebben geen archeologische waarde. Van de overige tien wrakken zijn de exacte locatie en verdere details als scheepsnamen, scheepstypes niet bekend. Aanvullend onderzoek is nodig om de archeologische waarde van deze wrakken vast te stellen.

Vliegtuigwrakken
Gedurende de Tweede Wereldoorlog zijn veel vliegtuigen neergestort in de Noordzee. Verschillende bronnen zijn onduidelijk over het aantal vliegtuigen dat nog vermist wordt, maar het moeten er honderden zijn. Zowel tijdens zandwinning en kustbeschermingsprojecten als door vissers worden regelmatig resten van vliegtuigen aangetroffen. In de omgeving van het onderzoeksgebied is één locatie bekend met vliegtuigresten.

Prehistorie
In situ resten van prehistorische kampplaatsen worden verwacht in de top van dekzandduinen en –ruggen (Laagpakket van Wierden) en in rivierduinafzettingen (Laagpakket van Delwijnen) mits deze afzettingen niet door erosie zijn aangetast. In de Basisveen Laag en Velsen Laag kunnen gave en goed geconserveerde verloren objecten of gedumpte objecten worden aangetroffen. De archaeologische niveaus liggen onder het bligh Bank Laagpakket.

Resten van Neanderthaler kampen kunnen worden verwacht in de lacustriene kleiafzettingen van de Brown Bank Laagpakket en de (fluvio)glaciale afzettingen van de formatie van Drente (indien aanwezig).

Op dit moment is weinig bekend over de integriteit van het Pleistocene landschap. De Pleistocene lagen liggen dicht onder de zeebodem. Hierdoor is de kans op erosie aannemelijk. Lokaal kan het bovengelegen Basisveen het Pleistocene landschap hebben beschermd tegen erosie. Voor een beter onderbouwd verwachtingsmodel adviseren wij een *subbottom profiling* onderzoek uit te voeren in combinatie met de analyse van onverstoorde boorkernen. Daarmee kunnen het basisveen en de onderliggende goed bewaarde archeologische lagen beter worden gekarteerd. In het algemeen is de aanleg van het windpark een mogelijkheid om informatie op te doen over het paleothische en mesolithische landschap en de daaraan gerelateerde archeologie. De ontwikkeling van het windpark vormt geen bedreiging voor deze landschappen.

De lithostratigrafische eenheden waarbinnen, en de diepte ten opzichte van de zeebodem waar resten worden verwacht, is samengevat in onderstaande tabel.

Lithostratigrafische eenheid	Depth top of unit	Archaeological remains	In situ
Southern Bight Formatie - Bligh Bank Laagpakket	0	scheeps- en vliegtuigwrakken	yes
		verspoelde vuurstenen en benen artefacten	no
Laag van Velsen	0 - 8	verloren objecten, dumps	yes
Basisveen Laag	0 - 10	verloren objecten, dumps	yes
Formatie van Boxtel - Wierden Laagpakket - Delwijnen Laagpakket	0 - 10	kampplaatsen van jagers en verzamelaars vuurstenen en benen artefacten; verbrandde noten en zaden; houtskool; jachtattributen	yes yes
Formatie van Kreftenheye	0 - 10	verspoelde vuurstenen en benen artefacten verloren objecten, dumps; mogelijk kampplaatsen	no yes
Eem Formatie - Brown Bank Laagpakket	6 - 10	verspoelde vuurstenen en benen artefacten kampplaatsen van Neanderthalers	no yes
Formatie van Drente - Laagpakket van Gieten - Uitdam Laagpakket	?	kampplaatsen van Neanderthalers; vuurstenen artefacten	yes

In overeenstemming met de *AMZ*-cyclus wordt geadviseerd om een '*Inventariserend veldonderzoek opwaterfase*' uit te voeren om:

- De locaties van bekende wrakken in meer detail te karteren;
- De delen van het gebied waar nog geen survey opnames zijn uitgevoerd te inventariseren.

Vergelijkbare geofysische onderzoeken bestaan over het algemeen uit surveys met *side scan sonar*, *magnetometer* en een *subbottom profiler*. De resulterende data moeten geanalyseerd worden na oplevering van de gegevens door het surveybedrijf. De archeologische analyse van de gegevens dient te gebeuren door een geofysisch specialist (KNA prospector waterbodems).

Het onderzoek moet voldoen aan de Kwaliteitsnorm Archeologisch onderzoek (KNA). Om dit te waarborgen worden de eisen voorafgaand aan het onderzoek vastgelegd in een Programma van Eisen (PvE), dat is goedgekeurd door het bevoegd gezag.

Zoals gezegd blijven onzekerheden bestaan omtrent de aanwezigheid van archeologische waarden in het plangebied. Dat betekent dat dat ook tijdens de bouw onverwacht archeologische waarden kunnen worden aangetroffen. De civiel uitvoerder is conform de Erfgoedwet (2016), voortgekomen uit de Malta conventie verplicht om dergelijke vondsten te melden bij de bevoegde overheid. Dit is ook opgenomen in het Waterbesluit (artikel 6.16F) .Deze meldingsplicht voor archeologische vondsten moet als protocol in het bestek of Plan van Aanpak van het werk worden opgenomen.

Summary

Periplus Archeomare was assigned by RVO.nl to conduct an archaeological assessment of the Hollandse Kust (noord) Wind Farm Zone. The research area of 304 km^2 is located in the North Sea, 18.5 km off the coast of IJmuiden.

Within the investigated area of the wind farm zones there is a high expectation for the presence of (remains of) ship wrecks and WWII plane wrecks. Locally *in situ* remains of Paleolithic and Early Mesolithic camp sites might be present.

Parts of the research area have been investigated by geophysical surveys in the past. During the geophysical survey for sand extraction area Q05, two locations were classified with a possible archaeological expectation, but no detailed information is currently available

Over 90 % of surface of the wind farm area has not been investigated by detailed geophysical surveys. The area may contain more undiscovered shipwrecks or remains of shipwrecks.

Shipwrecks
A total of 14 shipwrecks are known in the area. Four ship wrecks have been identified and have no archaeological value. For the remaining 10 wrecks, 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, but estimates range into the hundreds. Remains are found regularly by fishermen or during sand extraction. In the vicinity of the research area, one location of a plane wreck is known. It may be expected to find plane wrecks within the research area.

Prehistory
Remains of prehistoric camp sites are expected *in situ* in cover sand dunes and ridges (Wierden Member) and river dunes (Delwijnen Member) provided these units are un-eroded. Within the Basal Peat Bed and Velsen Bed well-preserved lost objects and dumps can be encountered. The archaeological levels of interest located under a cover of the Bligh Bank Member.

Remains of Neanderthaler camp sites can be expected within lacustrine clays of the Brown Bank Member and (fluvio)glacial deposits of the Uitdam Member, if these units are in fact present in the area.

At this stage little is known about the integrity of the Pleistocene landscape. The Pleistocene units are encountered at shallow depths. Erosion of these units and archaeological remains therein therefore seems likely. Locally the Basal Peat Bed and/or Velsen Bed might have protected the Pleistocene landscape against erosion. By means of subbottom profiling in combination with analysis of undisturbed borehole samples the Basal Peat Bed and Velsen Bed and the underlying well-preserved archaeological level can be mapped. In general the development of the wind farm is an opportunity to learn about the paleolithic and mesolithic landscape and related archaeology. The wind farm development is not considered to be a possible threat for these landscapes.

The lithostratigraphic units in which and the depth below the seabed at which archaelogical remains are to be expected is is summarized in the table below.

Unit	Depth top of unit	Archaeological remains	In situ
Southern Bight Formation - Bligh Bank Member	0	ship and plane wrecks	yes
		reworked flint and bone artifacts	no
Velsen Bed	0 - 8	lost objects, dumps	yes
Basal Peat Bed	0 - 10	lost objects, dumps	yes
Boxtel Formation - Wierden Member - Delwijnen Member	0 - 10	camps sites of hunters and gatherers; flint and bone artifacts; burnt nuts and seeds; charcoal; hunting gear	yes yes
Kreftenheye Formation	0 - 10	reworked flint and bone artifacts lost objects, dumps; possible camp sites	no yes
Eem Formation - Brown Bank Member	6 - 10	reworked flint and bone artifacts camps sites Neanderthaler; flint artifacts	no yes
Drente Formation - Gieten Member - Uitdam Member	?	camps sites Neanderthaler; flint artifacts	yes

In accordance with the AMZ cycle it is advised to conduct a field investigation (in Dutch '*Inventariserend veldonderzoek opwaterfase*') in order to:

- Map the locations of known wreck sites in great detail;
- Make an inventory for the parts of the area which have not been covered in previous surveys.

In general, similar investigations carried out in the past consist of a geophysical survey with *side scan sonar*, *magnetometer* and *subbottom profiler*. The resulting data should be assessed after the general processing, interpretation and reporting has been performed by the survey contractor, if possible in combination with analysis of core samples. The archaeological assessment of the data has to be conducted by a geophysical specialist (KNA prospector Waterbodems).

The data quality expected from the surveys need to match the demands for this archaeological assessment. To ensure compatibility between the site investigation and the required quality for this assessment it is recommended to define a Program of requirements (In Dutch: '*Programma van Eisen'*) in accordance with the 'KNA' (the Dutch quality standards for archeological research), to be authorized by the competent authority.

During the installation of the wind turbines and construction of the cables archaeological remains may be encountered that were fully covered by sediment or not identified as archaeological remains during the geophysical survey. In accordance with the Malta convention incorporated in the Erfgoedwet (2016) it is required to report those findings to the competent authority. This is also incorporated in the Water Decree (section 6.16F). This notification for archaeological finds should be included in the specifications or scope of work.

1 Introduction

Periplus Archeomare was assigned by RVO.nl to conduct an archaeological assessment of the Hollandse Kust (noord) Wind Farm Zone. The research area of 304 km^2 is located in the North Sea, 18.5 km off the coast of IJmuiden.

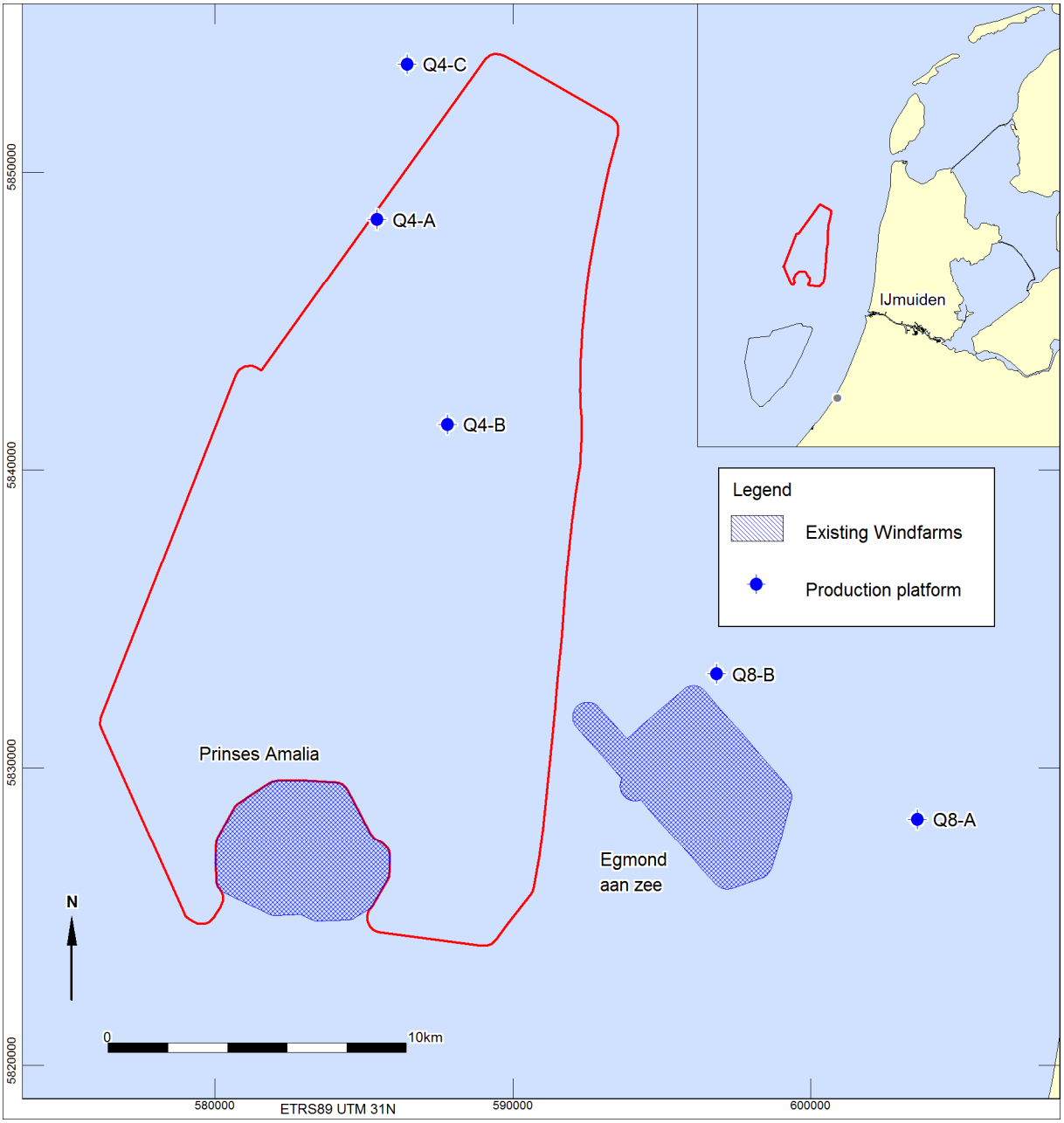

Figure 1. Overview of the research area

The assessment and reporting were carried out in accordance with the Dutch quality standards for archaeological research[1].

[1] Kwaliteitsnorm Nederlandse Archeologie (KNA waterbodems 4.0).

1.1 Motive

In 2013 more than 40 organizations and the Government entered into the Energy Agreement for Sustainable Growth (Energieakkoord voor Duurzame Groei). An important part of this agreement includes scaling up of offshore wind power development. The Ministry of Economic Affairs presented a road map outlining how the Government plans to achieve its offshore wind goals in accordance with the time line agreed upon in the Energy Agreement.
The road map sets out a schedule of tenders offering 700 MW of development each year in the period 2015 – 2019. The Dutch Government has developed a systematic framework under which offshore wind farm zones are designated. Any location outside these wind farm zones are not eligible to receive a permit. Within the designated wind farm zones the government decides the specific sites where wind farms can be constructed using a so-called Wind Farm Site Decision ('Kavelbesluit'). This contains conditions for building and operating a wind farm on a specific site. The Dutch transmission system operator TenneT will be responsible for grid connection.

Winners of the site development tenders will be granted a permit to build a wind farm according to the Offshore Wind Energy Act (Wet windenergie op zee[2]), a SDE+ grant and offered a grid connection to the main land. The Ministry provides all relevant site data, which can be used for the preparation of bids for these tenders. This Archeological Desk Study is part of the site data for Wind Farm Zone Hollandse Kust (noord).

In the Law on Archaeological Heritage (Erfgoedwet 2016), emerged from the Malta Convention (1992), incorporated in the Monuments Act through the Archaeological Heritage Act, the protection of the archaeological heritage is regulated. Planned activities, such as the installation of wind turbines and cables in the North Sea, may affect the archaeological values if present. If effects on possible remains are expected, there is a statutory obligation to conduct archaeological research. This process is also outlined in the law "windenergie op zee".
This archaeological desk study for the proposed Wind farm Zone Hollandse Kust (noord) is the first step in the archaeological process as part of the so-called *AMZ* cycle.

1.2 Objective

The purpose of this desk study is to establish whether archaeological remains are, or are likely to be, present within the wind farm zone as well as a 1 km wide buffer zone around it, and whether these (possible) remains could be effected by the development of offshore wind farms within the area. Where possible, the desk study aims to give insight into the archaeological value of these (possible) remains in terms of their physical or scientific value, such as the overall quality of preservation and the rarity of the remains. Furthermore, this report aims to make recommendations regarding subsequent steps in dealing with known and expected archaeological remains within the wind farm zone and the buffer zone (1km).

The archaeological management procedure ('AMZ-cycle') is a defined sequence of steps and decisions within archaeological heritage management in the Netherlands. The procedure is embedded in the Dutch Quality Standard for Archaeology (KNA Waterbodems 4.0) as the mandatory workflow for archaeologists. A detailed description of the different phases of archaeological research is included in appendix 1.

[2] http://wetten.overheid.nl/BWBR0036752

1.3 Research questions

For an archaeological desk study, the following research questions are applicable:

- Are there any known archaeological values present within the research area? If so, what is the nature, extent (depth) location and dating of these sites?
- Are there, in addition to any known values, archaeological remains be expected? If so, what is the nature, extent (depth) location and date of the expected archaeological remains?
- Can the proposed activities in the wind farm zones affect known or expected archaeological values? If so, can an impact on archaeological assets be prevented or restricted by planning adaptation?
- If the archaeological values cannot be saved:
  What kind of further research is needed to determine the presence of archaeological values and their size, location, type and date to be determined enough to come to a selection decision?

In addition, the following points of attention and questions have been defined by RVO.nl:

- Define an overview of the archaeological aspects on which basis the wind farm zone will be assessed.
- Assess whether there are (indications for) areas with specific archaeological interest (wrecks and prehistoric life) at the Hollandse Kust (noord) wind farm zone.
- If present, define expected location, size and dating of the areas with specific archaeological interest.
- Determine the possible effect of the installation of offshore wind farms on the areas with specific archaeological interest.
- Assess possibilities to mitigate the disturbance of areas with specific archaeological interest as a result of installing offshore wind farms.
- Identify whether any further investigations should be carried out from archaeological point of view and make a recommendation on the scope and specifications of these investigations.
- Define requirements for any activity carried out in the wind farm area (investigations or monitoring activities, installation activities, operational activities) that could have an effect on archaeological aspects in the wind farm area.
- What is the expectation of the physical quality of possible archaeological sites and objects?
- Which lithostratigraphic units can be determined and what is their spatial distribution (both horizontal and vertical)?
- Allocate archaeological levels within the lithostratigraphic sequence
- Is it possible to define zones where the (buried) prehistoric landscape is eroded or intact? Are the expected lithostratigraphic boundaries erosive or non-erosive?
- If so, will these zones be affected by the work envisaged?
- Investigate whether human activities which could have led to a disturbance of the seabed and archaeological remains therein.
- If present, define the expected intrinsic quality in terms of rarity, research potential, group value and representativeness of the areas with specific archaeological interest.
- Define the expected physical quality in terms of integrity and preservation of the areas with specific archaeological interest.

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2 Methodology

The desk study was conducted in accordance with the Dutch Quality Standard for Archaeology (KNA Waterbodems 4.0, Protocol 4102). This concerns in particular the specifications LS01wb, LS02wb, LS03wb, LS04wb and LS05wb. The study is reported in accordance with specification LS06wb.

In order to comply with the main objectives and answer the research questions, the archeological desk study is carried out according to the scope of Work as described in the following steps:

- Description of the Area of Interest and determination of the consequences for future use (LS01wb)
- Description of the current usage of the area of Interest (LS02wb)
- Description of the historical situation and possible disturbances (LS03wb)
- Description of the known archaeological features and objects (LS04wb)
- Description of the geological setting within which the archaeological objects are to be found (LS04wb)
- Definition of a specified archaeological expectation (LS05wb)

Based on these components a specified archaeological expectation is defined. It is expressed whether, and if so, which archaeological values can be expected. The properties of these values will be indicated in as much detail as possible.

The results of the study are summarized in chapter three. Based on the results the research questions are answered in Chapter four. The study concludes with a summary and recommendation in chapter five.

The research and reporting were conducted by S. van den Brenk and R. van Lil (both senior prospector). The results were approved and authorized by B. van Mierlo (Senior KNA prospector).

2.1 Sources

The following sources were consulted for the study:

- Archis III, archaeological database of the Dutch Cultural Heritage Agency
- Databases of Periplus Archeomare
- Dutch Federation for Aviation Archaeology (NFLA)
- Geological Desk Study Hollandse Kust (noord) Wind Farm Zone by Deltares
- HKN_20170106_RVO_STARTING POINTS ASSUMPTIONS_PART I GENERAL_V01_RdB
- HKN_20170111_RVO_STARTING POINTS ASSUMPTIONS_PART II RVO_V01
- National Contact Number (NCN) database Rijkswaterstaat
- Rijkswaterstaat Zee en Delta
- Stichting Aircraft Recovery Group 40-45
- The Hydrographic Service of the Royal Netherlands Navy
- *TNO-NITG*; geological borehole data and maps
- UXO-study (REASEuro) draft
- Various sources from the Internet

For a complete overview of the sources and literature see references on page 49.
Words in *italics* and abbreviations are explained in the glossary on page 48.

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3 Results

3.1 Definition of the research area and consequences of future use (LS01wb)

The Hollandse Kust (noord) Wind Farm Zone (HKN WFZ) is located 10 Nautical Miles off the west coast of the Netherlands. Telecom cables (operational and abandoned) and three pipe lines are crossing the Wind Farm Zone.

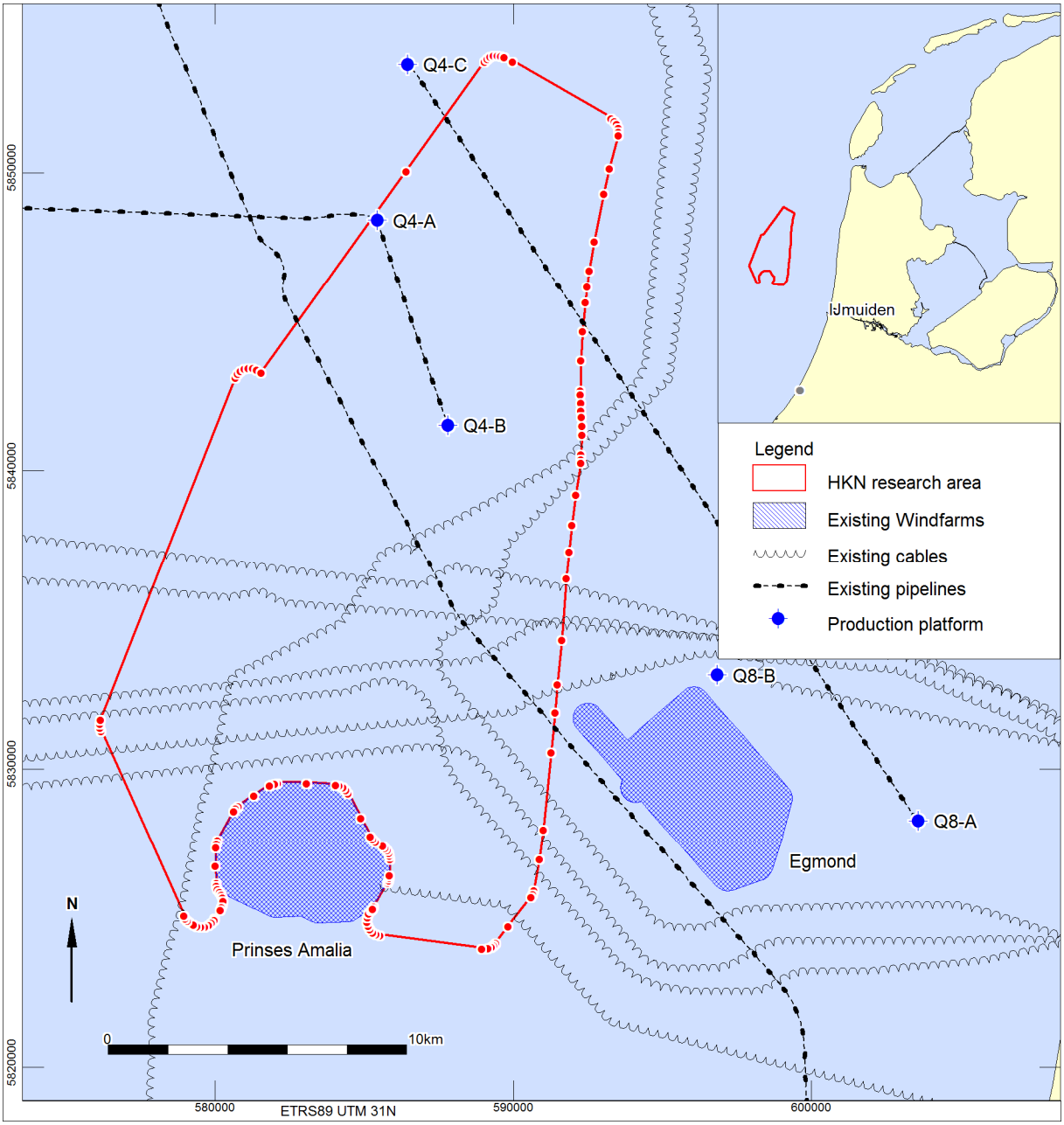

Figure 2. Overview of the research area

The wind farm zone is not sub-divided in wind farm sites. The existing Princess Amalia Wind Farm (120 MW) lies within the WFZ. In total, 700 MW new offshore wind capacity is planned in the zone.

The Hollandse Kust (noord) Wind Farm Zone has the following general characteristics, as shown in the table below.

Water depth (LAT)	15.0 to 34.5m
Mean water depth (LAT)	22.6m
Distance from shore	From 18.5 km (10 nautical miles)
Total surface area (including maintenance and safety zones within the WFZ)	Not yet available
Overall Wind Turbine Density	4.3 MW/km2

Table 3. General characteristics of the wind farm zone

The installation of the windfarm is expected to have a direct impact on the seafloor. Foundations need to be installed, and trenches are created for the infield cables, which might have an effect on the possible presence of cultural heritage.

In the longer term, wind turbines can cause a change in seafloor morphology due to change of tidal currents. This may, in turn, cause buried ship wrecks to emerge at the surface, exposing them to erosion.

Previous research

Parts of the research area have been investigated in the past for archaeological purposes:

- Windfarm and export cables Tromp-Binnen 2008. Archaeological desk study[3];
- Archaeological desk study and assessment of geophysical survey data sand extraction area Q05 Zeewaarts[4];
- Archaeological desk study and assessment of geophysical survey data sand extraction area Q7A[5]
- Former planned Windfarm Q4 (not realized), archeological desk study[6];

Figure 3 Area covered by earlier conducted archaeological investigations

The results of these investigations have been incorporated in paragraph 3.5, description of known archaeological values.

[3] Van den Brenk et al, 2008

[4] Van Lil et al, 2013

[5] Van Lil et al, 2014

[6] Van Lil et al, 2014

3.2 Description of the current situation (LS02wb)

The water depth within the research area varies from 15.0 to 34.5 meter (LAT), with an average of 22.6 meter (LAT). The figure below shows a color depth map based on data from the Hydrographic service (25m grid, 2009) combined with multibeam echosounder data from the Q7A survey (2014).

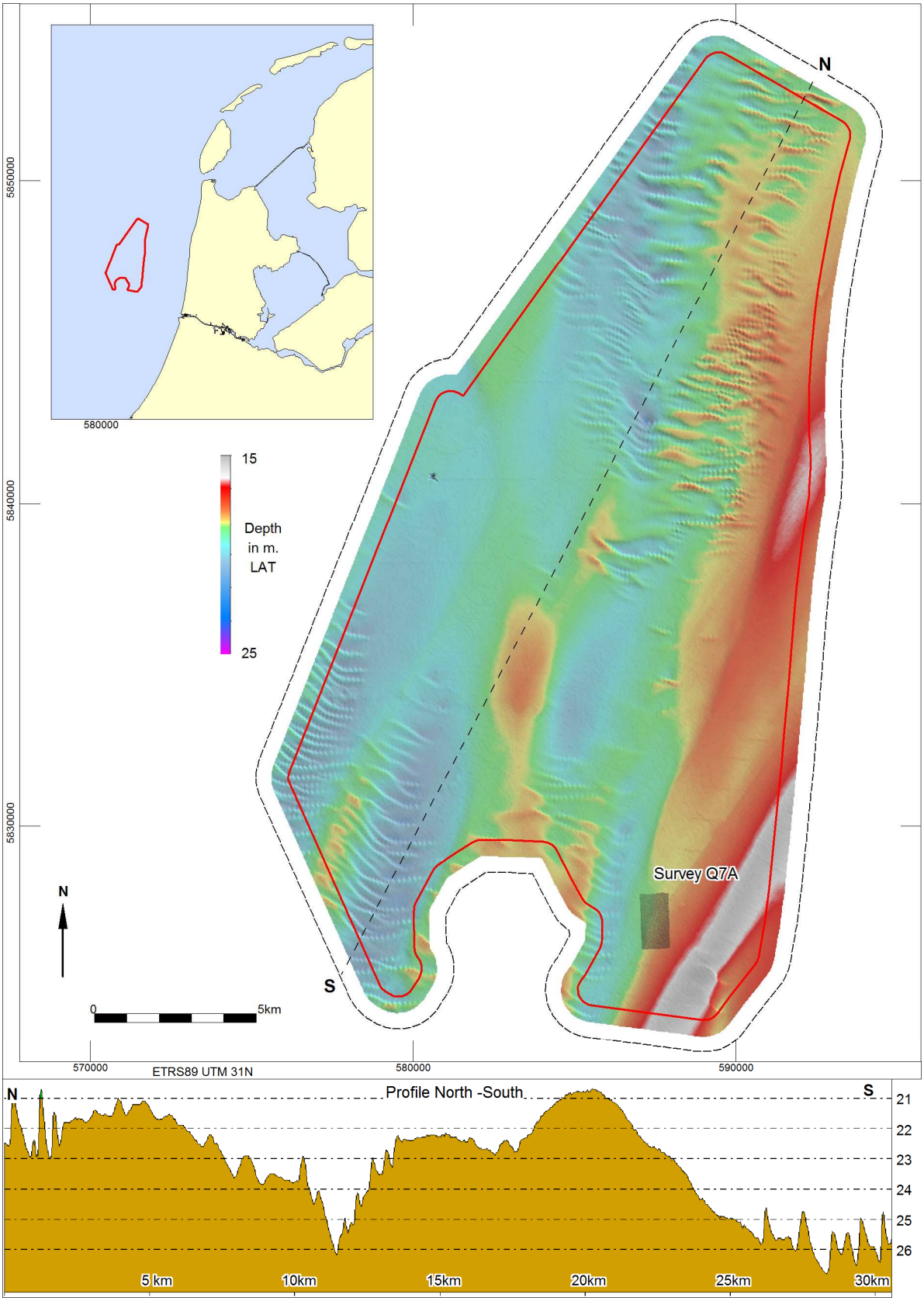

Figure 4. General bathymetry of the seabed

The seabed in the northwest and southwest consists of sand dunes with a west-northwest-east-southeast orientation and an average height of two meters. The distance between the crests amounts to 1200 meter. The dunes are superimposed by current ripples. Both sand dunes and current ripples have formed in the top layer of mobile sand. The ripples migrate along with tidal currents; the large sand dunes typically migrate with a speed of 1 to 10 m/year. The migration rate of sand dunes in the Princes Amalia Wind Farm Zone were recently assessed to be in the order of 4 m/year.[7]

The seabed in the center of the research area is relatively flat. A large sand bar with a height of four meters runs along the eastern border of the research area from north to south.

3.3 Description of geological data (LS04wb)

The archaeological prospect for (pre)historic settlements to occur is strongly related to the geogenesis of the plan area. The geogenesis is reflected by the lithostratigraphic units present, the character of layer boundaries (erosive vs non-erosive) and indications for the formation of soils within the sediments. Therefore geophysical and geological data are an important source to answer questions with respect to the nature, age, depth and location of occurrence, integrity and preservation of the archaeological remains which are to be expected within the plan area.

Deltares has published an extensive report on the geology of the research area.[8] On request Deltares has provided Periplus with grid models (MSL) of a) the depth at which the formation transitions are to be expected within the North Sea area and b) the thicknesses of these units. The grids available comprise the Pleistocene Eem Formation, Kreftenheye Formation and Boxtel Formation and the Holocene Naaldwijk Formation and Bligh Bank Member. Periplus does not avail of grids of the Drente Formation and Drachten Formation. The occurrence of these formations is mapped by means of publications of Schüttenhelm and Laban.[9]

Drente Formation

The Drente Formation consists of glacial deposits from the Saalien.[10] According to Laban lacustrine deposits of the Uitdam Member are to be expected in the northern part of the area. The Uitdam Member has formed by a clastic infill of glacial basins. The infill sediments consist of sand, silt and clay layers which can exhibit a typical varve layering on millimeter and centimeter scale. This varve layering occurs when the sediments deposited in glacier lakes vary in grain size due to seasonal differences in the amount of melting water and sediment load.

The extent of the Drente Formation in the area is not exactly known. The autors of the Deltares report acknowledge this by stating that '*glacial till and moraine deposits containing blocks and boulders (Drente Formation - Gieten Member) have not been observed but might be present in the area'* and *'based on borehole data, the Drente Formation (possibly), the Drachten Formation and the Egmond Ground Formation occur locally as disconnected bodies at depths ranging from 25 to 30 m below LAT.'*

Evidence of the occurrence of moraine deposits in the proximity of the plan area has come forward during the beach replenishment in Bergen aan Zee and Egmond aan Zee in 2016. A vast amount of pebbles, cobbles and boulders were dumped on the beaches. The sediments containing these clasts presumably originate from the Q05 zeewaarts and Q05 kustwaarts sand extraction areas. As shown in figure 3 the Q05 zeewaarts area is largely located within the current plan area. It is however not known if the cobbles and boulders have been extracted from the Q05 zeewaarts or the Q05 kustwaarts area which is located more than 5 kilometer east of the plan area.

Eem Formation

The Eem Formation predominantly consists of shell bearing marine deposits deposited during the Eemian.[11] At the end of the Eemian period brackish and fresh water clays were deposited in lagones and lakes which remained in

[7] Forzoni 2017.

[8] Forzoni et al. 2017

[9] Schüttenhelm and Laban 2005.

[10] Saalian: glacial period which ended 130.000 years ago.

[11] Eemien: interglacial period between 130.000 and 115.000 years ago.

the glacial basins during regression of the Eemian sea. These lake and lagone deposits have separately been classified as the Brown Bank Member within the Eem Formation.

The Brown Bank Member was previously referred to as Brown Bank Bed or Brown Bank Formation. Zagwijn describes the unit as follows: '*The Brown Bank Formation is of fresh-water origin except for its lowermost layers, which are marine in some places. It was deposited in a lagoon or a lake. Underlying these beds there are marine shelly sands which contain a fauna characteristic of the Eemian. These sands are rarely absent. Their thickness varies from around 10 m in the south to more than 20 m locally in the north. The base of these sands is flat in the south (at about 46 to 47.5 m below the present sea-level) and more sloping in the north.*'

The description of Zagwijn refers to a north-south profile located 50 kilometers west of the HKN wind farm area. As stated above the Brown Bank unit nowadays is defined as a member the Eem Formation. Forzoni concludes that *'The Eem Formation occurs in the southernmost part of the study area as a continuous body. Even though the Brown Bank Member is not present in the area based on the geological maps, seismic and borehole data indicate its occurrence in disconnected bodies in the central and northern part of the study area.'*[12]
This conclusion is supported by the Deltares grids of the Eem Formation.

However, the data published by Schüttenhelm and Laban seem to indicate that the Eem Formation is also present in central part of the area[13]. In the central and northern part of the area the geological cross sections included in the Deltares report indicate the presence of the Yarmouth Roads Formation at 26 meters in the western part of the area and more than 29 meters in the eastern part of the area. The Yarmouth Roads Formation is in the central and northern part of the area overlain by the Boxtel Formation. Given the geogenesis of the North Sea area it does not seem unlikely that these deposits are part of the Eem Formation possibly partly underlain by moraine or lacustrine deposits of the Drente Formation.

<u>Kreftenheye Formation</u>
The Kreftenheye Formation consists of fluvial deposits of the Rhine which were deposited during the Weichselien.[14] In the warmer summer periods peak discharges of melt water resulted in the transport of fast amounts of sand and gravel to the North Sea area.

[12] Forzoni 2017.

[13] Schüttenhelm en Laban, 2005.

[14] Weichselien: ice age which lasted from 115.000 till 12.000 years ago.

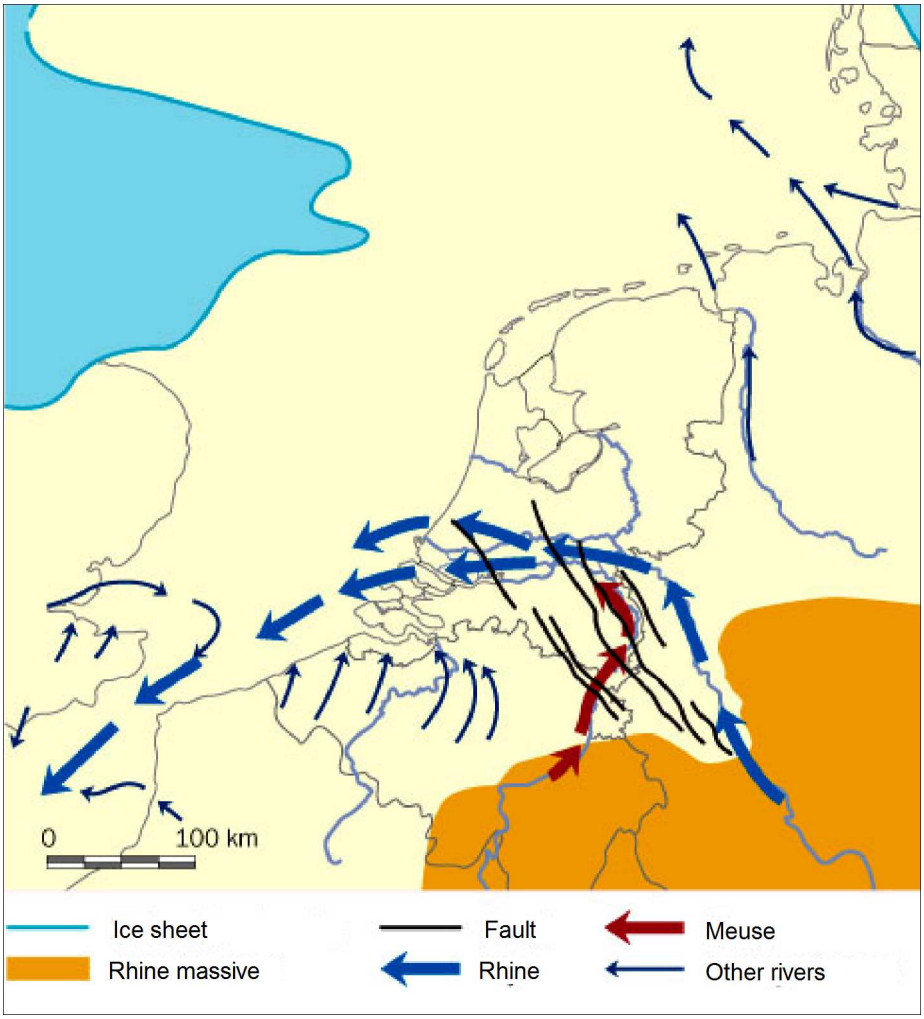

Figure 5. Course of the river Rhine (blue arrows) during the Weichselien (source: TNO)

Because large amounts of water were captured in the polar ice sheets the sea level was significantly lower: the Netherlands including the North Sea area formed a dry periglacial landscape. The Rhine was a braiding river running through this landscape.

The Kreftenheye Formation occurs in the southern part of the area at -25 to -30 meter LAT. In the southeastern part of the area the top of the formation is located at 6 to 10 meters below the seabed; in the southwestern part at 0 to 4 meters below the seabed. The large depth at which the unit occurs in the southeastern part of the area is caused by to the presence of a meters high sand dune in this part of the area (see figure 4).

The sandy sediments of the Kreftenheye Formation might be hard to distinguish from the Eem Formation. This is particularly the case when the Kreftenheye Formation contains reworked shells form the Eem Formation.

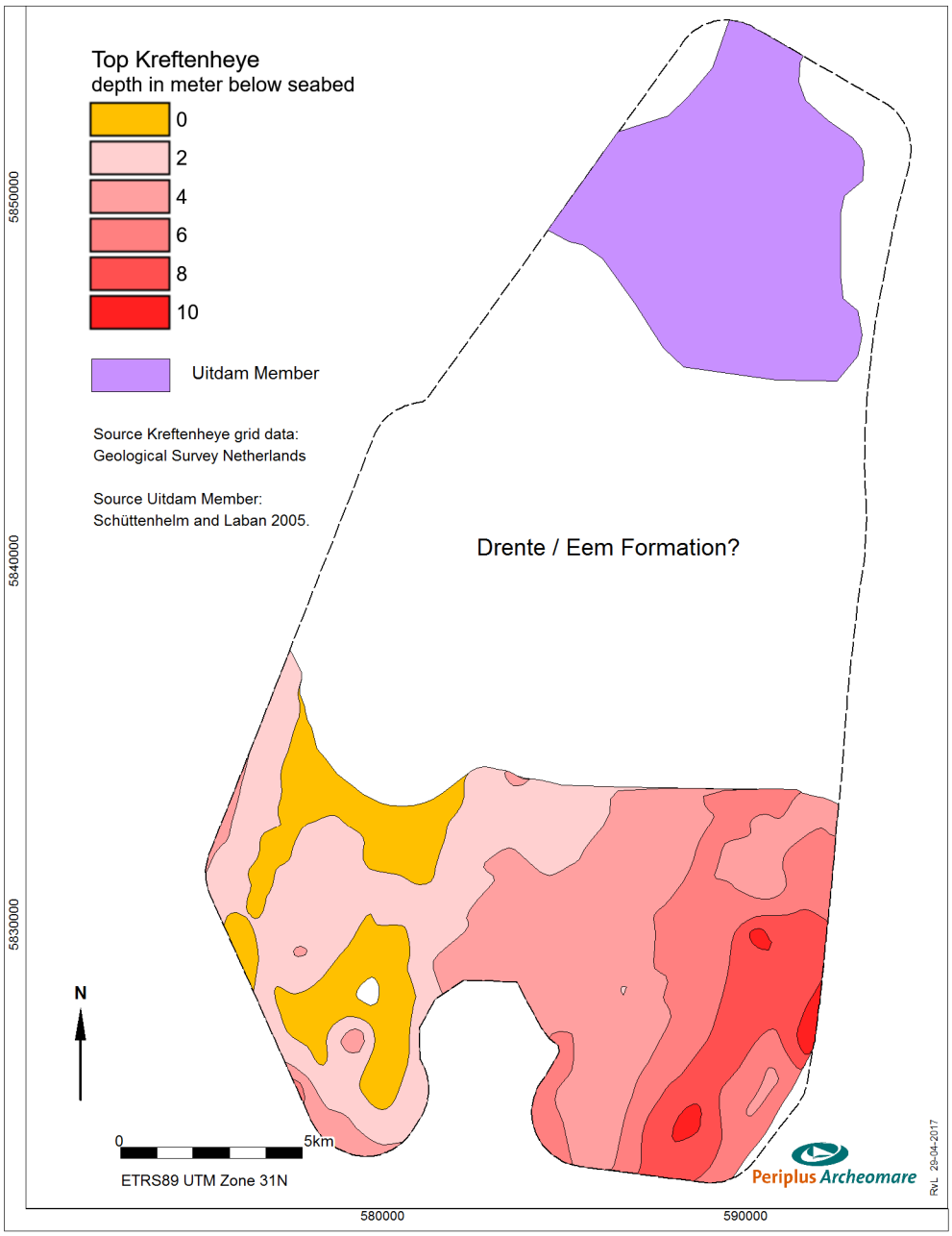

Figure 6. Occurrence of Kreftenheye Formation and Uitdam Member (possibly)

Boxtel Formation

The Boxtel Formation presumably consists of eolean deposits of the Wierden Member (cover sands), Delwijnen Member (river dunes) and loamy stream deposits of the Singraven Member. In the southern part of the area these very fine to medium fine deposits of sand and loam have been deposited on the Kreftenheye Formation.

Cover sand ridges and dunes as well as river dunes might have been preserved in isolated areas. If so, it is to be questioned if the top of these units is intact or eroded. The top of the Boxtel Formation is expected to be covered by the Basal Peat Bed as part of the Nieuwkoop Formation or Velsen Bed (as part of the Naaldwijk Formation), both marking the Early Holocene transgression in the area. The presence of the Basal Peat Bed is a clear indication that the underlying Boxtel Formation might be intact.

The Boxtel Formation is the dominant Pleistocene unit in the area. Figure 8 shows the occurrence of this unit including the depth in meters LAT at which the top of this unit is to be expected in the area.

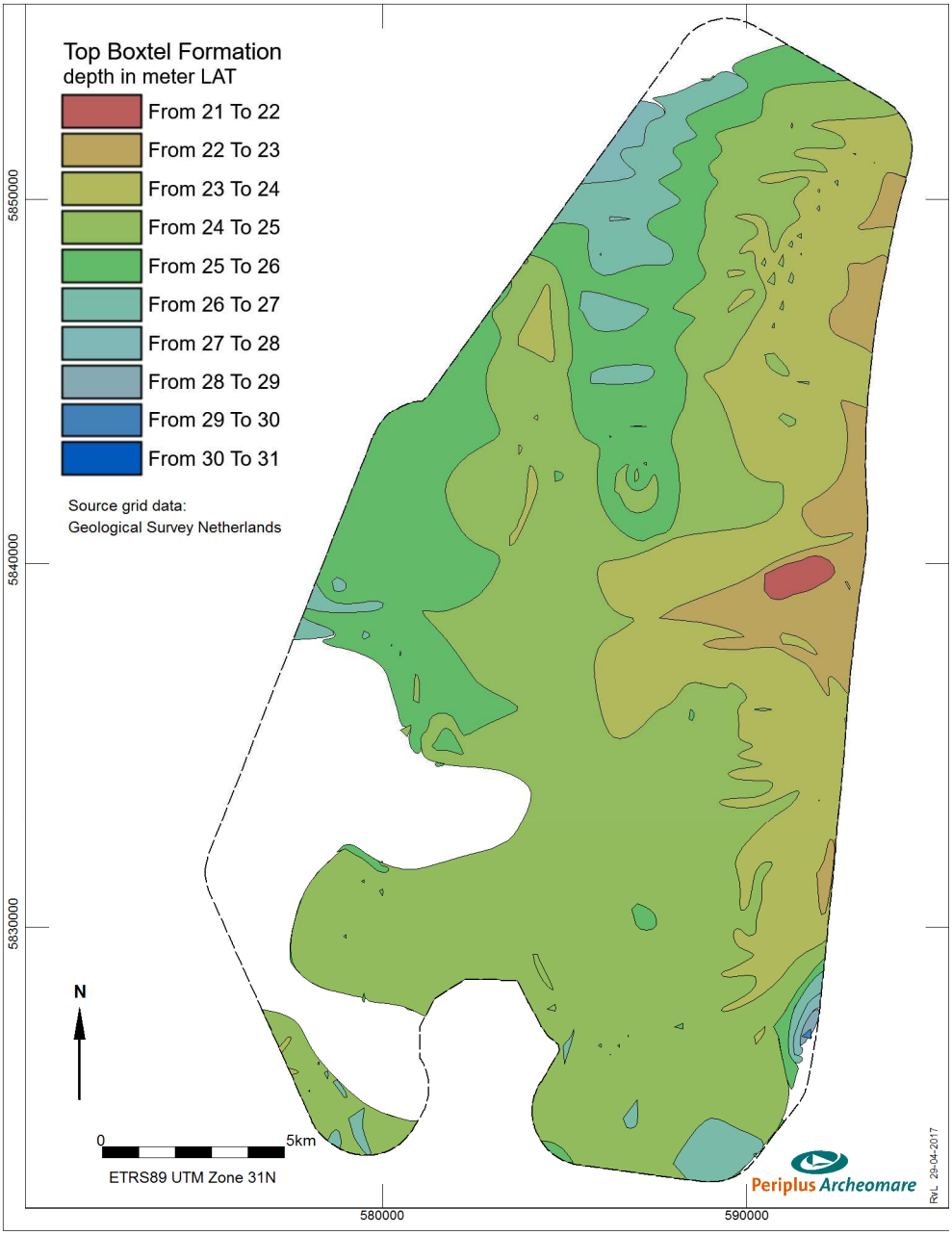

Figure 7. Subcropmap of the Boxtel Formation

The Boxtel Formation subcrops beneath a 0.5 to 10 meter layer of Holocene deposits of the Bligh Bank Member, Naaldwijk Formation and Basal Peat Bed (figure 8).

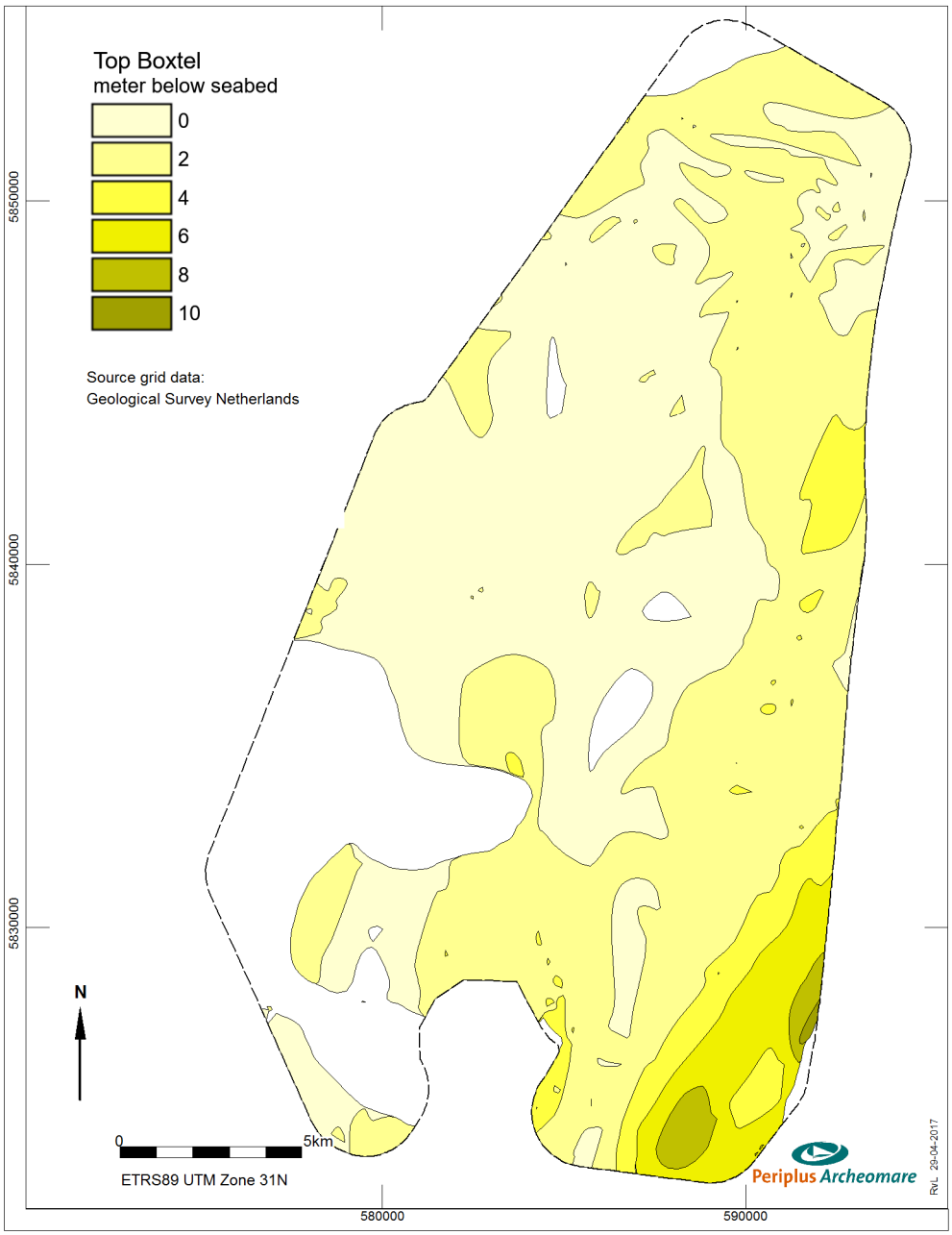

Figure 8. Indication of the thickness of Holocene units covering the Boxtel Formation

Naaldwijk Formation

Along the Dutch coast, Pleistocene units are in places covered by Holocene tidal deposits (clay and fine sand). These tidal deposits are part of the Wormer Member within Naaldwijk Formation. The earliest clastic deposits are those of the Velsen Bed. The Velsen Bed consists of firm humic clay sometimes containing considerable amounts of hydrobia shells. As with the Basal Peat Bed the stratigraphic units beneath the Velsen Bed might have been well preserved.

The (depth of) occurrence of the Naaldwijk Formation and the Velsen Bed herein is displayed in figure 9.

Figure 9. Occurrence of the Naaldwijk Formation

Bligh Bank Member

The Bligh Bank Member covering Pleistocene units consists of a mobile sand layer in which sand dunes and mega-ripples have developed.

This unit consists of marine, medium- or fine to medium-grained, clean, yellow-brown sands with local mud laminae. The formation often has a more gravelly structure towards the base. The thickness of the Bligh Bank Member ranges from 0 meter in the valleys of the sand dunes to 10 meters at the crests of the sand dunes. The Boxtel Formation and Kreftenheye Formation could be locally exposed at the sea floor.

3.4 Description of the historical situation and possible disturbances (LS03wb)

The North Sea basin formed about 12,000 years ago as an extensive aeolian sand landscape with a tundra climate. At the end of the last Ice Age (ca 11,500 years ago), the temperature rose as a result, the northern glaciers melted. The sea level rose and the North Sea basin was gradually filled. The residents of the area had to leave for higher ground[15].

The Dogger Bank in the North of the Dutch Continental Shelf is an example of an elevated area. Remnants of the tundra landscape and its inhabitants are regularly found in the nets of fishermen. Best known are the many fossils that have been caught in the Dogger Bank. Closer to the research area artifacts of bone and antler were found[16].

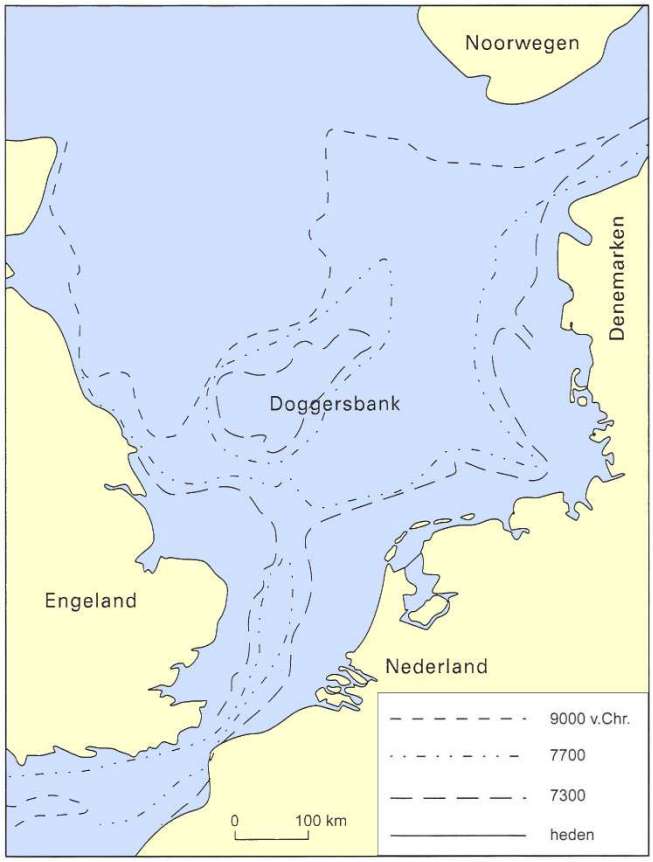

Figure 10. Reconstruction of the historical coast lines in the North Sea basin

Due to the sea level rise the ancient landscapes drowned. These landscapes are depicted through geophysical and geotechnical engineering. Recently, for example, on the basis of seismic data from the oil industry a prehistoric landscape was reconstructed near the east coast of England[17].

Shipping

The earliest evidence of shipping in the North Sea dates from the Bronze Age. Since then, there is an increase of shipping in the North Sea with a few well-documented historical peaks. During Roman times, the North Sea and in particular the Channel served as connecting bridge for the empire. From the Early and High Middle Ages new centers of power arose along the North Sea coast. Furthermore, the raids of the Vikings should also be mentioned in this context. From the late Middle Ages, the international trade and the shipbuilding industry developed so that the North Sea was a stepping stone for global shipping routes. In all periods, ships were lost at sea. Shipwrecks are the traces of the maritime past and this can be preserved under favorable storage conditions in sediment.

[15] Gaffney e.a. 2005.

[16] Louwe Kooijmans 1970.

[17] Project 'North sea paleo-landscapes' of the University of Birmingham

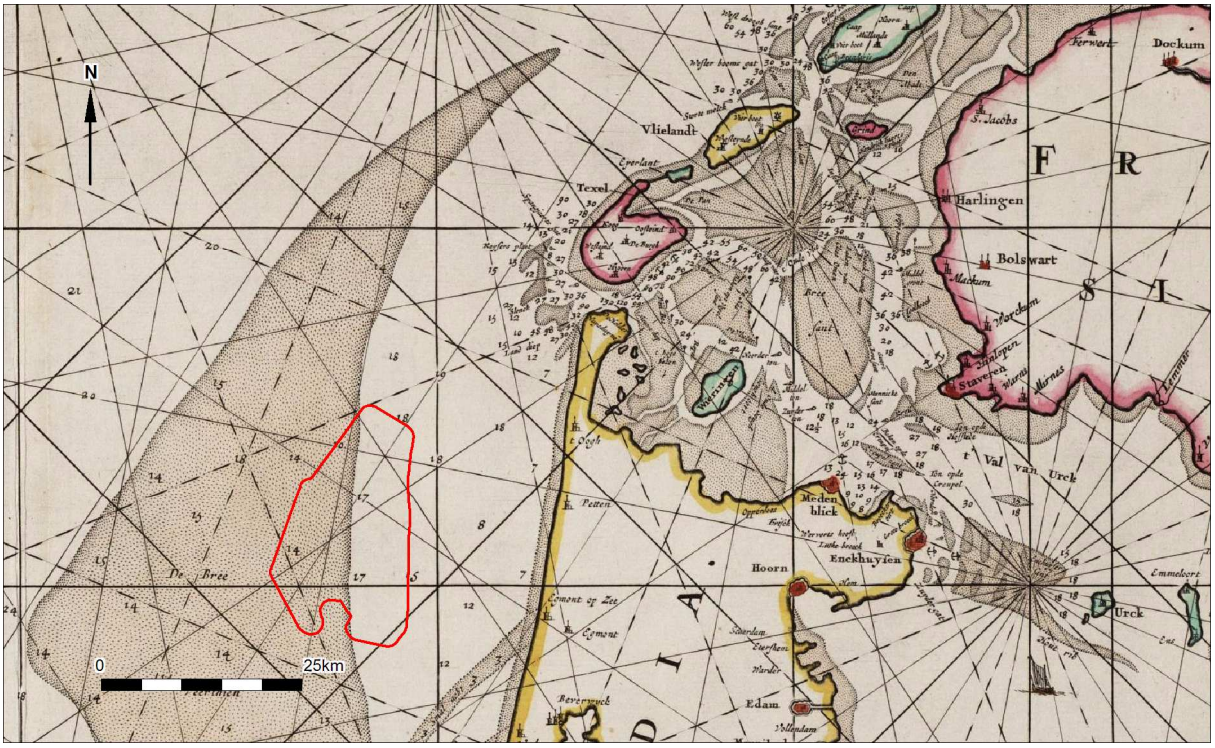

Figure 11. Research area on the historical map of 1675 (Pascaert de Wit, 1675)

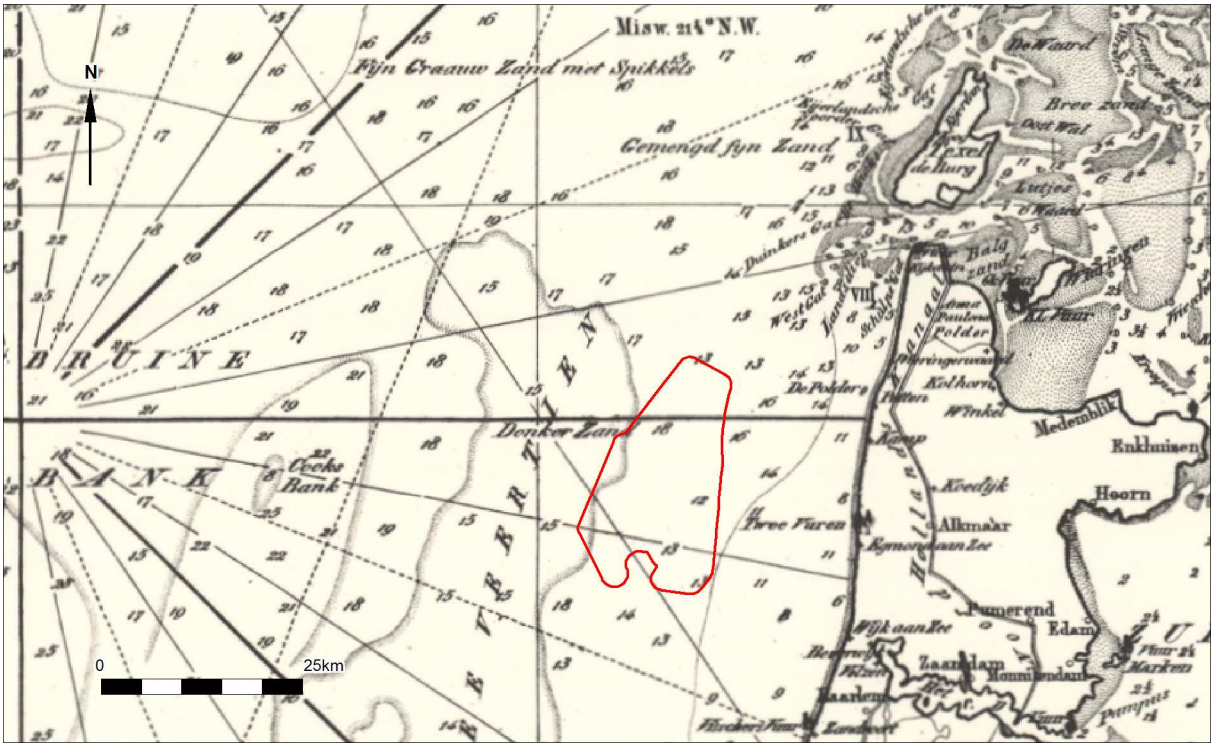

Figure 12. Research area on the historical map of 1852 (Jacob Swart, 1852)

Known disturbances of the seabed in the research area

In the past, parts of the seabed within the research have been disturbed by trenches and sand extraction. In general, parts of the area may have been disturbed by fishing nets and anchoring during cable-lay operations.

The majority of the cables crossing the area have been laid in a trench by ploughing or jetting. The initial depth of burial of these cables is unknown, but should be a minimum of 1 meter according to the environmental permits. It is however expected that the cables are laid at a depth of 2 meters up to a maximum of 5 meters below the seabed. This also applies to the pipelines in the area.

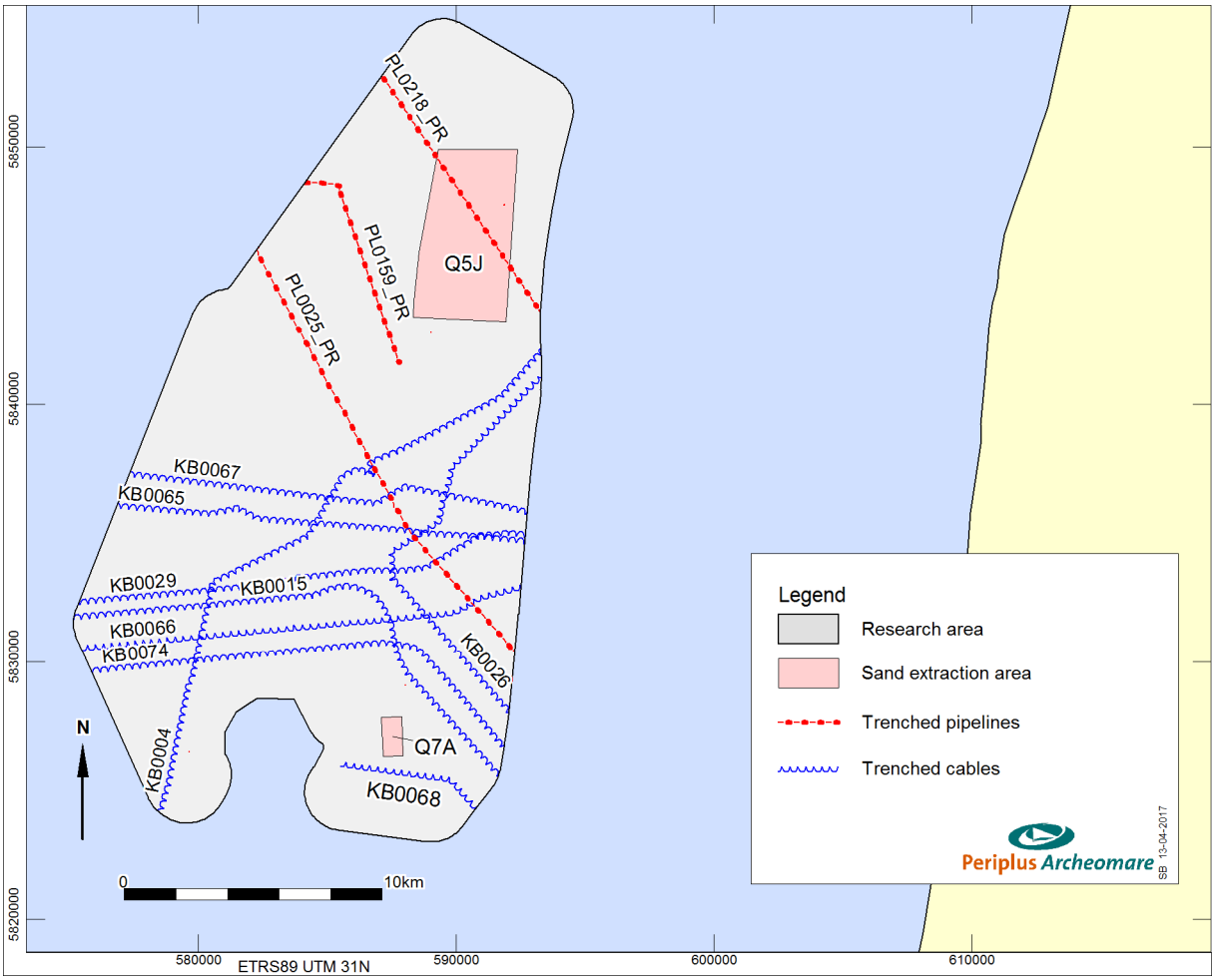

Figure 13. Known seabed disturbances within the research area

Name	Used up	Description	Status
Q5J	No	Area formerly known as Q5 Zeewaarts, has not been in production	Licensed 2015; reserve sand extraction for beach replenishment (Zwakke schakel Noord-Hollandse kust
Q7A	No	Commercial sand extraction	Licensed 2014 for commercial use

Table 4. Overview of sand extraction areas within the research area

Number	Trace	Type	Diameter	Trenched	Remark	Status
PL0218_PR	Q4-C to Q8-A	Gas	10 inch	Presumably	Buried	In use
PL0025_PR	Q1_Helm-AP	Oil	20 inch	unknown	-	In use
PL0159_PR	Q4-B to Q4-A	Gas	10 inch	Presumably	Burried	In use

Table 5. Overview of pipeline trenches within the research area

Number	Trace	Type	Installation	Status
KB0029	Lowesoft (GB) to Egmond (NL)	Fibre Optic	Trenched	In use
KB0004	Katwijk (NL) to Norden (D)	Fibre Optic	Trenched	In use
KB0065	Egmond (NL) to Lowesoft (GB)	Coax	Unknown	Abandoned
KB0067	Egmond (NL) to Winterton (GB)	Fibre Optic	Trenched	In use
KB0068	Wijk aan Zee to Q7-WP_Zuid	Copper Electra	Trenched	In use
KB0015	Beverwijk (NL) to Lowesoft (GB)	Fibre Optic	Trenched	In use
KB0026	Castricum (NL) to Sylt (DK)	Fibre Optic	Trenched	In use
KB0074	Castricum (NL) to Whitesand (GB)	Fibre Optic	Trenched	In use
KB0066	Veurne (B) to Egmond (NL)	Fibre Optic	Trenched	Abandoned

Table 6. Overview of cable trenches within the research area

3.5 Description of known archaeological values (LS04wb)

The former National Service for Archaeological Heritage (ROB, now Dutch Cultural Heritage Agency or RCE) in collaboration with Rijkswaterstaat and TNO NITG have developed a comprehensive archaeological map of the continental shelf based on geological and archaeological observations[18] (see figure 14).

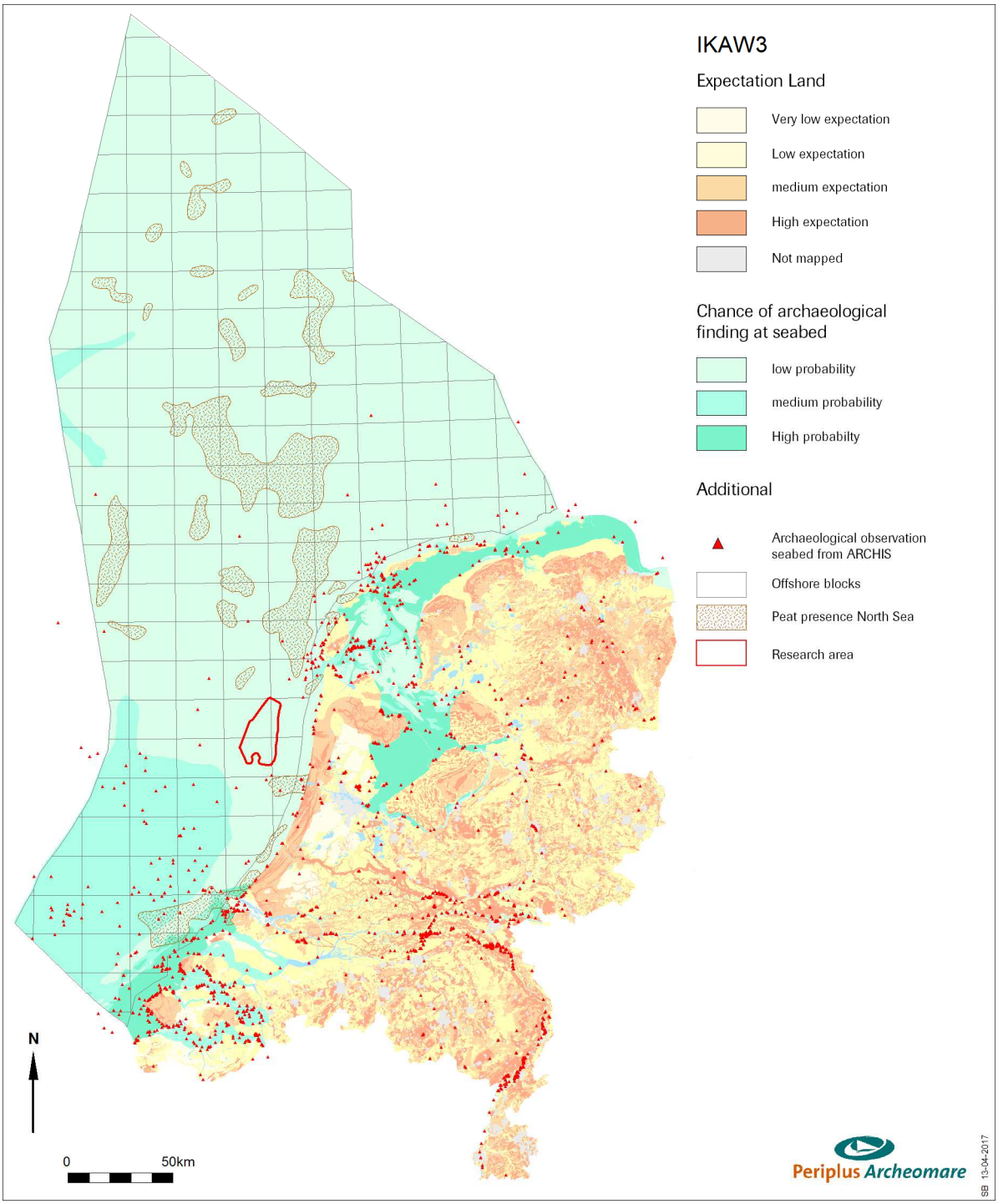

Figure 14. Overview indicative map of archaeological values (IKAW)

This global map will give the chance of presence of well-preserved shipwrecks (and often a ship's discovery of high archaeological value) for the Dutch part of the Continental Shelf. However, this map has a very limited use, partly due to the large scale of 1: 500,000. In addition, the degree of conservation is closely related to geology and

[18] IKAW 3e generatie, RCE 2008

morphology. The idea here is that in channel deposits or regions with soft sediment, a wreck quickly sinks into the seabed and therefore remains in good condition. In other areas with harder top sediments the chance of a find is not necessarily lower, but the chance to find a well-preserved ship with the cargo and equipment still intact is considerably less.

The map also indicates areas where peat and clay are preserved. This cover with clay / peat only refers to the possible location of Pleistocene deposits on / near the seabed. Where Holocene clay or peat is eroded Pleistocene layers with artifacts and fauna fossils may be present. The presence of early Holocene sediments could indicate the presence of a well preserved prehistoric landscape.

Research in the last decade has shown that the probability of encountering prehistoric residues in the North Sea is much greater than originally thought. The archaeological map for the Dutch continental shelf is therefore being revised. In 2016, an indicative model of the archaeological potential of the North Sea was published by Deltares.[19] A detail of this map is shown in figure 15. The expectancy for prehistoric remains is closely related to the lithostratigraphic units which are discussed and outlined in previous paragraphs.

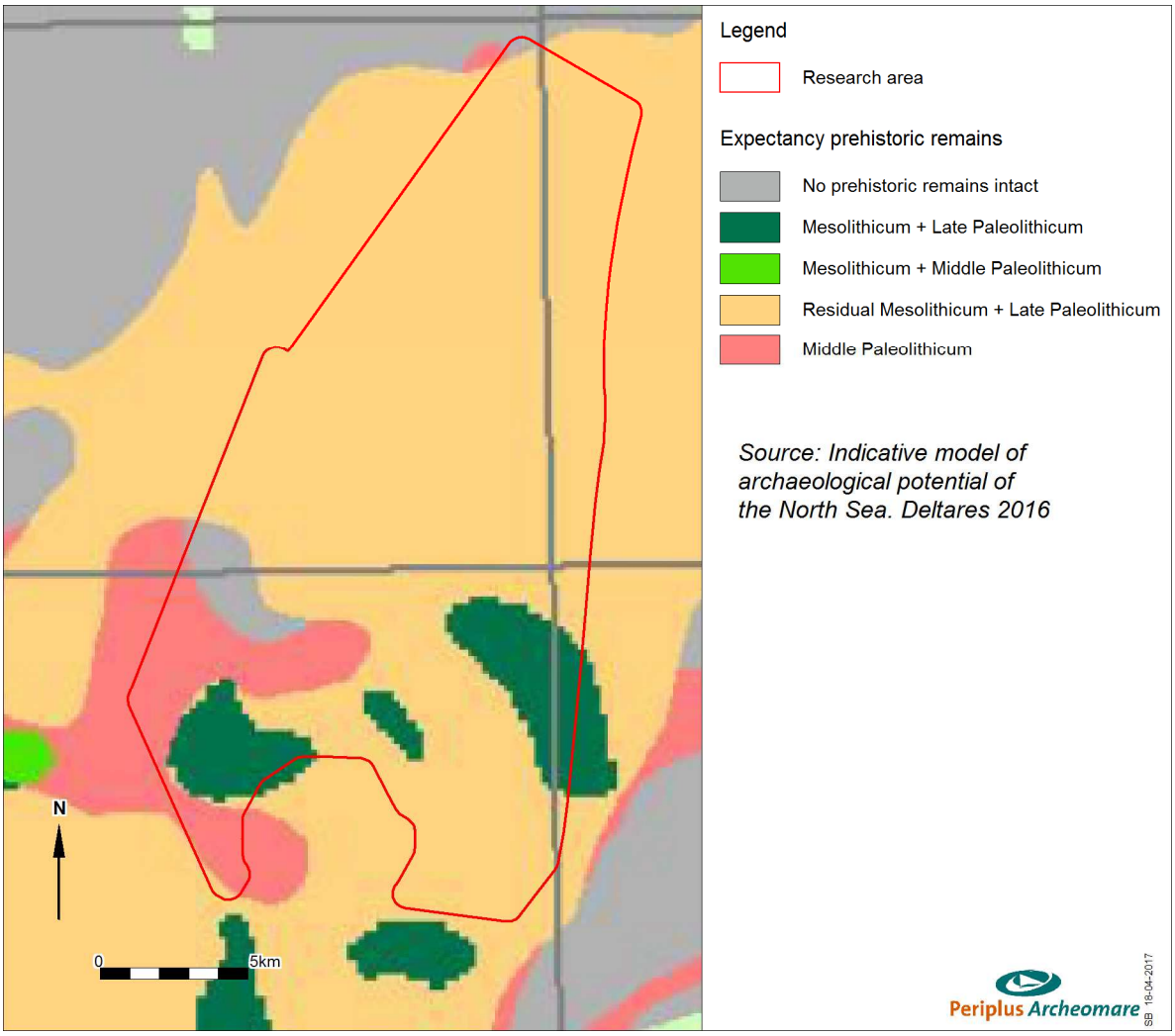

Figure 15. Expectancy of prehistoric remains

For instance the expectancy for Middle Paleolitic remains indicated in red coincides with the occurrence of the Kreftenheye Formation, the expectancy for residual Mesolithic and Late Paleolithic remains indicated in beige coincides with the occurrence of the Boxtel Formation and the expectancy for Mesolithic and Late Paleolithic remains indicated in dark green coincides with the Velsen Bed. It should however be stressed that figure 15 offers

[19] Vonhögen et al, 2016.

a two dimentional view. The Kreftenheye Formation is not limited to the area indicated in red but extends underneath the Boxtel Formation (beige) and Velsen bed (dark green). This means that Middle Paleolithic remains are to be expected in these areas. In central and northern parts of the area the Drente Formation including the Uitdam can occur beneath the Boxtel Formation. If not eroded by the deposition of marine sands of the Eem Formation at this level *in situ* Middle Paleolithic remains can be expected to.

Furthermore it is important to bear in mind that the occurrences and bounderies of the lithostratigraphic units mapped are based on a limited amount of geological data. The occurrences and bounderies should therefore not be considered definite, but an indication of the of what is to be expected in the area and a framework for further research.

Details research area

Figure 16 shows a detailed map of the research area and the officially known archaeological finds in the surrounding area. ARCHIS III is the official database of the National Cultural Heritage Agency in which all archaeological findings and observations in the Netherlands and territorial waters are stored. The database contains more than 85,000 underwater locations (mainly land-based) where archaeological observations have been made.

The onshore archaeological expectation is related to the geogenesis of North Holland. In prehistoric times the shoreline was intermitted by a fast inlet near Bergen aan Zee.[20] Behind the shoreline Bergen tidal basin developed with coastal dunes, branching tidal channels and kreeks, mud flats, tidal marshes and fens. From the hinterland the basin was fed with fresh water from the Vecht, Eem and smaller tributaries. Around 2100 BC the basin size diminished. In the Late Neolithic seasonal exploitation of levees and splay deposits took place. Pleistocene outcrops and creek ridges were exploited permanently. In the Bronse Age farmsteads arise on beach barriers and former tidal marsh and creek deposits. Numerous sites are known in the West Frisian area. Due to the presence of the Bergen inlet the Pleistocene deposits are relatively deep seated in the HKZ windfarm zone.

[20] Zijverden 2017.

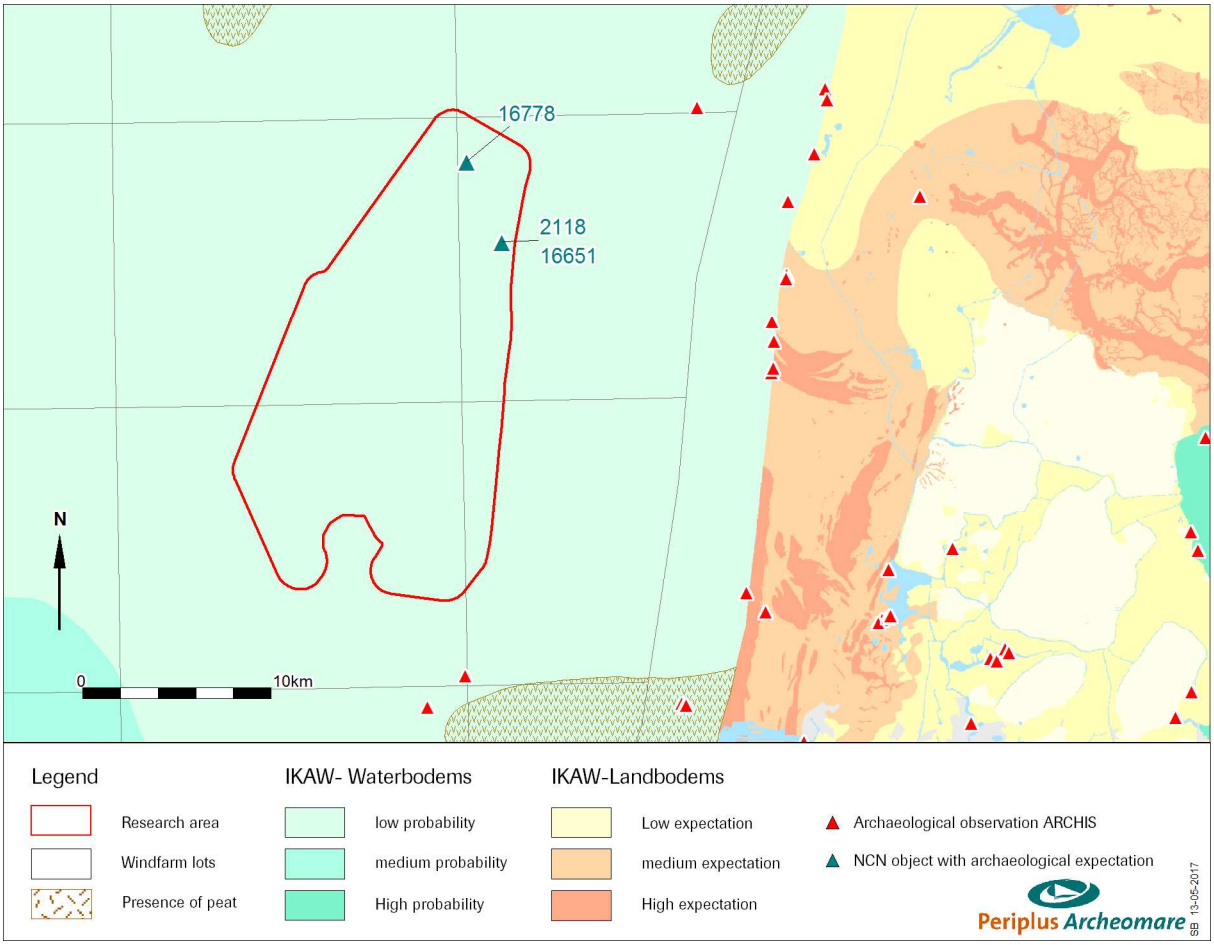

Figure 16. Detail indicative map of archaeological values (IKAW)

Within the plan area no archaeological sites are reported. During the geophysical survey for sand extraction area Q05[21] in 2013, three objects (two of which at one location) were classified as of potential archaeological value. The two locations with these three objects lay within the research area. These will be discussed in the next paragraphs.

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[22]. Remains are found on a regular basis by fishermen or during sand extraction or and beach protection projects. For example, parts of a B17 bomber were discovered south of the research area near Hoek van Holland in 2009. The figure below shows the known locations of plane wreck findings. Additional information for the research area is requested from the salvage officer from the Royal Netherlands Air Force[23], but no information is available at this moment.

[21] Van Lil, van den Brenk and Muis, 2013

[22] Dutch Federation of Aviation Archaeology

[23] Email Major A. Kappert

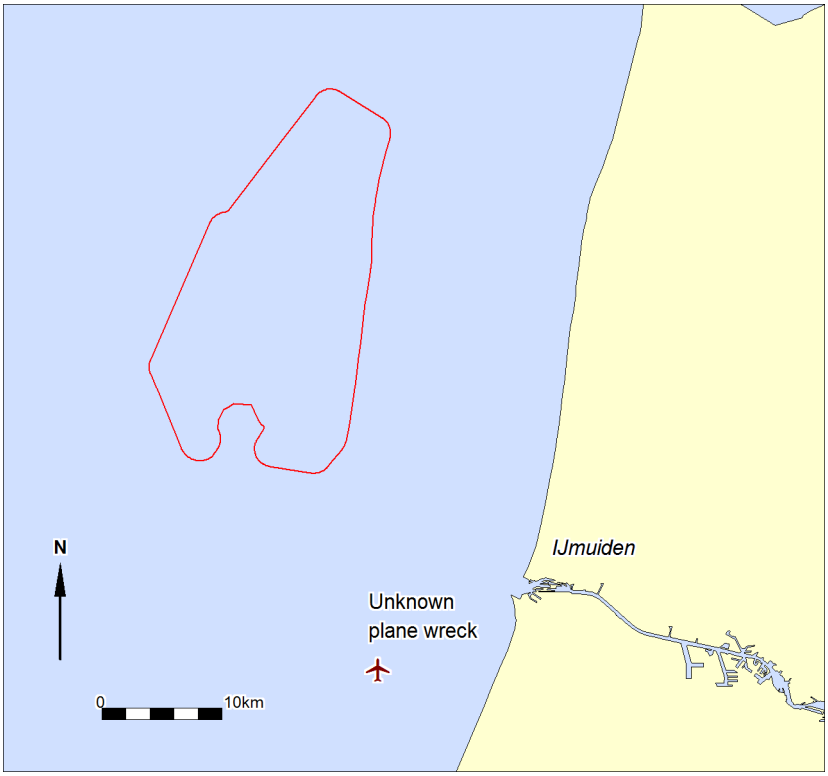

Figure 17. Known locations of plane wrecks in the vicinity or the research area

Shipwrecks

In general, when a sinking ship ends up on the seabed, the tidal currents will create scouring around the wreck, and bury it down to a level of a harder surface within the sedimentary sequence. The thicker the layer of loose material, the more the ship will be packaged therein and will be retained. Especially in areas where the sediments have a high clay content the wreck remains will be sealed and well preserved. In more sandy areas this effect is much smaller. Uncovered wooden parts may be effected by a naval shipworm (*Teredo Navalis*).

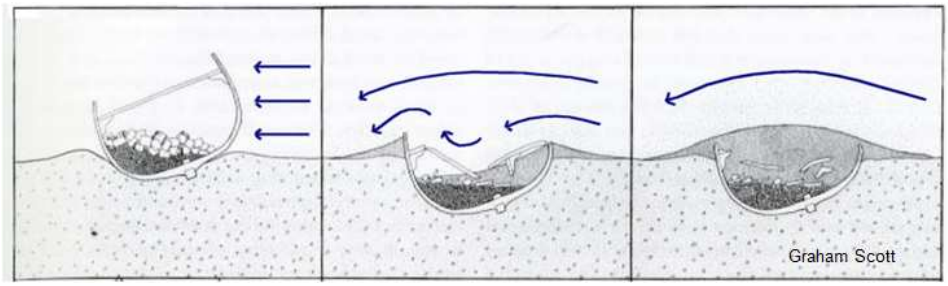

Figure 18. Example of wreck site formation (Graham Scott)

Known objects and shipwrecks

For a listing of known objects and shipwrecks within the research area, the united NCN database is consulted[24].

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)

Additional information of known wrecks and background information was retrieved from various sources and online databases on the Internet like wrecksite.eu and marhisdata.nl. From the various sources 244 known objects are present within the research area:

NCN type	Known
Shipwreck remains	14
Other (obstacle)	230
Total	**244**

Table 7. Observations of known objects

The map and tables on the next pages show all known observations in the research area.

[24] With permission of G. Poot, data manager Rijkswaterstaat Centrale Informatievoorziening

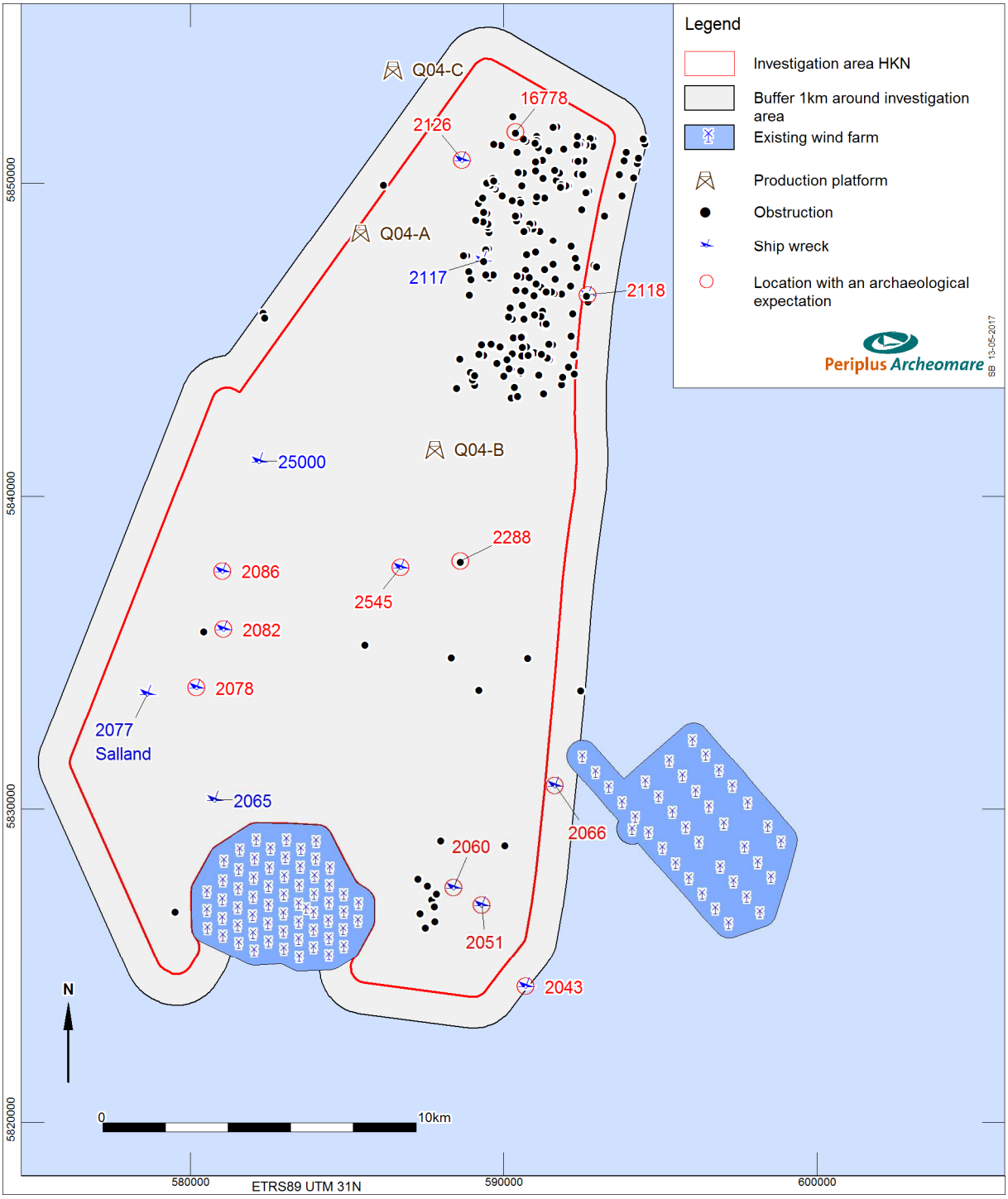

Figure 19. Overview of known objects and contacts in the research area

A total of 14 shipwrecks are known in the area. Four ship wrecks have been identified and have no archaeological value. For the remaining ten wrecks, 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.

NCN	DHY	Easting	Northing	Description	Arch. value
2043	2230	590712	5824349	Wreck; unknown; BDS 1452/2004	Unknown
2051	2241	589301	5826959	Wreck Eton; Buyskes HY01129; British cargo ship built 1890 sunk 25-08-1912	Unknown
2060	2251	588397	5827512	Wreck; unknown; HY 09223 Wreck is broken; partially covered with sand	Unknown
2065	2257	580767	5830306	Wreck; Fishing vessel, TX 24, sunk 29-05-1957 pos. acc. 20m	No
2066	2258	591639	5830773	Wreck; unknown; pos. acc. 20m; Buyskes HY01129	Unknown
2077	2270	578616	5833718	Wreck; unknown, pos. acc. 20m, 42.2x7.6m. Marhis: wreck of Salland, Dutch cargo vessel, sunk february 1953	No
2078	2271	580189	5833909	Wreck; unknown; pos. acc. 1000m; Buyskes HY00087 wreck not found	Unknown
2082	2275	581060	5835778	Wreck; unknown; pos. acc. 1000m; Buyskes HY00087 wreck not found	Unknown
2086	2279	581029	5837632	Wreck; unknown; pos. acc. 1000m; Buyskes HY00087 wreck not found	Unknown
2117	2312	589328	5847520	Wreck Sirabuen; Norwegian cargo vessel, built 1921, sunk 1956 after collision pos. acc. 20m; 43x11m;HY12322	No
2118	2313	592677	5846416	Wreck; pos. acc. 20m, 60x15m;HY12322	Unknown
2126	2321	588678	5850747	Wreck; unknown; pos. acc. 20m;HY10322	Unknown
2545	2990	586708	5837737	Wreck; unknown; 67.9m	Unknown
25000	42	582190	5841144	Former wreck Kugelbake SH 23 sunk 19-09-1989, wreck raised, remains may be present	No

Table 8. Overview of the known ship wrecks in the research area

One of the wrecks (NCN 2077, DHY 2270) has been identified as the *Salland*. This cargo vessel was built in 1951 and, loaded with China clay sunk during a major storm on Januari 29th, 1953. The wreck has no archaeological value, but may form an obstacle.

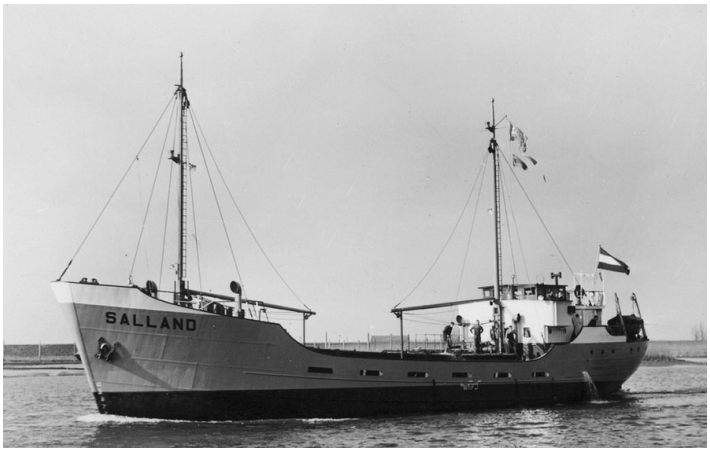

Figure 20. Photograph of the Salland in 1952 (source: marhisdata.nl)

During geophysical surveys for sand extraction area Q05 (2013)[25] and Q7A (2014)[26] several objects were mapped with side scan sonar. Within the sand extraction area Q05, two locations were classified with remains of possible archaeological value.

NCN 2118 & 16651 represents two objects laying 25 meters apart. The location is known at the Hydrographic Service as `Foul Ground, nlhono nr. 2313. NCN 2118 consists of an elongated toothed object with a length of 8 meters and a width of 2 meters, surrounded by several loose objects. These are probably the remains of a ship or a plane wreck. As long as no further details are known this location has given an archaeological expectation.

[25] Van Lil et al. 2013

[26] Van Lil et al. 2014

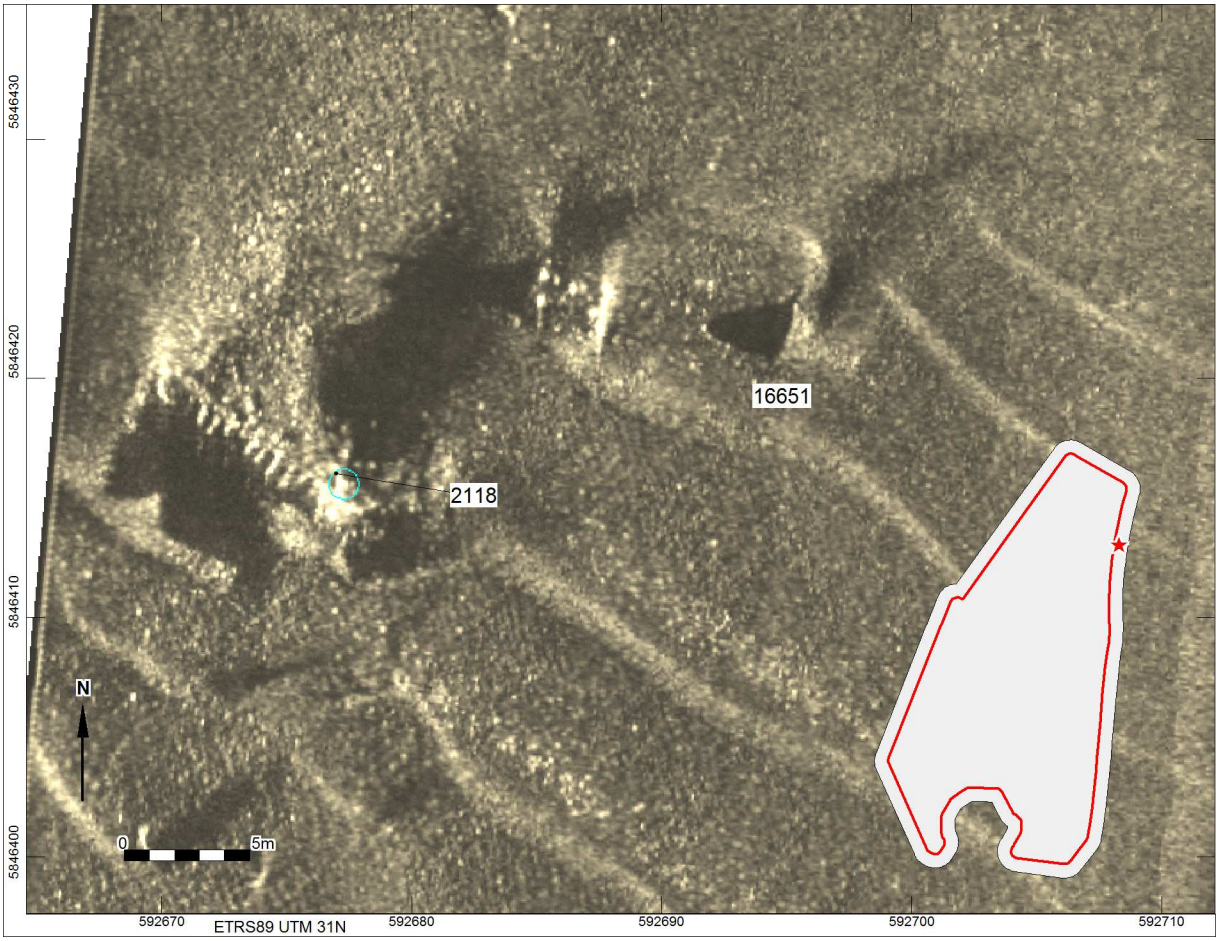

Figure 21. Sonar image of NCN 2118 and NCN 16651

At a second location, an unknown structure was found with side scan sonar (NCN 16778). This elongated structure has a length of 17.4 m and a width of 2.3 m. The nature of this structure is unknown, therefore this location has been given an archaeological expectation.

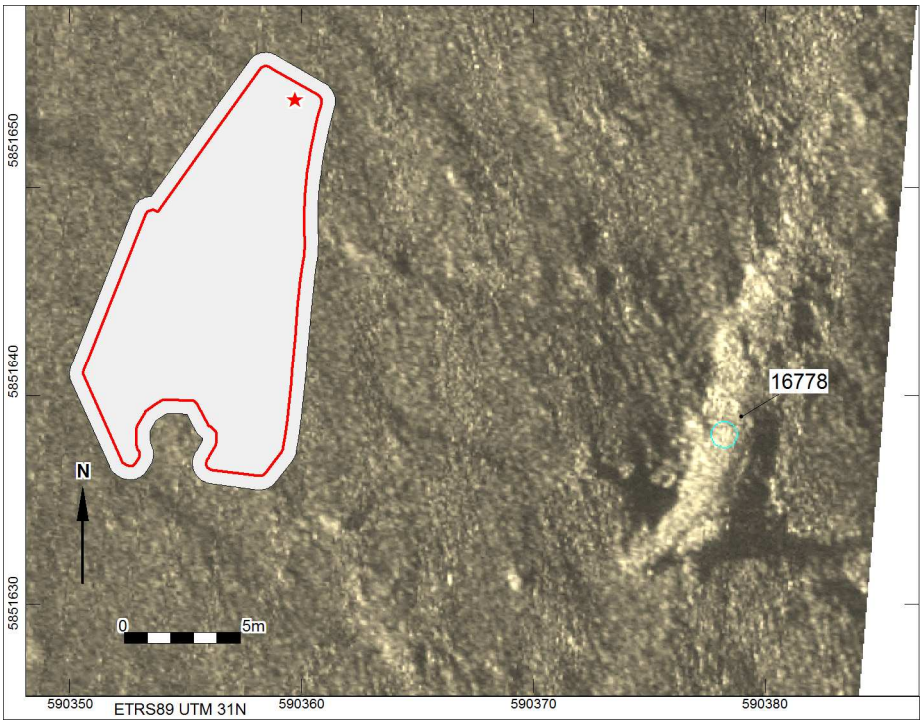

Figure 22. Sonar image of NCN 16778

NCN 2117 shows a complex of debris, covering an area of 40 x 20 meter. The location corresponds to the location of Hydrographic service nlhono 2312, the *Sirabuen.* This was a Norwegian cargo vessel sunk January 10th 1956 after a collision. The wreck has no archaeological value, but may form an obstacle.

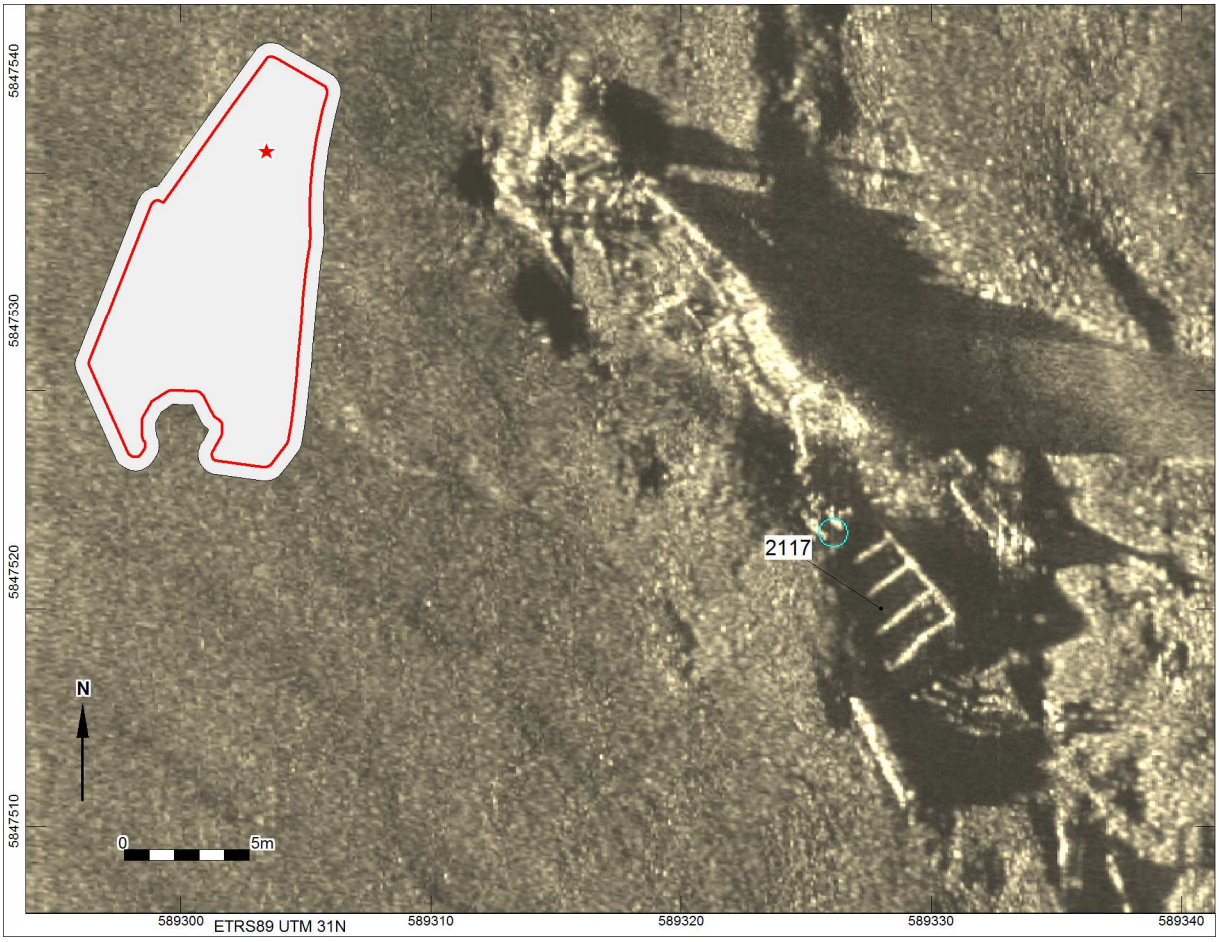

Figure 23. Sonar image of NCN 2117, the wreck remains of the Sirabuen

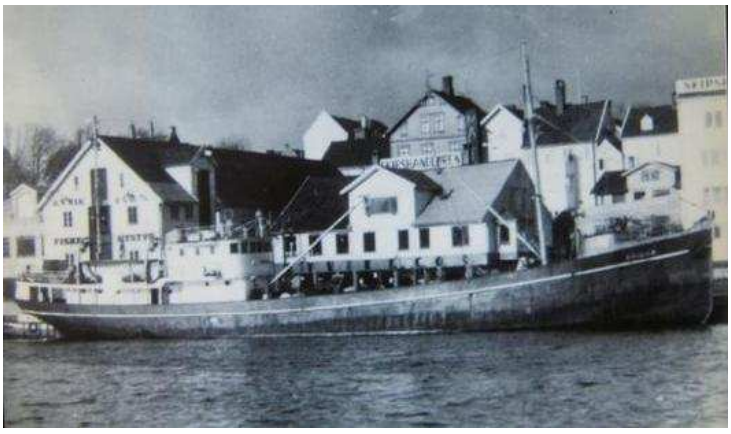

Figure 24. Photograph of the Sirabuen (www.wrecksite.eu)

At about 500 meters south of the wreck site an elongated object (NCN 16783) was found that is probably related to the wreck site. A similar object (NCN 16621) was found at 400 meters north of the wreck site.

Within sand extraction area Q7A, no objects with an archaeological expectation were found.

The table below lists the known objects and contacts with a potential archaeological value.

NCN	HY	Easting	Northing	Description
2043	2230	590712	5824349	Wreck; unknown; BDS 1452/2004
2051	2241	589301	5826959	Wreck Eton; Buyskes HY01129; British cargo ship built 1890 sunk 25-08-1912
2060	2251	588397	5827512	Wreck; unknown; HY 09223 Wreck is broken; partially covered with sand
2066	2258	591639	5830773	Wreck; unknown; pos.acc. 20m
2078	2271	580189	5833909	Wreck; unknown; pos.acc. 1000m
2082	2275	581060	5835778	Wreck; unknown; pos.acc. 1000m
2086	2279	581029	5837632	Wreck; unknown; pos.acc. 1000m
2118 16651	2313	592677	5846416	From Q05 survey; shipwreck remains 30x15x0.5 (SonarReg contacts 13590 & 13436)
2126	2321	588678	5850747	Wreck; unknown; pos.acc. 20m;HY10322
2288	2520	588628	5837944	Obstruction; HY 09223 Hr.Ms. Luymes. Wreck records MO100 and Wk 2520 merged. Total area wreck remains ca. 300 x 100 mtr.
2545	2990	586708	5837737	Wreck; unknown; 67.9m
16778	-	590379	5851639	From Q05 survey; unknown object or seabed disturbance, elongated structure 17.4x2.3x0.2m (SonarReg contact 13563)

Table 9. Overview of known objects with a potential archaeological value

Currently no further information is available regarding these objects. Further research is needed to determine the cultural-historical value.

The topic of Unexploded Ordnance has been described extensively in the UXO Desk Study of REASeuro[27]

A complete list of all 244 known wrecks and objects with descriptions within the research area is presented in appendix 3.

[27] Schuddinck en van den Berg, 2017

3.6 Specified archaeological expectation (LS05wb

Shipwrecks
The area has a high expectation for shipwrecks from all periods. A total of 14 shipwrecks are known in the area. Four ship wrecks have been identified and have no archaeological value. For the remaining 10 wrecks, 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.

During the geophysical survey for sand extraction areas Q05 and Q7A, which cover approximately 12 percent of the research area, two objects were classified as of possible archaeological value. Approximately 90 % of surface of area has not been investigated by detailed geophysical surveys. The area may contain more undiscovered shipwrecks or remains of shipwrecks.

Plane wrecks
The area has a high expectation for plane wrecks from the Second World War. Several sources are ambiguous about the number of aircraft still missing. It is at least hundreds[28]. One plane wreck site is known in the vicinity of the research area.

Prehistory
During the last ice ages the research area was exposed due to very low sea levels. In those times the landscape was occupied by hunters and gatherers. Therefore camps sites are to be expected in the top of Pleistocene formations. The archaeological expectation is discussed below by means of the geogenesis of the area and lithostratigraphic units present. As discussed in the section on ship wrecks, also for the Pleistocene landscape applies that our specific knowledge is limited, because major part of the area has not been investigated by detailed geophysical surveys or the analysis of high quality borehole samples.

Drente Formation
Within the Drente Formation remains of Neanderthaler sites can be expected. Of special interest are gradients within the prehistoric landscape such as the shores of lakes and riversides, which might have been used for the installation of camp sites. The presence of the Drente Formation in the area is uncertain. This also apllies for the depositional environment. Therefore it is not possible to specify the the expectancy for the Drente Formation in the area.

Eem Formation
The Eem Formation consists predominantly of marine sand which was deposited in the Eem Sea during the Eemien.[29] Within the sandy Eem deposits no archaeological remains are expected. The Brown Bank Member at the top of the Eem Formation consists of lacustrine fresh water and coastal marine brackish water deposits of silty clay. At the end of the Eemien the sea regressed and the Brown Bank clays were deposited. This layer can contain artifacts from or remains of Neanderthaler who in this period populated the Netherlands and the North Sea area. Little archaeological research has been done into this often deep-seated stratigraphical unit. The occurrence of the Brown Bank unit within the area has not been proven, but as with the other units shallow seismic research can clarify if this unit is present. The top of the Eem Formation is expected at depths varying between 6 and 10 meters below the seabed.

Kreftenheye Formation
The braided river Rhine ran through the area depositing poorly sorted sand and gravel. The expectancy for this unit comprises primaraly reworked lost hunting gear or dumped objects, though in isolated parts within the unit *in situ* remains of camp sites cannot fully be excluded. The top of the Kreftenheye Formation is expected at depths varying between 0 and 10 meters below the seabed.

[28] Dutch Federation of Aviation Archaeology

[29] Eemien: interglacial which lasted from 130.000 till 115.000 years ago.

Boxtel Formation

During very cold and dry conditions at the end of the Weichselien the landscape was covered by aaeolian sands. The cover sand landscape with alternating dunes, ridges and valleys which formed at the end of the last ice age is known to be occupied intensively in prehistoric times. Also river dunes formed which formed within and alongside the Rhine valley are known to contain many prehistoric sites. River dunes (Delwijnen Meber) and cover sands (Wierden Member) are part of the Boxtel Formation. The Boxtel Formation is mapped in major part of the area. The area in which the Boxtel Formation is present can be outlined in more detail by the execution of subbottom profiler survey and by the collection of undisturbed borehole samples. Also the integrity of the top of this unit can be judged in this way. Levels of archaeological interest are paleosols within the sandy sediments. Known paleosols are the 'Usselo' soil formed during the Allerød and a podzol formed in the Early Holocene.[30]

If the Boxtel Formation is covered by the Basal Peat Bed or the Velsen Bed the integrity and conservation of archaeological remains is expected to be high. Considering our limited knowledge of prehistoric sites in the North Sea area such well preserved finds would *a priori* be worth preserving. Archaeological markers consist of flint and bone artifacts, burnt nuts and seeds and charcoal. Zones of interest are locations where the top of the cover sands and river dunes (if present) are not eroded. The presence of the Basal Peat Bed and Velsen Bed indicate that underlying Boxtel Formation and possible archaeological remains herein are intact. The Basal Peat Bed and Velsen Bed can also contain archeological remains. These remains comprise of attributes used for hunting which because of the low levels of oxygen and wet conditions might be well preserved.

The top of the Boxtel Formation is expected at depths varying between 0 and 10 meters below the seabed.

[30] Allerød: interstadial which lasted from 14.000 till 13.000 years ago.

4 Synthesis

Based on the results of de data analysis the research questions are answered.

- *Are there any known archaeological values present within the research area? If so, what is the nature, extent (depth) location and dating of these sites?*
  No proven archaeological values are known within the research area. During the geophysical survey for sand extraction area Q05, two locations were classified with a possible archaeological expectation, but detailed information is not available. A total of 14 shipwrecks are reported in the NCN database. Four wrecks have been identified and have no archaeological value. For the remaining ten wrecks additional information is not available. The archaeological value of these wrecks has yet to be determined.
- *Are there, in addition to any known values, archaeological remains be expected? If so, what is the nature, extent (depth) location and date of the expected archaeological remains?*
  During previous geophysical surveys in the area, two locations with possible archaeological values were found in the Q05 sand extraction area. More than 90 % of surface of the wind farm area has not been investigated by detailed geophysical surveys. The area may contain more undiscovered shipwrecks, remains of shipwrecks or remains of airplanes from the Second World War. Apart from wrecks archaeological remains of Paleolithic and Mesolithic camp sites of hunters and gatherers can be encountered. These sites are characterized by the presence of flint and bone artifacts, burnt nuts and seeds, charcoal and hunting gear.
- *Can the proposed activities in the wind farm zones affect known or expected archaeological values? If so, can an impact on archaeological assets be prevented or restricted by planning adaptation?*
  This question can only be answered once the area has been geophysically investigated and when the cultural historic value of the objects in the area has been determined.
- *If the archaeological values cannot be saved:*
  - *What kind of further research is needed to determine the presence of archaeological values and their size, location, type and date to be determined enough to come to a selection decision?*
    If archaeological values are present, additional dive research is required to investigate the objects in order to define a selection decision. (in Dutch: KNA onderwater verkennend/ waarderend onderzoek, see also appendix 1.
  - *What are the possible effects of the installation of offshore wind farms on the areas with specific archaeological interest?*
    Cable-lay operations can be conducted by means of trenching. Present archaeological values can be affected by seabed disturbing activities situated on or close to the seabed. In addiction the installation of wind turbines will have an effect on the morphology of the seabed and might affect the prehistoric landscape. They will have an effect on tidal currents creating scouring, which might uncover buried values and expose them to the erosional seabed surface.
- *What are the possibilities to mitigate the disturbance of areas with specific archaeological interest as a result of installing offshore wind farms?*
  In general, a buffer or safety zone of 100 meters around an archaeological object or an object with an archaeological expectation is to be defined in which seabed disturbing activities are not allowed.[31] If additional research shows that the object has no archaeological value, the location and the buffer zone can be omitted.
- *Should further investigations be carried out from archaeological point of view and what are the recommendations on the scope and specifications of these investigations?*
  Additional research in the form of a geophysical survey is standard in the process of archaeological investigations. (in Dutch: *Inventariserend veldonderzoek opwaterfase*). The scope and specifications for this geophysical survey are to be recorded in a mandatory Program of Requirements (PvE). Typical requirements include restrictions about the maximum range and minimum frequency of the side scan sonar, survey speed and line spacing.

[31] Beleidsregels ontgrondingen in Rijkswateren, see http://wetten.overheid.nl/BWBR0028498/

- *What are the requirements for any activity carried out in the wind farm area (investigations or monitoring activities, installation activities, operational activities) that could have an effect on archaeological aspects in the wind farm area?*
  In general, a buffer or safety zone of 100 meters around an archaeological object is to be defined in which no activities such as trenching or anchoring are allowed. This applies only for objects with an archaeological expectation. If additional research shows that the object has no archaeological value, the location and the buffer zone can be omitted, and the objects may be removed during a debris clearance campaign.
  Additional prospection will clarify if it is feasible to keep the depth of the cables above possible archaeological levels.

  What is the expectation of the physical quality of possible archaeological sites and objects?
  The physical quality of wreck sites is expected to be high in case these wrecks are covered with sediments. If wooden ship wrecks are exposed at the seafloor biological deterioration by the naval shipworm could result in a lowering of the level of preservation. Moreover these wrecks are subject to demolishment by anchors and fishing nets which will result in a lowered integrity of the wreck site.

- *Which lithostratigraphic units can be determined and what is their spatial distribution (both horizontal and vertical)?*
  The following units have been determined:

Unit	Below-seabed	Occurrence	Remark
Southern Bight Formation - Bligh Bank Member	0	Total area	Mobile layer, seabed. Medium to poorly sorted, fine to coarse sand, carbonate and shell-rich, sparse clay and silt laminae, locally with gravel
Naaldwijk Formation - Wormer Member - Bergen Bed and - Velsen Bed	0 - 8	Southeastern part	clay, locally on top of peat, some shell remains
Boxtel Formation - Wierden Member - Delwijnen Member	0 - 10	Eastern part	Very fine to coarse sands, locally with thin layers of fine gravel
Kreftenheye Formation	0 - 10	Southern part	Fine to coarse, poorly sorted sands, with gravel, shells, wood fragments, clay pebbles.
Eem Formation - Brown Bank Member	6 – 10	Southeastern part; possibly also in the middle and northern part of the area.	Top and bottom of formation uncertain. Fine to medium coarse sand, silt and silty sand, with shells and locally gravel and mud.
Drente Formation - Gieten Member - Uitdam Member	?	Northern part	Moraine comprising very poorly sorted boulder clay and boulder sand (Gieten); layered alternation of fine sand, silt and clay, varves (Uitdam); occurrence uncertain

Table 10. Different lithostratigraphic units with in the area of interest

- *What are the archaeological levels within the lithostratigraphic sequence?*

Unit	Archaeological remains	In situ
Bligh Bank Member	reworked flint and bone artifacts	no
Velsen Bed	lost objects, dumps	yes
Basal Peat Bed	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 Formation	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
Drente Formation - Gieten Member - Uitdam Member	camps sites Neanderthaler; flint artifacts	yes

Table 11. Different archaeological levels within the lithostratigraphic units

- *Is it possible to define zones for windfarms where the (buried) prehistoric landscape is eroded or intact? Are the expected lithostratigraphic boundaries erosive or non-erosive?*
  No, the data available do not contain information from which can be deduced if the (buried) prehistoric landscape is intact. However, the major unit (Boxtel Formation) is expected to contain *in situ* remains of prehistoric settlements occurs at shallow depths. The chance that these sandy sediments and the archaeological levels herein are eroded by the covering Bligh Bank Member is considerable. Well preserved valuable sites however are to be expected in areas where the Boxtel Formation is covered by the Basal Peat Bed or the velsen Bed. A subbottom profiling survey in combination with borehole sampling sampling could result in the information needed to map the occurrence of the Basal Peat Bed and/or the Velsen Bed and provide with information on the zones where the prehistoric landscape is expected to be intact.

- *If so, will these zones be affected by the work envisaged?*
  If the archaeological levels within the Kreftenheye Formation, Boxtel Formation and Basal Peat Bed are intact, these levels - considering their occurrence close to the seabed – will be affected by work envisaged. After installation scouring in the vicinity of the monopiles might affect archaeological levels. Geological research comprising a combination of geophysical research, borehole sampling, CPT's and the analysis of known geological data is necessary to provide the information needed to map the Early Prehistoric landscape including the integrity of archaeological levels. The outcome of this geological investigation is used to refine the model for the expected archaeological remains (wrecks of ships and planes and prehistoric camp sites) in the area.

- *Could human activities have led to a disturbance of the seabed and archaeological remains therein?*
  Yes. In the past, several cables were trenched in the area (general up to one meter below the seabed), and sand has been extracted from sand extraction areas. Furthermore, fishing activities using trawls may have damaged archaeological remains at the seabed surface.

- *What is the expected intrinsic quality in terms of rarity, research potential, group value and representativeness of the areas with specific archaeological interest?*
  This question can only be answered when the cultural historic value of the objects in the area has been determined. In the process of valuation of archaeological sites the physical quality in terms of integrity and preservation of those sites shall be assessed first (see answer to question below). At this stage no archaeological sites are known in the area and the archaeological expectancy model has to be refined. Therefore, additional research is required. According to the Dutch archaeological management procedure (Dutch: 'AMZ Cycle') this subsequent steps shall be taken assess the occurrence and value of archaeological in the area. A description and flow chart of the AMZ Cycle is included as Appendix 1. The first step, an archaeological desk study, has been carried out. The next step is an inventory field research. For the Hollandse Kust Noord area it is advised to carry out a geophysical survey by means of sidescan sonar, multibeam echosounder, subbottom profilere and magnetometer and a geotechnical works including borehole sampling and cone penetration testing.

- *What is the expected physical quality in terms of integrity and preservation of the areas with specific archaeological interest?*
  The physical quality of prehistoric settlements in the North Sea area is to a large extent dependent on the integrity of archaeological levels. The chance that these levels have deteriorated due to erosion or human activities is considerable. On the other hand archaeological remains are expected to be well-preserved under water. Therefore if the archaeological levels have not been altered by natural or human causes, prehistoric settlements of high physical quality are to be expected. As stated in the answers to previous questions no sites are known in the area yet and additional research is needed to refine the model of the expectancy for archeological remains to occur in the area. The refinement of this model of archaeological expectancy includes the context and as such the physical quality of the remains expected.

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5 Summary and advice

Within the investigated area of the wind farm zones there is a high expectation for the presence of (remains of) ship wrecks and WWII plane wrecks. Locally *in situ* remains of Paleolithic and Early Mesolithic camp sites might be present.

Parts of the research area have been investigated by geophysical surveys in the past. During the geophysical survey for sand extraction area Q05, two locations were classified with a possible archaeological expectation, but no detailed information is currently available

Over 90 % of surface of the wind farm area has not been investigated by detailed geophysical surveys. The area may contain more undiscovered shipwrecks or remains of shipwrecks.

Shipwrecks
A total of 14 shipwrecks are known in the area. Four ship wrecks have been identified and have no archaeological value. For the remaining 10 wrecks, 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, but is at least hundreds. Remains are found on a regular base by fishermen or during sand extraction. In the vicinity of the research area, one locations of a plane wreck is known. It is quite possible to expect plane wrecks within the research area.

Prehistory
Remains of prehistoric camp sites are expected *in situ* in cover sand dunes and ridges (Wierden Member) and river dunes (Delwijnen Member) provided these units are un-eroded. Within the Basal Peat Bed and Velsen Bed well-preserved lost objects and dumps can be encountered. The archaeological levels of interest located under a cover of the Bligh Bank Member. Remains of Neanderthaler camp sites can be expected within lacustrine clays of the Brown Bank Member and (fluvio)glacial deposits of the Uitdam Member, if these units are in fact present in the area.

At this stage little is known about the integrity of the Pleistocene landscape. The Pleistocene units are encountered at shallow depths. Erosion of these units and archaeological remains therein therefore seems likely. Locally the Basal Peat Bed and/or Velsen Bed might have protected the Pleistocene landscape against erosion. By means of subbottom profiling in combination with analysis of borehole samples the Basal Peat Bed and Velsen 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. At this stage focus should therefore not be put on tracing prehistoric camp sites but on a pragmatic employment of geophysical and geotechnical techniques in order to obtain a better insight in (the integrity of) the Pleistocene landscape. The insights gained shall be used to a) refine the archaeological expectancy model and b) allocate areas with a high expectancy for *in situ* prehistoric remains.

In accordance with the AMZ cycle it is advised to conduct a field investigation (in Dutch '*Inventariserend veldonderzoek opwaterfase*') in order to:

- Map the locations of known wreck sites in great detail;
- Make an inventory for the parts of the area which have not been covered in previous surveys.

In general, similar investigations carried out in the past consist of a geophysical survey with *side scan sonar*, *magnetometer* and *subbottom profiler*. The resulting data should be assessed after the general processing, interpretation and reporting has been performed by the survey contractor.

Based on the processed seismic data the survey contractor will advice on the borehole sample locations to acquire the information on soil parameters needed for construction purposes. In order to meet the goals set for this stage of archaeological research, which comprises a refinement of the archaeological expectancy model and allocation of areas with a high archaeological expectancy, it is adviced to consult with the archaeological contractor and the RCE in the determination of the sample locations. Of course the 'archaeological' sample locations should fit in the program of data acquisition for engineering purposes, which will be the primary objective of the borehole sampling.

The archaeological assessment of the data has to be conducted by a geophysical specialist (KNA prospector Waterbodems). The data quality from the surveys needs to match the demands for this archaeological assessment. To ensure compatibility between the site investigation and the required quality for this assessment it is recommended to define a Program of Requirements (In Dutch: '*Programma van Eisen*') in accordance with the 'KNA' (the Dutch quality standards for archeological research), to be authorized by the competent authority.

During the installation of the wind turbines and construction of the cables archaeological remains may be encountered that were fully covered by sediment or not identified as archaeological remains during the geophysical survey. In accordance with the Malta convention incorporated in the Erfgoedwet (2016) it is required to report those findings to the competent authority. This notification for archaeological finds should be included in the specifications or scope of work.

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Glossary and abbreviations

Terminology	Description
AMZ	Archeologische Monumenten Zorg
CPT	Cone penetration test
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 (Programma van Eisen)
RCE	Rijksdienst voor het Cultureel Erfgoed
ROV	Remotely Operated Vehicle
Side scan sonar	Acoustic instrument that registers the strength 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 sub surface.
Trenching	Construction of a trench for the purpose of burying a cable or pipeline
Vibrocore	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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Atlases and Maps

- GeoTOP-model Laag van Wijchen en Hollandveen Laagpakket
- Globale Archeologische Kaart van het Continentale Plat
- Noordzeeatlas

Sources from the Internet

- Dienst der Hydrografie (www.hydro.nl)
- Dutch Federation of Aviation Archaeology (www.nfla.nl)
- Geologische Dienst Nederland - Data Informatie Nederlandse Ondergrond (www.dinoloket.nl)
- Noordzeeloket (www.noordzeeloket.nl)
- North sea paleolandscapes, University of Birmingham (http://www.iaa.bham.ac.uk)
- Olie en Gasportaal (www.nlog.nl)
- Stichting Aircraft recovery Group 40-45 (http://www.arg1940-1945.nl)
- Stichting Infrastructuur Kwaliteitsborging Bodembeheer (SIKB.nl)
- Stichting Maritiem Historische Databank (http://www.marhisdata.nl/)

Various sources

- Archis III, archeologische database Rijksdienst voor het Cultureel Erfgoed
- Databases Periplus Archeomare
- KNA Waterbodems 4.0
- Nationaal Contactnummer Nederland (NCN)
- SonarReg92, objectendatabase Rijkswaterstaat Noordzee en Delta

Appendix 1. Phases of maritime archaeological research

The Dutch Quality Standard for Archaeology (KNA Waterbodems, version 4.0) describes all procedures and requirements for the archaeological research process. 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 archeology, 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 archeological 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:

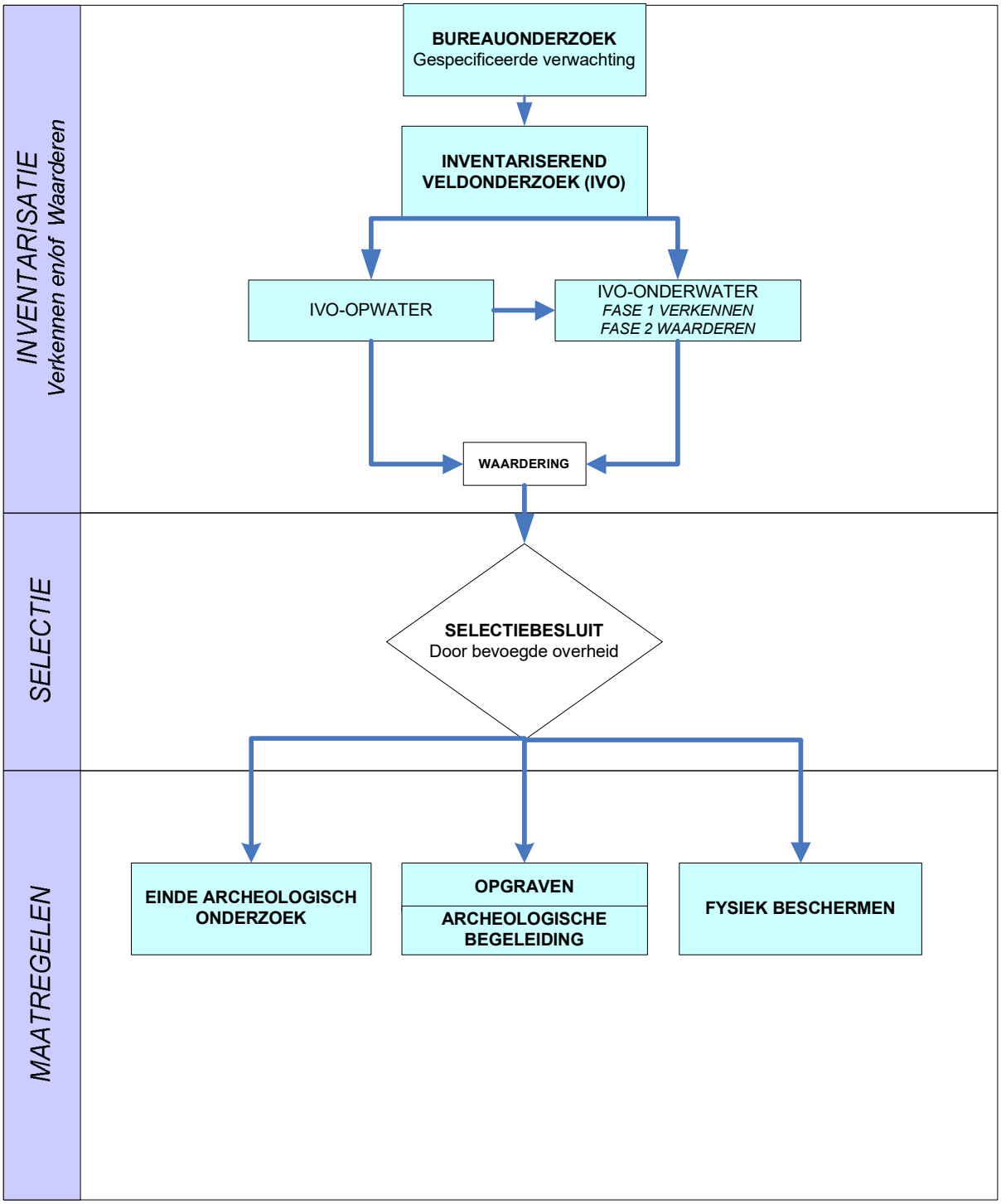
4. **Appreciative field research (onderwaterfase waarderend)**
   The archaeological remains at the site are thoroughly investigated and mapped by a specialized archaeological diving team and samples are collected for additional research. Then a decision will be made whether the archaeological remains 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 archeological objects. The figure on the next page shows these moments schematically.

Schematic overview KNA Waterbodems version 4.0

(in Dutch)



Appendix 2. Archaeological and geological periods and time scale

CHRONOSTRATIGRAFIE				ARCHEOLOGISCHE PERIODE				
SERIE	ETAGE - CHRONOZONE		TIJD	TIJDPERK				DATERING
Holoceen	**Laat Subatlanticum**		**1150 n. Chr**					
	Vroeg Subatlanticum		0	Nieuwe tijd			C	1850
			450 v. Chr				B	1650
	Subboreaal		3700				A	1500
	Atlanticum		7300	Middeleeuwen	Laat		B	1250
	Boreaal		8700				A	1050
	Preboreaal		9700		Vroeg		D	900
Pleistoceen	Weichselien	Laat Glaciaal	Jonge Dryas				C	725
			Allerød				B	525
			Oude Dryas				A	450
			Bølling	Romeinse tijd			Laat	270
		Pleniglaciaal L					Midden	70 n. Chr.
			Late Glacial Max				Vroeg	15 v. Chr.
			Denekamp	Prehistorie	Metaaltijden	IJzertijd	Laat	250
		Pleniglaciaal M	Hengelo				Midden	500
							Vroeg	800
		Pleniglaciaal V	Moershoofd			Bronstijd	Laat	1100
							Midden	1800
							Vroeg	2000
		Vroeg Glaciaal	Odderade		Steentijd	Neolithicum	Laat	2850
							Midden	4200
			Brørup				Vroeg	4900/5300
						Mesolithicum	Laat	6450
			Amersfoort				Midden	8640
							Vroeg	9700
			114.000			Paleolithicum	Laat B	12.500
	Eemien		126.000				Jong	16.000
	Saalien		236.000				Jong A	35.000
	Oostermeer		241.000				Midden	250.000
	onbenoemd		322.000					
	Belvédère		336.000				Oud	
	onbenoemd		384.000					
	Holsteinien		416.000					
	Elsterien		463.000					

Appendix 3. Listing of all known objects within the research area.

Locations with a possible archaeological value are displayed in red.

			ETRS89 UTM31N			
NCN	**SR92**	**DHY**	**Easting**	**Northing**	**Type**	**Description**
2043	-	2230	590712	5824349	Wreck	Wreck; unknown; BDS 1452/2004
2051	-	2241	589301	5826959	Wreck	Wreck Eton; Buyskes HY01129; British cargo ship built 1890 sunk 25-08-1912
2060	-	2251	588397	5827512	Wreck	Wreck; unknown; HY 09223 Wreck is broken; partially covered with sand
2065	-	2257	580767	5830306	Wreck	Wreck; TX 24, fishing vessel, sunk 29-05-1957, pos. acc. 20m
2066	-	2258	591639	5830773	Wreck	Wreck; unknown; pos. acc. 20m; Buyskes HY01129
2077	-	2270	578616	5833718	Wreck	Wreck; unknown, pos. acc. 20m, 42.2x7.6m. Marhis: wreck of Salland, Dutch cargo vessel, sunk february 1953
2078	-	2271	580189	5833909	Wreck	Wreck; unknown; pos. acc. 1000m; Buyskes HY00087 wreck not found
2082	-	2275	581060	5835778	Wreck	Wreck; unknown; pos. acc. 1000m; Buyskes HY00087 wreck not found
2086	-	2279	581029	5837632	Wreck	Wreck; unknown; pos. acc. 1000m; Buyskes HY00087 wreck not found
2117	13579	2312	589328	5847520	Wreck	Wreck Sirabuen; Norwegian cargo vessel, built 1921, sunk 1956 after colission pos. acc. 20m; 43x11m;HY12322
2118	13590	2313	592677	5846416	Wreck	Wreck; pos. acc. 20m, 60x15m;HY12322
2126	-	2321	588678	5850747	Wreck	Wreck; unknown; pos. acc. 20m;HY10322
2288	-	2520	588628	5837944	Obstruction	Obstruction; HY 09223 Hr.Ms. Luymes. Wrakkenbladen van MO100 en Wk 2520 samengevoegd. Total area wreck remains ca. 300 x 100 mtr.
2545	-	2990	586708	5837737	Wreck	Wreck; unknown; 67.9m
2654	-	3120	588336	5834898	Obstruction	Obstruction; pipeline crossing. Total area on sea floor 56 x 12 mtr
2655	-	3121	589216	5833863	Obstruction	Obstruction; HrMs Urk\Identification: Shell bank
2661	-	3129	586174	5849981	Obstruction	Obstruction; HY12322
427	1688	3412	590037	5828883	Obstruction	Obstruction; unknown; pos. acc. 1000m
14253	11062	-	589195	5849400	Obstruction	Anchor with chain 55x0x0m
16594	13379	-	593227	5848990	Obstruction	Possible cable or chain 16.7x0x0m
16596	13381	-	591855	5846494	Obstruction	Contact 1.2x1x0.1m
16597	13382	-	591990	5849905	Obstruction	Contact 1.4x1.2x0.1m
16633	13418	-	588822	5847708	Obstruction	Possible cable or chain 6.4x0.4x0m
16643	13428	-	592884	5847398	Obstruction	Seabed disturbance 7.5x2.8x0.2m
16644	13429	-	593870	5850797	Obstruction	Contact 1.2x1.1x0.1m
16645	13430	-	593852	5850756	Obstruction	Contact 1.7x1x0.2m
16646	13431	-	593705	5850318	Obstruction	Contact 1x0.9x0.1m
16648	13433	-	593924	5851030	Obstruction	Elongated contact 1.6x0.9x0.1m
16649	13434	-	592970	5847353	Obstruction	Contact 2x1x0.1m
16650	13435	-	592704	5846240	Obstruction	Contact 1.9x1.2x0.2m
16651	13436	-	592694	5846419	Obstruction	Contact/seabed disturbance 1.4x1.3x0.3m
16652	13437	-	592644	5846419	Obstruction	Elongated contact 2.5x0.7x0.1m
16653	13438	-	592860	5851445	Obstruction	Cluster of contacts 1.1x1x0.1m
16654	13439	-	592866	5851257	Obstruction	Contact 1.9x1.2x0.1m
16655	13440	-	592847	5851216	Obstruction	Contact 1.4x1x0.1m
16656	13441	-	592723	5849787	Obstruction	Contact 1.3x1.2x0.1m
16657	13442	-	592261	5843953	Obstruction	Contact 1.8x1x0.2m
16658	13443	-	592776	5851467	Obstruction	Contact 1.2x1x0.1m
16659	13444	-	592631	5849757	Obstruction	Contact 1.5x1.1x0.1m
16660	13445	-	592627	5849739	Obstruction	Contact 1.5x1.1x0.1m
16661	13446	-	592247	5844567	Obstruction	Contact 1.7x1.3x0.1m
16662	13447	-	592352	5847341	Obstruction	Contact 1.1x1x0.1m
16663	13448	-	592081	5844177	Obstruction	Contact 1.8x1.2x0.1m
16664	13449	-	592168	5845155	Obstruction	Contact 1.4x0.9x0.1m
16665	13450	-	592497	5849193	Obstruction	Contact 1.1x1x0.1m
16666	13451	-	592628	5851268	Obstruction	Contact 1.2x1x0.1m
16667	13452	-	592292	5847624	Obstruction	Contact 1.8x1x0m

			ETRS89 UTM31N			
NCN	**SR92**	**DHY**	**Easting**	**Northing**	**Type**	**Description**
16668	13453	-	592218	5845866	Obstruction	Contact 1.4x1x0.1m
16669	13454	-	591927	5843807	Obstruction	Contact 1.3x1.2x0.2m
16670	13455	-	592521	5851298	Obstruction	Cluster of contacts 1.4x1x0.1m
16671	13456	-	592472	5850746	Obstruction	Cluster of contacts 1.7x1.2x0.1m
16672	13457	-	592561	5850758	Obstruction	Contact 1.4x1.1x0.1m
16673	13458	-	592530	5850318	Obstruction	Contact 1.7x1.1x0.1m
16674	13459	-	592514	5850324	Obstruction	Contact 1.3x1.1x0.1m
16675	13460	-	591863	5843610	Obstruction	Contact 1.6x1.2x0.1m
16676	13461	-	592466	5851251	Obstruction	Cluster of contacts 1.3x1.1x0.1m
16677	13462	-	592482	5851373	Obstruction	Contact 1.3x1x0.1m
16678	13463	-	592426	5851283	Obstruction	Cluster of contacts 1.4x1.3x0.1m
16679	13464	-	592385	5850794	Obstruction	Elongated contact 2.3x1x0.1m
16680	13465	-	592371	5850340	Obstruction	Cluster of contacts 1.6x1x0.1m
16681	13466	-	592160	5848017	Obstruction	Contact 1.2x1x0.1m
16682	13467	-	592136	5846746	Obstruction	Contact 1.4x1x0.1m
16683	13468	-	591895	5843851	Obstruction	Contact 1.7x1.3x0.1m
16684	13469	-	592347	5851256	Obstruction	Contact 1.3x1x0.1m
16685	13470	-	592304	5850754	Obstruction	Contact 1.3x1.1x0.1m
16686	13471	-	592386	5850739	Obstruction	Contact 1.6x1x0.1m
16687	13472	-	592368	5851538	Obstruction	Contact 1.5x1x0m
16688	13473	-	592084	5849967	Obstruction	Contact 1.3x1.1x0.1m
16689	13474	-	588505	5843491	Obstruction	Contact 1.4x1x0.1m
16690	13475	-	592005	5849986	Obstruction	Contact 1.3x1x0.1m
16691	13476	-	591997	5849961	Obstruction	Cluster of contacts 1.6x1x0.1m
16692	13477	-	591564	5844883	Obstruction	Contact 1.6x1x0.1m
16693	13478	-	589242	5848888	Obstruction	Contact 1.2x1x0m
16694	13479	-	591656	5846971	Obstruction	Contact 1.6x1.1x0.1m
16695	13480	-	591622	5846527	Obstruction	Contact 1.7x1x0.1m
16696	13481	-	591624	5846505	Obstruction	Cluster of contacts 1.4x1x0.1m
16697	13482	-	591462	5844408	Obstruction	Contact 2.5x1.5x0.1m
16698	13483	-	591449	5844906	Obstruction	Contact 1.2x1x0m
16699	13484	-	591927	5851131	Obstruction	Elongated contact manmade 3.1x0.6x0.1m
16700	13485	-	591834	5849992	Obstruction	Contact 1.5x1.3x0.1m
16701	13486	-	591828	5849912	Obstruction	Contact 1.4x1x0.1m
16702	13487	-	591542	5846562	Obstruction	Contact 1.4x1.2x0.1m
16703	13488	-	591392	5844464	Obstruction	Contact 1.4x1x0.1m
16704	13489	-	591277	5843335	Obstruction	Contact 1.2x1x0.1m
16705	13490	-	591578	5847446	Obstruction	Contact 1.2x1x0.1m
16706	13491	-	591791	5850365	Obstruction	Contact 1.3x1.1x0.1m
16707	13492	-	591341	5845488	Obstruction	Contact 1.2x1x0.1m
16708	13493	-	591680	5850125	Obstruction	Contact 1.5x0.8x0.1m
16709	13494	-	591151	5843904	Obstruction	Contact 1.5x1.1x0.1m
16710	13495	-	591125	5843927	Obstruction	Contact 1.8x1x0.1m
16711	13496	-	591266	5845543	Obstruction	Contact 1.6x1x0.1m
16712	13497	-	591629	5850452	Obstruction	Contact 1.2x1x0.1m
16713	13498	-	591298	5846550	Obstruction	Contact 1.3x1x0m
16714	13499	-	591247	5845945	Obstruction	Contact 1.5x1x0.1m
16715	13500	-	591198	5845784	Obstruction	Cluster of contacts 1.5x1x0.1m
16716	13501	-	591318	5847271	Obstruction	Contact 1.2x1x0.1m
16717	13502	-	591711	5851842	Obstruction	Contact 1.4x1.1x0.1m
16718	13503	-	591300	5846627	Obstruction	Contact 1.6x1.2x0.1m
16719	13504	-	591200	5846720	Obstruction	Contact 1.3x1.3x0.1m
16720	13505	-	591590	5851827	Obstruction	Contact 1.5x1.1x0.1m
16721	13506	-	590998	5845829	Obstruction	Contact 1.3x1.1x0.1m
16722	13507	-	590985	5844626	Obstruction	Cluster of contacts 1.6x1x0.1m
16723	13508	-	590840	5844561	Obstruction	Contact 1.2x1.1x0.1m
16724	13509	-	591458	5851082	Obstruction	Contact 1.7x1x0.2m
16725	13510	-	590984	5846442	Obstruction	Contact 2x1.3x0.1m

			ETRS89 UTM31N			
NCN	SR92	DHY	Easting	Northing	Type	Description
16726	13511	-	591154	5848498	Obstruction	Contact 1.7x1.1x0.1m
16727	13512	-	591245	5850780	Obstruction	Contact 1.4x1.1x0.1m
16728	13513	-	591306	5849575	Obstruction	Contact 1.1x1x0m
16729	13514	-	591220	5844587	Obstruction	Contact 1.3x1x0.1m
16730	13515	-	590746	5844819	Obstruction	Contact 1.8x1x0.1m
16731	13516	-	591067	5849600	Obstruction	Contact 1.4x1x0.1m
16732	13517	-	591048	5849460	Obstruction	Contact 1.3x1x0.1m
16733	13518	-	590550	5843983	Obstruction	Contact 1.4x1x0.1m
16734	13519	-	590546	5844058	Obstruction	Contact 1.3x1x0.2m
16735	13520	-	590585	5844525	Obstruction	Contact 1.2x1x0.1m
16736	13521	-	590609	5844802	Obstruction	Contact 1.4x1x0.1m
16737	13522	-	590944	5848589	Obstruction	Contact 1.1x1x0.1m
16738	13523	-	590948	5848752	Obstruction	Cluster of contacts 1.5x1x0.1m
16739	13524	-	591104	5851179	Obstruction	Contact 1.5x1.2x0.1m
16740	13525	-	590646	5845696	Obstruction	Contact 1.5x1x0.1m
16741	13526	-	590682	5846588	Obstruction	Cluster of contacts 1.3x1x0.1m
16742	13527	-	591032	5850716	Obstruction	Contact 1.3x1.1x0.1m
16743	13528	-	591068	5851536	Obstruction	Contact 1.6x1x0.1m
16744	13529	-	591053	5851395	Obstruction	Elongated contact 1.7x0.9x0.1m
16745	13530	-	590838	5848750	Obstruction	Contact 1.4x1x0.1m
16746	13531	-	590610	5846143	Obstruction	Contact 1.5x1.1x0.1m
16747	13532	-	590618	5845159	Obstruction	Contact 1.3x1.1x0.1m
16748	13533	-	590344	5843525	Obstruction	Cluster of contacts 1.4x1x0.1m
16749	13534	-	591009	5851322	Obstruction	Cluster of contacts 1.5x1x0.1m
16750	13535	-	590746	5847750	Obstruction	Elongated contact 1.5x0.5x0.1m
16751	13536	-	590713	5847250	Obstruction	Elongated contact 1.5x0.9x0.2m
16752	13537	-	590243	5843186	Obstruction	Contact 1.5x1.2x0.1m
16753	13538	-	590570	5847031	Obstruction	Cluster of contacts 1.3x1x0m
16754	13539	-	590740	5848562	Obstruction	Contact 1.3x1x0.1m
16755	13540	-	590651	5848504	Obstruction	Contact 1.8x1.2x0.1m
16756	13541	-	590246	5844097	Obstruction	Contact 1.5x1x0.1m
16757	13542	-	590439	5847060	Obstruction	Cluster of contacts 1.3x1x0.1m
16758	13543	-	590396	5846615	Obstruction	Contact 1.5x1.1x0.1m
16759	13544	-	590282	5845701	Obstruction	Cluster of contacts 1.3x1.1x0.1m
16760	13545	-	590320	5845098	Obstruction	Elongated contact 2.3x1.3x0.1m
16761	13546	-	590722	5851391	Obstruction	Contact 1.2x1x0.1m
16762	13547	-	590634	5850361	Obstruction	Contact 1.2x1.1x0.1m
16763	13548	-	590222	5846054	Obstruction	Elongated contact 2.1x1.1x0.2m
16764	13549	-	590488	5849009	Obstruction	Contact 1.4x1x0.1m
16765	13550	-	590527	5849500	Obstruction	Contact 1.5x1.1x0.1m
16766	13551	-	590641	5851457	Obstruction	Contact 1.5x1.3x0.1m
16767	13552	-	590417	5848844	Obstruction	Contact 1.6x1x0.1m
16768	13553	-	590169	5845763	Obstruction	Contact 1.2x1x0.1m
16769	13554	-	590005	5843893	Obstruction	Contact 1.2x1.1x0.1m
16770	13555	-	590389	5849000	Obstruction	Contact 1.4x1x0.1m
16771	13556	-	590463	5850378	Obstruction	Contact 1.9x1x0.1m
16772	13557	-	589949	5844775	Obstruction	Contact 1.9x1.5x0.2m
16773	13558	-	590442	5851026	Obstruction	Contact 1.4x1.2x0.1m
16774	13559	-	589882	5844803	Obstruction	Contact 1.2x1x0.1m
16775	13560	-	590279	5849483	Obstruction	Contact 1.3x1.1x0.1m
16776	13561	-	590283	5849493	Obstruction	Contact 1.3x1.2x0.1m
16777	13562	-	589799	5844291	Obstruction	Cluster of contacts 1.2x1x0m
16778	13563	-	590379	5851639	Obstruction	Seabed disturbance 17.4x2.3x0.2m
16779	13564	-	589664	5844849	Obstruction	Cluster of contacts 1.3x1x0m
16780	13565	-	589600	5844893	Obstruction	Cluster of contacts 1.3x1.1x0.1m
16781	13566	-	589964	5849640	Obstruction	Cluster of contacts 1.2x1x0.2m
16782	13567	-	589934	5851239	Obstruction	Contact 1.5x1.2x0.1m
16783	13568	-	589555	5846997	Obstruction	Contact/possible man-made 1.6x1x0.2m

			ETRS89 UTM31N			
NCN	**SR92**	**DHY**	**Easting**	**Northing**	**Type**	**Description**
16784	13569	-	589745	5849859	Obstruction	Contact 1.1x1x0.1m
16785	13570	-	589533	5848469	Obstruction	Contact 1.4x0.9x0.1m
16786	13571	-	589559	5848741	Obstruction	Cluster of contacts 1.3x1x0.1m
16787	13572	-	589664	5849947	Obstruction	Contact 1.6x1.1x0.1m
16788	13573	-	589509	5848646	Obstruction	Contact 1.2x1.1x0.1m
16789	13574	-	589077	5843605	Obstruction	Contact 1.3x1x0.1m
16790	13575	-	589366	5847529	Obstruction	Possible cable or chain 12.4x0.4x0.1m
16791	13576	-	589583	5849975	Obstruction	Cluster of contacts 1.2x1x0.1m
16792	13577	-	589694	5851274	Obstruction	Contact 1.6x1.2x0.1m
16793	13578	-	589467	5849073	Obstruction	Contact 1.6x1.1x0.1m
16794	13580	-	589376	5849121	Obstruction	Contact 1.4x1.2x0m
16795	13581	-	589359	5848802	Obstruction	Contact 1.9x1.2x0.1m
16796	13582	-	588947	5844006	Obstruction	Contact 1.3x1x0.1m
16797	13583	-	589018	5843761	Obstruction	Elongated contact manmade 1.6x0.5x0.1m
16798	13584	-	589412	5850005	Obstruction	Possible cable or chain 1.2x0x0m
16799	13585	-	589466	5850052	Obstruction	Contact 1.6x1x0.1m
16800	13586	-	589333	5849564	Obstruction	Contact 1.4x1x0.1m
16801	13587	-	589122	5848860	Obstruction	Contact 1.8x1.4x0.1m
16802	13588	-	588898	5847197	Obstruction	Elongated contact 1.7x0.5x0.1m
16803	13589	-	588607	5844431	Obstruction	Seabed disturbance 5x1.2x0.2m
16598	13383	-	591363	5845542	Obstruction	Contact 1x1x0.1m
16599	13384	-	591518	5844394	Obstruction	Contact 1.3x1x0m
16600	13385	-	591578	5848193	Obstruction	Elongated contact 1.8x0.9x0.1m
16601	13386	-	591031	5850435	Obstruction	Contact 1.2x1.1x0.2m
16602	13387	-	591371	5846560	Obstruction	Contact 1.3x1x0.1m
16603	13388	-	591046	5846805	Obstruction	Contact 1.2x1x0.1m
16604	13389	-	591267	5850191	Obstruction	Contact 1.2x1x0.1m
16605	13390	-	590796	5844553	Obstruction	Contact 2x1.1x0.1m
16606	13391	-	591025	5847835	Obstruction	Contact 1.6x1.1x0.2m
16607	13392	-	590829	5847016	Obstruction	Elongated contact 1.1x0.7x0.1m
16608	13393	-	590577	5845128	Obstruction	Contact 1.7x1.1x0.1m
16609	13394	-	590453	5843235	Obstruction	Contact 1.3x1.2x0.1m
16610	13395	-	588733	5847717	Obstruction	Contact 1.3x1.2x0.1m
16611	13396	-	590290	5844599	Obstruction	Contact 1.3x1x0.1m
16612	13397	-	590117	5844403	Obstruction	Contact 1.8x1x0.1m
16613	13398	-	590178	5844114	Obstruction	Contact 1.3x1x0.1m
16614	13399	-	590589	5849967	Obstruction	Contact 1.1x1x0.1m
16615	13400	-	590547	5849422	Obstruction	Contact 1.2x1x0m
16616	13401	-	589901	5844824	Obstruction	Elongated contact 1.5x0.7x0.1m
16617	13402	-	590306	5852161	Obstruction	Contact 1.1x1x0.1m
16618	13403	-	589680	5847098	Obstruction	Contact 1.6x1x0.1m
16619	13404	-	589363	5844537	Obstruction	Contact 1x1x0m
16620	13405	-	589756	5850007	Obstruction	Contact 1.4x1.3x0.1m
16621	13406	-	589516	5847933	Obstruction	Contact/seabed disturbance 2.6x1.2x0.2m
16622	13407	-	589217	5844543	Obstruction	Contact 1.1x1x0.1m
16623	13408	-	589222	5844574	Obstruction	Contact 1.2x1x0.1m
16624	13409	-	589297	5844880	Obstruction	Contact 1.5x1.1x0.2m
16625	13410	-	589430	5847100	Obstruction	Contact 1.3x1.1x0.1m
16626	13411	-	589649	5850195	Obstruction	Contact 1.3x1x0.1m
16627	13412	-	589502	5848745	Obstruction	Contact 1.1x1x0m
16628	13413	-	589436	5847896	Obstruction	Contact 1.4x1x0.1m
16629	13414	-	589083	5843900	Obstruction	Contact 1.1x1x0.1m
16630	13415	-	588966	5846956	Obstruction	Possible cable or chain 12.6x0.3x0m
16631	13416	-	589692	5850105	Obstruction	Contact 1.4x1x0.1m
16632	13417	-	588903	5846455	Obstruction	Cluster of contacts 1.1x1x0.1m
18122	14438	-	587476	5826243	Obstruction	Ridge 8.6x1.4x0.1m
18123	14439	-	587502	5826260	Obstruction	Possible cable or chain 3.7x0x0m
18124	14440	-	587717	5827167	Obstruction	Possible cable or chain 10.8x0x0m

			ETRS89 UTM31N			
NCN	**SR92**	**DHY**	**Easting**	**Northing**	**Type**	**Description**
18125	14441	-	587796	5826963	Obstruction	Possible cable or chain 6.3x0x0m
18126	14442	-	587797	5826947	Obstruction	Possible cable or chain 10.5x0.1x0m
18127	14443	-	587860	5827359	Obstruction	Possible cable or chain 5.3x0.3x0m
18128	14444	-	587813	5826479	Obstruction	Possible cable or chain 4x0.2x0m
18129	14445	-	587279	5827842	Obstruction	Elongated contact 2x0.4x0.1m
18130	14446	-	587571	5827603	Obstruction	Contact 1.1x1x0.2m
18131	14447	-	587273	5827820	Obstruction	Contact 1.2x0.5x0.2m
18132	14448	-	587340	5826719	Obstruction	Possible cable or chain 5x0.4x0m
3693	2198	-	582320	5845879	Obstruction	Pipeline PL025 (bypass Vinca Gorthon)
3699	2204	-	582374	5845729	Obstruction	Pipeline PL025 (bypass Vinca Gorthon)
16636	13421	-	594520	5851300	Obstruction	Contact 1.2x1x0.1m
16637	13422	-	594461	5851442	Obstruction	Contact/seabed disturbance 5.2x1.6x0.2m
16638	13423	-	594268	5850679	Obstruction	Contact 1.6x1x0.1m
16639	13424	-	594318	5850846	Obstruction	Contact 1.6x1.3x0.1m
16640	13425	-	594157	5850223	Obstruction	Contact 1.4x0.9x0.1m
16647	13432	-	593777	5849645	Obstruction	Contact 1.6x1.2x0.2m
14288	11097	-	592462	5833842	Obstruction	Anchor with chain 50x0x0m
25000	-	42	582190	5841144	Wreck	Former wreck Kugelbake SH 23 sunk 19-09-1989, wreck raised, remains may be present
25001	-	135	580441	5835731	Obstruction	Obstruction; cable amplifier
25002	-	136	590773	5834874	Obstruction	Obstruction; cable amplifier
25003	-	137	585578	5835299	Obstruction	Obstruction; cable amplifier
25004	-	465	579521	5826781	Obstruction	Obstruction; Well Q07-4 NAM
25005	-	513	587991	5829044	Obstruction	Obstruction; Well Q07-5 Unocal

NCN: Nationaal Contactnummer Nederland
DHY: Nlhono nr. From the Dutch Hydrographic Service

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The information in this document is valid at the time of publishing (see month/year). Updates will be published on the website http://offshorewind.rvo.nl/ at the relevant sitemap (Hollandse Kust (zuid)/Hollandse Kust (noord), General Information, submap Revision Log and Q & A. In the Revision Log is indicated which versions are the latest and what the changes are in relation to previous versions. The documents can be found at the relevant sites, indicated in the Revision Log.

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