Netherlands Enterprise Agency

# Site Studies Wind Farm Zone Borssele

## Archaeological desk study

>> *Sustainable. Agricultural. Innovative. International.*

VESTIGIA

*Archeologie & Cultuurhistorie*

# Borssele Wind Farm Zone, North Sea, the Netherlands

Archaeological desk study, risk assessment and recommendations

V1199

# Borssele Wind Farm Zone, North Sea, the Netherlands

*Archaeological desk study, risk assessment and recommendations*


| | |
|---|---|
| Report: | V1199 |
| Project: | V14-2900 |
| ISSN: | 1573 - 9406 |
| Status and version: | Final version 2.0 |
| Client: | Rijksdienst voor Ondernemend Nederland |
| Authors: | C.A. Visser/W.J. Weerheijm/R. Schrijvers/W.A.M. Hessing |
| Editor: | K.E. Waugh |
| Place and date: | Amersfoort, 28 November 2014 |





Vestigia BV
Spoorstraat 5
3811 MN Amersfoort
telefoon 033 277 92 00
info@vestigia.nl

| Project details | | |
|---|---|---|
| Initiative | Execution of the EIA and selection of the offshore wind sites (*kavels*) in preparation of the *kavelbesluit* | |
| Location | Borssele wind farm zone, North Sea | |
| Client | Rijksdienst voor Ondernemend Nederland<br>PO Box 8242<br>NL-3503 RE Utrecht | |
| Contact | mr. R. de Bruijne<br>Phone: (+31) (0)88 6022419<br>E-mail ruud.debruijne@rvo.nl | |
| Surface area Borssele wind farm zone | 34,466.9 hectares | |
| Depth soil disturbance | unknown | |
| Current use | Dutch Exclusive Economic Zone and Contiguous Zone | |
| Survey registration number | 63,102 | |
| Type of survey | Desk study | |
| Coordinates wind farm zone | 504039.560 / 5713246.091<br>484178.546 / 5732482.796 | 504373.703 / 5738878.380<br>509706.860 / 5731271.298 |
| Coordinate system and projection | ETRS89/TM31 | |
| Contractor | Vestigia *Coastal & River Archaeology*,<br>as part of Vestigia BV *Archeologie & Cultuurhistorie* | |
| Project manager/Senior archaeologist | Drs. W.A.M. Hessing | |
| Project staff | Drs. C.A. Visser MA (maritime archaeologist)<br>Mr. W.J. Weerheijm MA (archaeologist)<br>Drs. R. Schrijvers (physical geographer)<br>Dr. K.E. Waugh (senior archaeologist/editor) | |
| Authorisation | | |

## Contents

Figure 1 Ship on the North Sea, *Vlakte van de Raan* (http://beeldbank.rws.nl)

## List of abbreviations

| | |
|---|---|
| AMZ | Archeologische Monumentenzorg |
| Archis | Archeologisch Informatiesysteem |
| DANS-EASY | Data Archiving and Networked Services - Electronic Archiving System |
| DINO | Data en Informartie van de Nederlandse Ondergrond |
| EDNA | e-Depot voor de Nedrelandse Archeologie |
| EIA | Environmental Impact Assessment |
| KNA | Kwaliteitsstandaard voor de Nederlandse Archeologie |
| MACHU | Managing Cultural Heritage Underwater |
| MER | Milieu Effect Rapport (=EIA report) |
| m.e.r. | milieu effect rapportage (= EIA process) |
| RCE | Rijksdienst voor het Cultureel Erfgoed |
| RVO | Rijksdienst voor Ondernemend Nederland (Netherlands Enterprise Agency) |
| SIKB | Stichting Infrastructuur Kwaliteitsborging Bodembeheer |
| SGLO | Studiegroep Luchtoorlog 1939-1945 |
| TNO | Nederlandse Organisatie voor toegepast-natuurwetenschappelijk onderzoek |
| UXO | Unexploded ordnance |
| Wamz | Wet op de archeologische monumentenzorg |

## Summary and recommendations

Vestigia *Archeologie & Cultuurhistorie* has conducted an archaeological desk study for the Netherlands Enterprise Agency related to the Borssele wind farm zone. The Borssele wind farm zone is located in the North Sea, just outside Dutch Territorial Waters, within the Exclusive Economic Zone and Contiguous Zone, and it borders the Belgian Exclusive Economic Zone and Contiguous Zone (*map 1*).

For this archaeological desk study two types of archaeological remains have been assessed:

1) Early prehistoric sites and finds, either directly on the seabed, or covered by later sediments buried under the seabed.

   *In situ* early prehistoric archaeological remains can be present in areas where the late Pleistocene to early Holocene landscape is still preserved in the geological stratigraphy. The remnants of this landscape - where they seem to be present in the Borssele wind farm zone - are located at a depth of about 30 to 40 meters below present day sea level, and are mostly covered by a thick layer of mid- to late-Holocene marine sediments. These sites could be damaged by drilling, coring, cabling and foundation work.

   Early prehistoric sites have not been identified within the wind farm zone itself, the nearest location or find spot of early prehistoric remains lies 9 miles south-east of the Wind farm zone. If present at all, remains of the Pleistocene and early Holocene landscape in the Borssele wind farm zone are located at a depth of about 30 to 40 meters below present day sea level. This means that around the transition from Late Palaeolithic to early Mesolithic, most, if not all, of the area in and around the Wind farm zone had been submerged by the expanding North Sea. It can therefore be concluded that within the Wind Farm zone most if not nearly all early prehistoric sites - if present - should date from the Middle and Upper Paleolithic periods. These sites are extremely low in density. Any possible Later Paleolithic and Early Mesolithic sites in the area can only have been situated on higher parts within the landscape, which consequently were also more exposed to North Sea erosion. General expectancy of well-preserved early prehistoric sites with in situ remains should therefore be considered as low, albeit not completely to be excluded.

   The two lithological cross sections from the wind farm zone show a few locations where early Holocene terrestrial deposits seem to cover the Late Pleistocene or Neogene ('Tertiary') deposits. However, due to the low spatial resolution of available data, it is unknown at this point to what extent non-erosive late Pleistocene and early Holocene remnants are present within (and in the vicinity of) the wind farm zone. Although the location of such remnants would constitute the most promising locations to find in situ prehistoric archaeology, it is difficult to establish their predictive value.[1] We know the area was only suitable for human exploitation during the earliest phases of prehistory (i.e. roughly before 8,000 BP = c. 7,000 BC). We know that in some places the early prehistoric landscape has been covered by non-erosive sediments and therefore preserved. But we also know that the population density in North-western Europe during these early stages of prehistory was very low. Therefore, the density of archaeological traces of those people is also very low. The chance that these sparse remains happen to be located within the relative few locations where soils from this period have been covered by non-erosive later sediments and hence

1 For an insight in factors determining the scale and accuracy of palaeogeographical reconstructions in the North Sea area: Cohen et al. 2014.

preserved, is very slim. The chance to actually encounter such remains during surveys or developments in the area, even slimmer.

Archaeological sensitivity expresses how likely it is in a given area to encounter archaeological remains (the chance to encounter archaeology, not the chance that archaeology is present). Overall, the chance to encounter prehistoric archaeology within the wind farm zone is small (=low sensitivity).

2) Historic wrecks and other objects, such as lost equipment or cargo and crashed airplanes.

As far as shipwrecks are concerned, these may be affected by disturbing the bottom of the sea, by drilling, coring, cabling, foundation work and anchoring and jack-up of working vessels. Historic vessels and warplanes, generally situated on or near the sea bed could be damaged by drilling, coring, cabling and foundation work.

So far, only three objects have been identified as a shipwreck within the boundaries of the wind farm zone. Only one has been further identified. It originates from the late 20th century and can be considered of no archaeological value. There are a number of obstructions reported within the wind farm zone at present unidentified. These could be wrecks, part of wrecks, but also lost objects (e.g. anchors, chains), cargo, garbage etc. They may also be the remains of aircrafts, lost in the World War II. In the immediate vicinity of the wind farm zone several historic wrecks are attested, most from the 19th of 20th century. Among these, The best known wreck, of high archaeological importance, is the East Indiaman '*t Vliegend Hart*, sunk in 1729.

Vestigia has found no records of systematic surveys with side-scan sonar or other geophysical techniques within the wind farm zone. Recorded finds of historic wrecks and other objects mentioned in the present desk study should therefore be considered as accidental and more or less random discoveries. The low number of find spots is therefore not necessarily a reflection of the actual density of historic archaeological finds including World War I and II shipwrecks and warplanes. It is merely caused by the absence of systematic surveys, which normally are concentrated within the main shipping lines. More undiscovered shipwrecks and other historical objects are therefore very likely present within the wind farm zone.

The recorded wreck locations and other objects may or may not be of archaeological significance. It is not possible to determine that at this stage, with the available information. In the mean time, these locations are best avoided during developments. Unfortunately it is not possible at this stage to distinguish between areas of low, high and medium archaeological sensitivity within the wind farm zone. There are no clear low sand banks, shallows , or regular shipping lanes within the area, which could be defined as high risk areas for accidents, also no clustering of wrecks can be distinguished, indicating sea battle areas or other incident areas. For the entire wind farm zone the chance to encounter historic archaeology (shipwrecks, airplanes, etc.) is average (=medium sensitivity).

Vestigia makes the following recommendations:

1) Due to the small chance to encounter early prehistoric archaeological sites within the wind farm zone and the limited possibilities for further research and knowledge gain, once encountered, further archaeological survey with the intention to establish prehistoric sites is not recommended.

2) In order to define areas of low, medium and high archaeological sensitivity in relation to shipwrecks and airplanes within the wind farm zone, it is recommended to perform a geophysical area survey (side scan sonar or multi beam). Such a survey and the subsequent report should meet the requirements of the KNA *Waterbodems*.

   Once a wreck or other archaeological site has been identified, that lies in an area were soil disturbing activities are planned, the historic or scientific value of the site should be established, ultimately by the RCE through a so-called *selectiebesluit*, taken on the basis of additional research and inspection. In case a wreck or archaeological site is determined as of archaeological significance, the effects of the development can be mitigated by preferably avoiding the site, or otherwise further archaeological interventions. In case of historic wrecks this could involve archaeological excavations underwater, in case of historic airplanes, this could involve the salvage and lifting of the wreck or parts of it, and in case of early prehistoric archaeological sites an archaeological sampling strategy as was, for instance, used during the building of Maasvlakte II. These archaeological interventions can involve high costs and can only be carried out according the rules and regulations laid out in the Dutch Monuments Act. However, in case of discovery of any of the above-mentioned archaeological sites or objects, first the historic value needs to be established by further research and inspection.

3) To draft at an early stage as possible a protocol and work plan for dealing with the archaeological heritage. In the work plan the necessary steps of further archaeological prospection and decision making in relation to the future project stages, are laid out and explained. In the protocol a procedure for dealing with 'accidental' archaeological finds during the construction and operational phases of the project is outlined. Accidental archaeological finds refer to archaeological remains that have not been identified during the stages of archaeological prospection, but are encountered unexpectedly during construction and operational phases. Such finds should always be reported according to the Monuments Act. It is in the interest of both developer and the curator (RCE) to anticipate on possible accidental finds and to make an agreement beforehand how and by whom these will be handled, and decisions on possible further actions will be reached. This saves essential time and money during operational stages. Provided that the developer has met his responsibilities with regard to archaeological prospection in the planning stages, the (financial) consequences of archaeological interventions that result from such an accidental find are not necessarily the responsibility of the developer, but a matter of negotiation between developer and the appropriate authority. In case of developments at sea, the likelihood of encountering 'accidental' archaeological finds is established beforehand based on the results of forthcoming archaeological surveys. The developer and the Cultural Heritage Agency (RCE) then agree to an additional maximum budget that the developer spends in case of accidental archaeological finds. Providing such an agreement, the responsibility of the developer for the financial consequences of accidental archaeological finds during the construction and operational phases of the project will not transcend the agreed budget.

## Samenvatting en advies

Vestigia *Archeologie & Cultuurhistorie* heeft in opdracht van de Rijksdienst voor Ondernemend Nederland (RVO) een archeologisch bureauonderzoek uitgevoerd in het kader van het windgebied Borssele. Het windgebied Borssele is gelegen in de Noordzee, net buiten de Nederlandse Territoriale Wateren, binnen de Exclusieve Economische Zone en Aansluitende Zone, langs de grens met de Belgische Exclusieve Economische Zone en Aansluitende Zone (*kaart 1*).

Het archeologisch bureauonderzoek richt zich op twee typen archeologische resten:

1) Vroeg-prehistorische vindplaatsen en vondsten, dan wel op de zeebodem, dan wel in de zeebodem, afgedekt door jonger sediment.

   Prehistorische archeologische resten in situ kunnen aanwezig zijn in gebieden waar laat-pleistocene en vroeg-holocene landschappen bewaard zijn gebleven in de geologische stratigrafie. De restanten van deze landschappen - waar ze zijn aangetroffen binnen de windpark zone - bevinden zich op een diepte van -30 tot -40 meter NAP, en worden grotendeels afgedekt door een dikke laag midden-holocene tot laat-holocene mariene afzettingen. Dergelijke vindplaatsen zouden kunnen worden aangetast door boren, het leggen van kabels en de aanleg van funderingen.

   Vroeg-prehistorische vindplaatsen zijn niet bekend uit het windgebied Borssele zelf. De dichtstbijzijnde vindplaats ligt 9 mijl ten zuidoosten van het windgebied Borssele. Als er al resten van een pleistoceen of vroeg-holoceen landschap aanwezig zijn binnen het windgebied Borssele, dan liggen deze 30 tot 40 meter onder het huidige zeeniveau. Dit betekent dat het windgebied Borssele tijdens de overgang van het Laat-Paleolithicum naar het Vroeg-Mesolithicum reeds grotendeels, zo niet helemaal, ondergelopen was door de oprukkende Noordzee. Daaruit kan geconcludeerd worden dat eventuele prehistoriche vindplaatsen grotendeels, zo niet vrijwel allemaal, zullen dateren uit het Midden-Paleolithicum en het Laat-Paleolithicum. Vindplaatsen uit deze perioden kennen een bijzonder lage dichtheid. Eventuele vindplaatsen uit het Laat-Paleolithicum en het vroeg-Mesolithicum in het gebied kunnen alleen verwacht worden op de hoger gelegen delen van het pleistoceen of vroeg-holoceen landschap, welke juist meer aangetast zullen zijn als gevolg van erosie door de Noordzee. De algehele archeologische verwachting met betrekking tot vroeg-prehistorische vindplaatsen is daarom laag voor de gehele windpark zone, maar de aanwezigheid van dergelijke vindplaatsen kan nooit helemaal worden uitgesloten.

   De twee lithologische dwarsdoorsneden uit het windgebied Borssele laten enkele locaties zien waar vroeg-holocene terrestrische afzettingen de laat-pleistocene of neogene (tertiaire) afzettingen lijken af te dekken. Vanwege de lage ruimtelijke resolutie van de beschikbare data, is het echter op dit moment niet bekend in hoeverre niet-erosive laat-pleistocene en vroeg-holocene resten verspreid aanwezig zijn in het windgebied Borssele en het omliggende gebied. Hoewel locaties waar zulke resten aanwezig zijn in principe veelbelovend zijn voor wat betreft het aantreffen van prehistorische archeologie in situ, is het moeilijk te bepalen wat de archeologische verwachting is in gebieden met dergelijke resten. We weten dat het gebied geschikt is geweest voor menselijke exploitatie gedurende de vroegste fasen van de prehistorie (grofweg vóór 8.000 BP = ca. 7000 voor Chr.). We weten dat op sommige plekken het vroeg-prehistorische landschap is afgedekt door niet-erosieve jongere sedimenten en daardoor is bewaard. Maar we weten ook dat de bevolkingsdichtheid in het gebied gedurende de vroege prehistorie erg laag was. Daarom is ook de dichtheid van archeologische vindplaatsen uit deze periode laag. De kans dat de schaarse sporen die deze mensen hebben achtergelaten nu juist precies op die enkele locaties liggen waar de bodem uit die tijd is afgedekt door niet-erosieve jongere sedimenten en daardoor bewaard gebleven, is erg klein. De kans dat dergelijke menselijke sporen daadwerkelijk worden aangetroffen tijdens een onderzoek of tijdens ingrepen in het gebied, is nog kleiner.

Een archeologische verwachting drukt de kans uit dat in een bepaald gebied archeologische resten worden aangetroffen (het is daarmee een trefkans, en niet de kans dat in het gebied archeologie aanwezig is). In de gehele windpark zone is de trefkans op prehistorische vindplaatsen laag (lage archeologische verwachting).

2) Historische wrakken en andere objecten, zoals verloren scheepsuitrusting of vracht en neergestorte vliegtuigen.

Scheepswrakken kunnen ook worden aangetast door boren, het leggen van kabels en de aanleg van funderingen. Historische scheepswrakken en vliegtuigwrakken, die zich gewoonlijk op of net onder de zeebodem bevinden, kunnen worden beschadigd.

Tot dusver zijn er slechts drie scheepswrakken bekend uit de het windgebied Borssele. Hiervan is er slechts één nader geïdentificeerd. Het wrak dateert uit de 20e eeuw en heeft geen archeologische waarde. Er zijn nog een aantal gerapporteerde obstructies bekend uit het gebied. Deze zijn niet nader geïdentificeerd. Het kan hier gaan om scheepswrakken of delen van scheepswrakken, maar ook om verloren objecten (bijvoorbeeld ankers, kettingen), vracht, afval etc. Het kan ook gaan om delen van neergestorte vliegtuigen uit de Tweede Wereldoorlog. Uit de directe omgeving van het windgebied Borssele zijn verschillende historische wrakken bekend, waarvan de meeste dateren uit de 19e en 20e eeuw. Het meest bekende archeologische wrak, en van groot archeologisch belang, is het spiegelretourschip *'t Vliegend Hart*, gezonken in 1729.

Vestigia heeft geen aanwijzingen gevonden dat binnen de het windgebied Borssele systematisch onderzoek heeft plaatsgevonden met behulp van side scan sonar of een andere geofysische methode. De bekende historische wrakken en andere objecten genoemd in dit rapport moeten daarom beschouwd worden als toevalsvondsten. Het kleine aantal vindplaatsen zegt daarom niet noodzakelijkerwijs iets over de daadwerkelijke dichtheid van historische archeologische objecten, waaronder ook scheepswrakken uit de Eerste en Tweede Wereldoorlog, alsmede gevechtsvliegtuigen. Het is slechts een reflectie van het ontbreken van systematisch onderzoek, dat normaliter voornamelijk wordt uitgevoerd op de belangrijkste scheepvaartroutes. Naar alle waarschijnlijkheid bevinden zich in het windgebied Borssele daarom nog meer onontdekte historische objecten.

De bekende wraklocaties en andere gedocumenteerde objecten kunnen al dan niet van archeologische betekenis zijn. Daarover is op dit moment op basis van de beschikbare gegevens geen uitspraak te doen. Zolang daarover niets bekend is, kunnen deze locaties het best vermeden worden. Het is helaas niet mogelijk in dit stadium om een onderscheid te maken binnen het windgebied Borssele tussen gebieden met een lage, een middelhoge en een hoge archeologische verwachting. Er zijn geen duidelijke zandbanken of ondiepten of drukbevaren scheepsroutes aan te wijzen binnen het gebied, die zouden kunnen worden gedefinieerd als locaties waar de kans op een ongeluk groot is. Er kunnen ook geen clusters van wrakken worden onderscheiden die duiden op de locatie van een zeeslag of een gebied met veel incidenten. De trefkans op historische vindplaatsen (scheepswrakken, vliegtuigwrakken, etc.) is voor het gehele windgebied Borssele middelhoog (middelhoge archeologische verwachting).

Vestigia doet de volgende aanbevelingen:

1) Vanwege de geringe trefkans in relatie tot prehistorische archeologische vindplaatsen binnen het windgebied Borssele, en de beperkte mogelijkheden voor nader onderzoek en kenniswinst in het geval een dergelijke vindplaats wordt vastgesteld, wordt verder onderzoek met als doel het vaststellen van prehistorische vindplaatsen in het gebied, niet geadviseerd.

2) Om binnen het windgebied Borssele gebieden aan te kunnen wijzen met een hoge, middelhoge en lage trefkans op scheepswrakken en vliegtuigwrakken, is het aan te bevelen om in het gebied een geofysisch opwateronderzoek (side scan sonar of multibeam) uit te voeren. Dit onderzoek en het daaruit volgende rapport dienen te voldoen aan de eisen opgenomen in de KNA Waterbodems.

   Wanneer een archeologische vindplaats wordt geïdentificeerd op een locatie waar bodemverstorende ingrepen gepland zijn, moet de historische of wetenschappelijke waarde van de vindplaats worden vastgesteld, uiteindelijk door de RCE door middel van een zogenaamd selectiebesluit. Dit selectiebesluit wordt genomen op basis van nader onderzoek en inspectie. Wanneer de vindplaats (een wrak of anderszins) als archeologisch waardevol wordt beoordeeld, kunnen de effecten van de ontwikkeling op de vindplaats worden gemitigeerd bij voorkeur door de locatie te vermijden bij verdere ontwikkelingen. Indien dit niet mogelijk is, moeten verdere acrheologische stappen worden ondernomen. In het geval van een historisch wrak zou deze stap kunnen bestaan uit een opgraving onder water, in het geval van een historisch vliegtuig uit het bergen van het wrak of delen van het wrak, en in het geval van een prehistorische vindplaats uit archeologische monstername, zoals bijvoorbeeld is gebeurd bij de aanleg van de Maasvlakte II. Deze archeologische stappen kunnen erg kostbaar zijn en moeten worden uitgevoerd conform de regels vastgelegd in de Monumentenwet 1988.

3) Geadviseerd wordt om in een zo vroeg mogelijk stadium een protocol op te stellen en een werkplan waarin wordt omschreven hoe wordt omgegaan met archeologisch erfgoed binnen het project. In het werkplan wordt uiteengezet welke noodzakelijke stappen moeten worden gezet voor het verdere archeologische proces en worden de beslismomenten geïdentificeerd. Het protol bevat een procedure voor de omgang met archeologsiche 'toevalsvondsten' gedurende het werk. Een toevalsvondst heeft betrekking op archeologische resten die niet aan het licht zijn gekomen gedurende de verschillende fasen van archeologische prospectie en die onverwacht worden aangetroffen tijdens de uitvoering van het werk. Zulke vondsten dienen conform de Monumentenwet 1988 gemeld te worden. Het is in het belang van zowel de initiatiefnemer als de RCE om te anticiperen op mogelijke toevalsvondsten en om vooraf afspraken te maken over hoe hiermee wordt omgegaan, en hoe besluiten over vervolgacties tot stand komen. Hiermee kan tijd en geld worden bespaard gedurende de uitvoering van het werk. Wanneer de initiatiefnemer aan zijn verplichtingen heeft voldaan ten aanzien van archeologisch vooronderzoek in de voorbereidende fasen, zijn de (financiële) consequenties die voortvloeien uit een toevalsvondst niet noodzakelijkerwijs voor de initiatiefnemer. Op zee geldt dat op basis van de resultaten van het archeologisch vooronderzoek de verwachting op toevalsvondsten gedurende de uitvoering van het werk wordt bepaald. In onderhandeling tussen de initiatiefnemer en de bevoegde overheid wordt bepaald hoeveel budget de initiatiefnemer reserveert voor nader onderzoek naar aanleiding van toevalsvondsten. In geval van een dergelijek afspraak, reikt de verantwoordelijkheid van de initiatiefnemer voor de financiële gevolgen van toevalsvondsten bij het uitvoeren van het werk niet verder dan dit vooraf in onderhandeling vastgestelde budget.

# Underpinnings of the recommendations

## 1 Project environment

### 1.1 General introduction to the offshore wind energy in the Netherlands

#### 1.1.1 Offshore wind farms in the Netherlands

The first two wind farms that were built in the Dutch part of the North Sea are the offshore Wind Farm Egmond aan Zee and the Princess Amalia Wind Farm. Wind Farm Luchterduinen is currently (2014) under construction and the wind farms Buitengaats and Zee-Energie (the so-called Gemini wind farms) are expected to be built in 2015-2016. These wind farms have a total capacity of some 1,000 MW.

#### 1.1.2 The Energy Agreement for Sustainable Growth

In the Energy Agreement for Sustainable Growth (*Energieakkoord voor duurzame groei*), more than forty organisations have laid the basis for a robust, future-proof energy and climate policy for the Netherlands, enjoying broad support.

An important part of this agreement is scaling up offshore wind power to 4,450 MW, operational in 2023. In addition to this, a total of 3,450 MW will be contracted for by means of phased tender procedures commencing in 2015. This assumes that the cost of offshore wind power will be cut by some 40% in the years ahead. The Government will ensure that there is a robust legal framework that makes it possible to scale up offshore wind power. The basic assumption is that the wind farms will become operational within four years of a decision being taken on funding, and will then make use of state-of-the-art technology.

#### 1.1.3 Wind farm zones

In the Netherlands, the spatial planning of the North Sea has been laid down in the 'National Waterplan' (*Nationaal waterplan*). This plan provides a description of the current use of the Dutch part of the North Sea and the vision on future utilization of the North Sea in the Dutch sector.

In the National Waterplan the following wind farm zones have been designated:

- Borssele
- Hollandse Kust
- IJmuiden ver
- Ten Noorden van de Waddeneilanden

Only within these wind farm zones developments can take place.

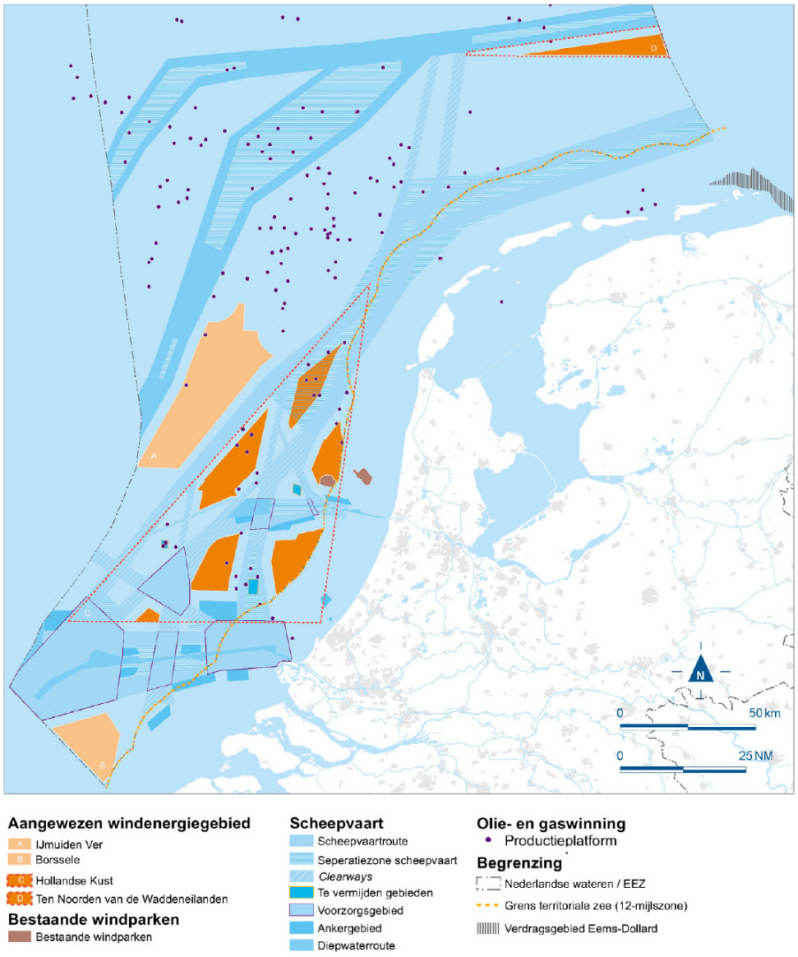



Figure 2 Wind farm zones on the Dutch continental shelf

### 1.1.4 Wind farm sites

In the new offshore wind energy bill (*Wet windenergie op zee*), which is expected to enter into force in Q3 2015, the legislative framework for the development of offshore wind farms in the Netherlands will be changed. By then new wind farms are only allowed to be constructed at sites within one of the wind farm zones.

The Ministries of Economic Affairs and of Infrastructure and Environment will take the 'Wind farm site decisions' (*kavelbesluiten*). A wind farm site decision includes the contours of the site and the conditions under which wind farms can be constructed and operated. The conditions will give maximum flexibility to developers in their wind farm design. A wind farm site decision is subject to an Environmental Impact Assessment.

For the deployment of new offshore wind farms until 2023, as agreed upon in the Energy Agreement for Sustainable Growth, the government has decided to select developers as follows:

Table 1 Selection of developers for deployment of offshore wind farms until 2023 (RVO)

| *Tendering* | | *Wind farm zone* |
|---|---|---|
| *Year* | *Capacity* | |
| 2015 | 700 MW | Borssele |
| 2016 | 700 MW | Borssele |
| 2017 | 700 MW | Hollandse Kust: Zuid-Holland |
| 2018 | 700 MW | Hollandse Kust: Zuid-Holland |
| 2019 | 700 MW | Hollandse Kust: Noord-Holland |

### 1.1.5 Selection of developers

Developers who can build and operate wind farms on the sites will be selected by a tender procedures in which respectively the grant and the permit for constructing and operating a wind farm can be awarded. To facilitate developers in competitive bids for the tenders, site data on the wind, water and soil conditions will be made available.

*Grant*

The Ministry of Economic Affairs will make a grant available for operating the wind farm, as part of the Stimulation of Sustainable Energy Production (SDE+, Stimulering Duurzame Energieproductie). Producers receive financial compensation for the electricity they generate for a fixed number of years. The participants of the subsidy tender in parallel request for a permit. The winner of the subsidy tender will both be granted a permit and a subsidy.

*Consent*

A developer needs a permit based on the wind farm site decision already been taken. This permit allows him to construct and operate a wind farm on a site for which a site decision has been taken. This permit can be obtained as part of the tender procedure for the grant. The permit will be awarded by the Ministry of Economic Affairs to the winner of the tender and defines the contours of the site and the conditions under which wind farms can be constructed and operated. The conditions will give maximum flexibility to developers in their wind farm design.

*Site data*

The Netherlands Enterprice Agency makes site data available. These site data include:

- geological, morphodynamical and geomorphological data;
- archaeological and UXO analysis;
- metocean data;
- geophysical and geotechnical data (based on surveys).

The investigations for this data will also be used for the EIA. Investigations relevant for the design basis will be certified according to DNV-OS-J101 or equal.

### 1.1.6 Substations and export cables

The national electricity transmission system operator (TSO), TenneT, will be assigned as TSO for the Dutch Exclusive Economic Zone. TenneT will build and operate substations near the sites and install and operate the export cables.

### 1.1 Borssele wind farm zone

The Netherlands Enterprise Agency (RVO: *Rijksdienst voor Ondernemend Nederland*) has requested Vestigia *Archeologie & Cultuurhistorie* to conduct an archaeological desk study for the Borssele wind farm zone.

The Wind Farm Zone Borssele is located in the North Sea, just outside Dutch Territorial Waters, within the Exclusive Economic Zone and Contiguous Zone, and it borders the Belgium Exclusive Economic Zone and Contiguous Zone (*map 1*).

Several cables and pipelines that are in use, as well as out of use, run through the wind farm zone. An aggregate extraction area is located southeast of it, a piloting area can be found to the east, while anchoring areas and the shipping lane are located north of the zone. The Belgian dedicated offshore wind zone lies directly southwest of it (*map 2*).

### 1.2 Archaeological heritage management in the Netherlands

In 1992, the Netherlands signed the European Convention on the Protection of the Archaeological Heritage, also called the 'Valletta Convention'. Since then, the premise of (national) policy is that archaeological values should be taken into account in any and all decision making regarding spatial planning in the Netherlands.

The basis of the Valletta Convention is that all traces of past human societies, that are preserved in the subsoil (i.e. the archaeological record), should be protected and managed as common European heritage.[2] In order to do so:

- archaeological values should be considered from the outset in spatial planning;
- archaeological remains should be preserved within the subsoil as much as possible (preservation *in situ*);
- initiators of soil disturbing activities can be held accountable for the costs of archaeological research, if preservation in situ is not possible. This is the 'developer pays' principle.[3]

Starting from the idea that historical awareness of one's environment is important, the Valletta Convention also focuses on making results of archaeological research available for the public. In order to preserve the archaeological record for posterity and ensure that it can still be consulted in the future, archaeological heritage management (AMZ: *Archeologische Monumentenzorg*) aims at preserving, protecting and managing the most valuable or representative archaeological remains. In situ preservation is the starting point. Only if no other options remain, an archaeological site should be excavated.

This is not only a task for archaeologists, but also and mainly for government bodies and all those who are concerned with spatial planning and development in the Netherlands. In the Netherlands, most spatial planning takes place at a municipal level. That is why the decision is made to let municipal governments play a key role in the implementation of the Valletta Convention. With the enactment of the Archaeological Heritage Management Act (Wamz: *Wet op de archeologische monumentenzorg*) and the revision of the Monuments Act (*Monumentenwet 1988*) on the 1st of September 2007, decision making with regard to managing the archaeological record has for the most part been decentralized and takes place at municipal level. Municipal archaeological policy is normally implemented through spatial planning policy and procedures.

2 http://conventions.coe.int/Treaty/en/Treaties/html/143.htm

3 The motivation for this is that those who have an economic (or other) interest in disturbing the soil, should also be stimulated financially to spare the archaeological record.

When the Minister of Infrastructure and Environment (I&M: *Infrastructuur en Milieu*) has the role of competent authority, Rijkswaterstaat (the executive agency of the Ministry of Infrastructure and Environment) fulfils the role with regard to archaeological heritage management. This is the case in all projects situated in the Dutch part of the North Sea. This is also the case in all projects initiated by Rijkswaterstaat itself. How Rijkswaterstaat fulfils this role, is laid down in an agreement between Rijkswaterstaat and the Cultural Heritage Agency (RCE: *Rijksdienst voor het Cultureel Erfgoed*). The Cultural Heritage Agency acts as a consultant for Rijkswaterstaat.

The archaeological management procedure ('AMZ-cyclus') is a set sequence of steps and decisions within archaeological heritage management in the Netherlands (*figure 3*). The procedure is embedded in the Quality Standard for Dutch Archaeology as the mandatory workflow for archaeologists (see also *paragraph 1.4*).

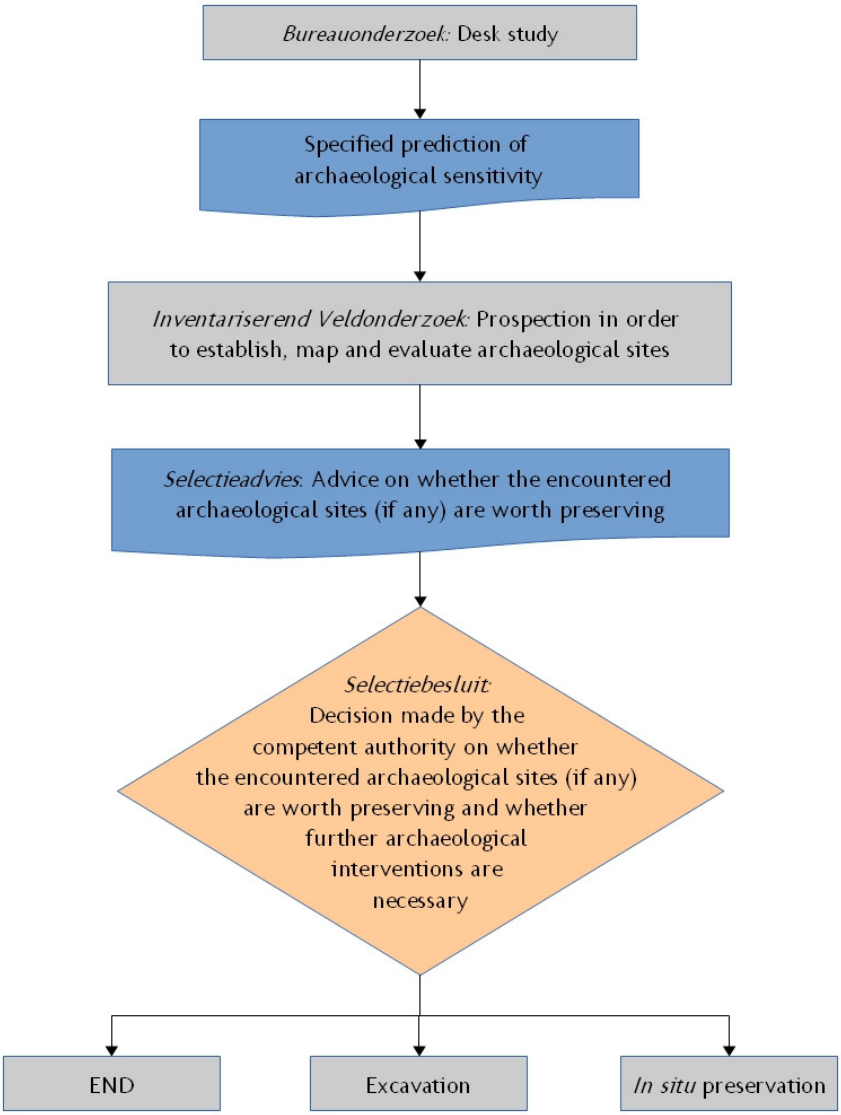



Figure 3 Archaeological management procedure in the Netherlands

### 1.3 Archaeological policy for the North Sea

The Cultural Heritage Agency (*Rijksdienst voor het Cultureel Erfgoed*: RCE) has published the *Globale Archeologische Kaart van het Continentaal Plat* (1:500,000). The map was published in July 2000.[4] This map distinguishes between three archaeological sensitivity zones: low sensitivity, medium sensitivity and high sensitivity. In a high sensitivity zone, the chance to encounter well-preserved remains of a historic ship or of a drowned archaeological landscape is relatively high.[5] According to this map, the wind farm zone, as well as its immediate surroundings, are largely located in a medium sensitivity zone. High sensitivity has been assigned to a relatively small area in the south-east corner of the area (*map 4*).

4 http://www.cultureelerfgoed.nl/node/1380.
5 Deeben 2008, 67.

### 1.4 Objective and methodology

The desk study aims to establish whether archaeological remains are, or are likely to be, present within the Borssele wind farm zone as well as a 1-kilometer wide buffer zone around it, and whether these (possible) remains could be jeopardized 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 (1 km).

To this end, The Netherlands Enterprise Agency has asked Vestigia to answer the following research questions:[6]

1. Define an overview of the archaeological aspects on which basis the wind farm zone will be assessed.
2. Assess whether there are (indications for) areas with specific archaeological interest (wrecks and prehistoric life) at the Borssele wind farm zone.
3. If present, define expected location, size and dating of the areas with specific archaeological interest.
4. Determine the possible effect of the installation of offshore wind farms on the areas with specific archaeological interest.
5. Assess possibilities to mitigate the disturbance of areas with specific archaeological interest as a result of installing offshore wind farms.
6. 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.
7. Define requirements for any activity carried out in the wind farm zone (investigations or monitoring activities, installation activities, operational activities) that could have an effect on archaeological aspects in the wind farm zone.

All archaeological surveys in the Netherlands must comply with the Quality Standard for Dutch Archaeology (*Kwaliteitsnorm Nederlandse Archeologie*: KNA). There is a Quality Standard for archaeological surveys on land (KNA) as well as one for archaeological surveys of waterbeds: (KNA *Waterbodems*). This desk study is conducted in compliance with the KNA *Waterbodems* 3.1.[7] The Quality Standard is available through the website of the *Stichting Infrastructuur Kwaliteitsborging Bodembeheer* (SIKB), a network, encompassing both the private and the public sector, set up to continuously and structurally enhance the standards of activities relating to soil management in the Netherlands.[8]

In an archaeological desk study an assessment is made of the area under survey, using existing and published sources. For this desk survey the following sources have been used:

1. M. Timmerman/R. de Bruijne, 2014: *Site Studies Wind Farm Zone Borssele: Starting points & Assumptions Wind Farm Zone Borssele*, Utrecht (RVO), 1 September 2014.
2. M. Timmerman, 2014: *Site Studies Wind Farm Zone Borssele: Scope description Archaeological Desk Study*, Utrecht (RVO), 16 July 2014.
3. J.K. Haasnoot/E. Diepstraten/C. Kleiboer, 2014: *Geological desk study windpark Borssele*, Amsterdam (CRUX report RE14254a1), 30 June 2014.

6 Timmerman 2014.
7 Centraal College van Deskundigen Archeologie, 10 December 2007.
8 http://www.sikb.nl.

4. M.P. Hijma/K.M. Cohen/W. Roebroeks/W.E. Westerhoff/F.S. Busschers, 2012: Pleistocene Rhine-Thames landscapes: geological background for hominin occupation of the southern North Sea region, *Journal of Quaternary Science* 27 (1), 17-39.
5. DINOloket: portal for Data and Information on the Dutch Subsoil: http://www.dinoloket.nl/ Through this portal descriptions of coring samples of the Geological Service of the Netherlands (TNO - *Geologische Dienst Nederland*) can be accessed.
6. Archis2: Archaeological Information System: http://archis2.archis.nl
   Archis is an online database that contains information on known archaeological sites and on their legal status (protected by law or not), on archaeological finds, and on conducted archaeological surveys. Archaeological contractors are obliged to register their surveys and subsequent finds in Archis. Archis is managed by the Cultural Heritage Agency (*Rijksdienst voor het Cultureel Erfgoed*: RCE).
7. DANS-EASY: online archiving system of the Data Archiving and Networked Services (DANS): https://easy.dans.knaw.nl.
   The electronic repository for Dutch archaeology (*elektronisch depot voor de Nederlandse archeologie*: EDNA) manages the digital research documentation of Dutch archaeologist. This repository is hosted by DANS. Through the online archiving system, the digital research documentation of executed surveys can be accessed.
8. Hydrografische Dienst: Hydrographic Services of the Dutch Royal Navy.
9. RCE: the Dutch Cultural Heritage Agency.
10. MACHU GIS: an internet application for Managing Cultural Heritage Underwater, hosted by Rijkswaterstaat.
11. Agentschap Onroerend Erfgoed: Flemish Cultural Heritage Agency.
12. Wreck Site: online wreck database: http://www.wrecksite.eu.
13. SGLO: Studiegroep Luchtoorlog 1939-1945: http://www.airwar39-45.nl/.
14. Historic maps accessible through: http://watwaswaar.nl; http://www.gahetna.nl/; http://www.geheugenvannederland.nl/ and http://imagebase.ubvu.vu.nl/.
15. Archaeological literature and reports.
16. Geological literature and reports.

## 2 Geological history and palaeo-landscape

The wind farm zone is located in the southern part of the North Sea, on the basin shoulder in the Southern Bight area.[9] As stated in an earlier desk study covering the Borssele wind farm zone, the publicly available geological data are scarce.[10] As the (deeper) geological strata in the area have not been considered of particular high value for public or commercial use, this may also have been the explanation for the lack of data collection in regard to the shallow subsurface. To date there are 131 locations recorded with some form of geological information within the wind farm zone: 77 of these locations are marked as geological bore or coring logs[11], resulting in a density of 0.013 per hectare.

When selecting the bore logs giving a description of - at least - the first 2 meters of the subsurface, only 59 records remain. As a result, the current analysis of the geological characteristics in relation to their archaeological potential is based on information (both maps and cross sections) aimed for use on a much *larger scale* than just the area of the wind farm zone and its direct surroundings. Reliable predictions of the presence, and distribution of subsurface levels with archaeological potential are therefore not possible.

However, two recently published geological cross-sections - parts of which are located within the wind farm zone (*annex 3 and map 3*) - give some indications.[12] These two cross-sections, numbered IX and X, can be used to summarize the relevant geology within the research area. Geological layers and levels of any archaeological significance in the wind farm zone are limited to the top of the Tertiary, the Pleistocene and the early to mid-Holocene deposits.[13]

In some parts of the wind farm zone, the top layer of the pre-Holocene sediment is formed by Neogene material. These areas are indicated as 'Tertiairy' in *annex 3* and *map 3*.[14] In most parts, however, it is formed by Pleistocene deposits. Most of these Pleistocene deposits are Pleniglacial fluvial deposits, formed by the Rhine-Meuse river system. In the southern part of the wind farm zone, as seen in cross section X in *annex 3,* some Eemian and early Weichselian shallow marine and estuarine deposits are present as well (unit MIS 5).

In addition to this, at a few locations early Holocene terrestrial deposits seem to cover the Late Pleistocene or Neogene (or Tertiary) deposits. These areas are shown in the cross section of *annex 3*, under the units EH and BP:

- the Basal Peat Bed (BP): In the wind farm zone, the Basal Peat Bed is of early to earliest middle Holocene age. It started to form when a downstream advance of sea-level rise lead to a groundwater-table rise.[15] Locations where the Basal Peat Bed is present indicate the preserved remnants of a late Pleistocene to early Holocene landscape. These locations are "[...] *of importance for in situ offshore Late Palaeolithic and Mesolithic archaeology"*.[16]

9 Hijma et al. 2012, figure 1.
10 Haasnoot et al. 2014, 9.
11 DINO*loket* (www.dinoloket.nl), accessed September 2nd, 2014.
12 Hijma et al. 2012.
13 For a more complete description of the geology and palaeogeographical development of the Southern Bight see e.g. Haasnoot et al. 2014, Hijma et al. 2012, Cohen et al. 2014.
14 In the most recent version of the chronostratigraphic chart by the International Commission on Stratigraphy (ICS), the Tertiary is no longer recognised as a formal unit. Cohen et al. 2013.
15 Hijma et al. 2012.
16 Hijma et al. 2012.

- the Early Holocene deposits (EH): This unit consists of fine-grained Rhine-Meuse deposits, formed in either a floodplain or flood basin situation before the Holocene transgression, or as freshwater to brackish-tidal deposits during the first phase of the Holocene transgression.[17]

Unfortunately, it is at present not possible to demarcate these areas spatially any further, because of the absence of reliable core data. Several miles further east of the wind farm zone an area has been identified, relatively rich in human artefacts, dating from the Middle Palaeolithic and younger periods. From this so-called Zeeland ridges site (see paragraph 3.1), also a Neanderthal skull fragment seems to have been retrieved. The find spot is situated on the lower edge of one of the sand banks that cover most of the sea bed. More specifically: that sand bank extends to the southernmost edge of the wind farm zone.

It is likely that the geological characteristics of the area around this find spot can be compared to those where the EH unit is still present in the geological record within the wind farm zone (see cross section IX, *annex 3*). As mentioned earlier, the low density of geological data within the research area does not allow any detailed mapping of the extent of these areas. Perhaps high density 2D and 3D seismic data collection and interpretation can add to the mapping of these units and to their placement in the palaeogeographic framework and development of the southern North Sea.[18]

The base of the younger Holocene deposits mainly consists of reworked fluvial deposits. Later deposits are formed in a gradually more marine environment, and consist of coastal deposits to onshore and near shore beach barrier deposits.

The remains of the Pleistocene and early Holocene landscape in the wind farm zone Borssele are located at a depth of about 30 to 40 meters below present day sea level (*map 3* and *annex 3*). This means that around the transition from Late Palaeolithic to early Mesolithic, most, if not all, of the area in and around the wind farm zone had been submerged by the expanding North Sea (*figure 4*).

17 Hijma et al. 2012, Hijma et al. 2009.

18 Rijsdijk et al. 2005, Van Heteren et al. 2014.

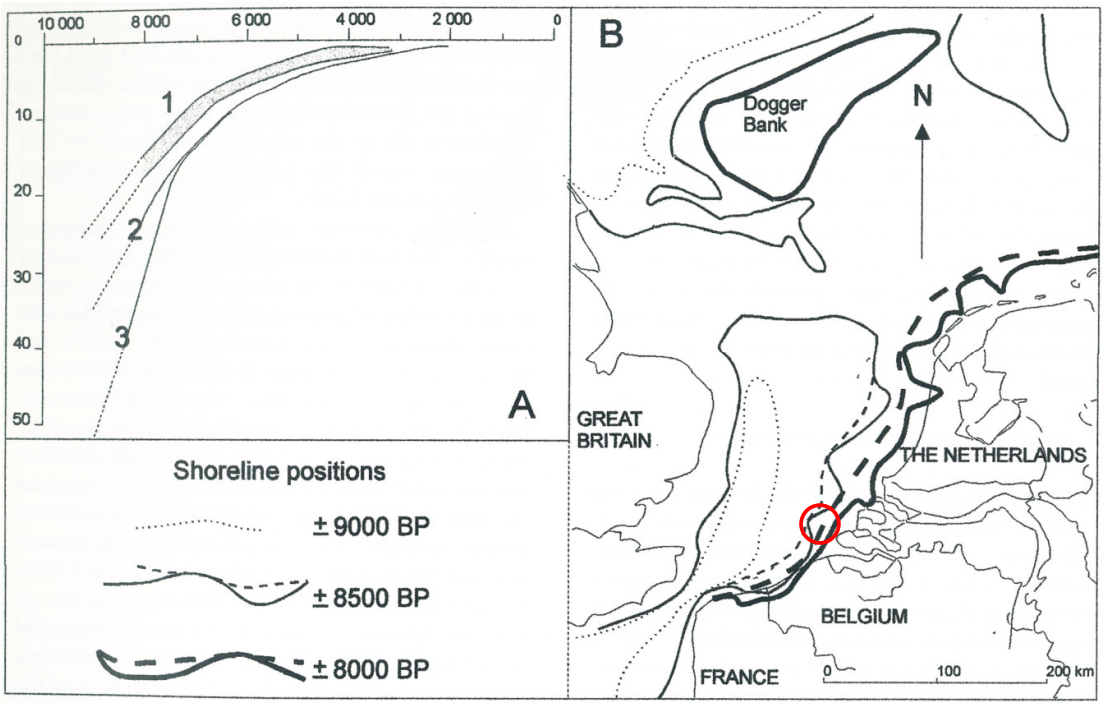



Figure 4 Sea level rise and resulting flooding history. A: time/depth plot of RSL rise for (1) the Belgian coastal plain, after Denys & Baeteman (1995), (2) the Holland coastal plain, after Jelgersma (1961, 1979), Van de Plassche (1982) and Van de Plassche & Roep (1989), and (3) the North Sea north of the Frisian Islands, after Behre et al. (1979) and Ludwig et al. (1979, 1981); the Belgian curve has been plotted as envelope; the basis for drawing this envelope was discussed by Denys & Baeteman (1995). B: Flooding history of the Southern Bight based on the RSL curve of figure 3A (extrapolated for the 9000 and 8500 reconstruction) and the reconstructed pre-transgressional surface (= reconstructed top of the Early Holocene back-barrier deposits, based on the 1:250,000 sheets of the southern North Sea by the Geological Surveys of the UK, the Netherlands and Belgium, and the unpublished map of the base Holocene of the Dutch sector of the North Sea by Kenneth Rijsdijk; solid lines represent the landward boundary of the back-barrier, dashed lines are the inferred barrier coastlines (Beets/Van der Spek 2000); wind farm zone roughly indicated in red

# 3 Archaeology

## 3.1 Prehistoric archaeology

During most of the Pleistocene, large areas of the North Sea were dry land. Extensive river systems with wide river channels and river planes characterised the area. These provided rich habitats for large herds of herbivores and for the animals that preyed on them.[19] North-western Europe was populated by the Neanderthals from c. 500,000 years ago. From 40,000 years ago, modern humans entered the scene. This marked the transition from Upper Palaeolithic to Middle Palaeolithic, a transition in stone knapping technology and the physical appearance of the artefacts.[20] The Middle Palaeolithic is characterised by the Levallois technique and by bifaces or hand-axes.[21] The Levallois technique consist of the careful preparation of a stone core. Through knapping, a turtle-shaped core is made. After the core has been given the desired shape, large, relatively thin flakes are removed from it. These are then shaped into side-scrapers for example.[22] Artefacts from the Middle Palaeolithic are often found on the beach near Cadzand. These finds most likely originate from Middle-Pleistocene layers in the North Sea bed.[23] Apart from these Middle Palaeolithic artefacts, finds at these beaches range from Jurassic fossils and shark teeth from the Tertiary to Roman and Medieval pottery. Among the Middle Palaeolithic finds are a Levallois core and a small hand-axe.[24] Small hand-axes and Levallois flakes were also dredged up from the bottom of the North Sea at the Zeeland Ridges. The flint knapping technique in the Upper Palaeolithic is aimed at producing relatively long blades.[25] Such blades have also been found on the beach of Cadzand.[26]

Apart from the artefacts, a small piece of a Neanderthal skull is thought to have been dredged up from the seabed east of the research area.[27] Radiocarbon and nitrogen isotopic analysis revealed that this hominin had been highly carnivorous and no evidence was found for an aquatic diet.[28] The skull part originated from a location 9 miles southeast of the wind farm zone.

At the start of the Mesolithic, sea levels in the North sea were around 65 meters lower than today, as much water was stored in the ice sheets. As the climate became warmer with the onset of the Holocene, c. 11.700 years ago[29], the ice sheets melted and sea levels started to rise. The landscape changed dramatically. In 2000 years sea level rose almost 40 meters and the North Sea basin drowned. Many Mesolithic (as well as Upper Palaeolithic) finds have been dredged up from the North Sea. In the 1980s more than 500 spearheads, arrowheads and harpoons, made out of bone and antler, were collected from the beaches of the Maasvlakte, as well as thousands of pieces of flint (all unworked). Along the Dutch coast and on the bottom of the North Sea axes have been found, made out of animal bone (such as aurochs) and antler, as well as flint tools.[30] The archaeological survey in relation to the realisation of the Yangtze harbour on Maasvlakte 2, the expansion of the port of Rotterdam off the Dutch coast, yielded ample evidence for Mesolithic habitation on a river dune complex. This dune complex probably drowned

19 Hublin *et al.* 2009, 777.
20 Rensink 2005, 119.
21 Rensink 2005, 123-124.
22 Verhart 2005a, 85.
23 Rensink 2005, 129.
24 Stapert 1981, 293-298.
25 Verhart 2005a, 85.
26 Stapert 1981, 293.
27 The skull fragment was found on land, in deposits extracted from the Zeeland ridges.
28 Hublin *et al.* 2009.
29 Rasmussen *et al.* 2006.
30 Verhart 2005b, 157-159.

around 6400/6300 BC, as a result of sea level rise, and human occupation ended around 6500 BC.[31] Before that, it had been occupied over many generations, stretching up to 1500 years. Occupation of the dune complex was not permanent, but most likely for short periods in different seasons and probably with some years in between visits. Use of the dune complex by its human occupants will obviously have changed over time in intensity, seasonality and purpose. Evidence of Mesolithic occupation of the Meuse delta is not unique and has been established in several places, in the area, so far exclusively on river dunes. [32]

To date no prehistoric finds have been registered in Archis, allocated within the wind farm zone, or the buffer zone. As most, if not all, of the wind farm zone had been submerged by the expanding North Sea around the transition from Late Palaeolithic to Early Mesolithic (c. 8,000 BP, i.e. c. 7,000 BC), prehistoric sites present in the wind farm zone - if any - should date from the Middle and Upper Palaeolithic periods. These sites are extremely low in density. Any possible Upper Palaeolithic and Early Mesolithic sites in the area can only have been situated on higher parts within the landscape, which consequently were also more exposed to later erosion. The chances of encountering well-preserved early prehistoric sites with *in situ* remains are therefore very slim, but cannot be completely excluded.

### 3.2 Historic archaeology

The Wind Farm Zone Borssele is situated in a part of the North Sea known for its dense sea traffic and trade routes from the time of earliest written records onwards. In the Roman period commercial trade and military traffic between Southern Britain, Northern France, The Flanders coast and the estuaries of Scheldt and Meuse rivers in what presently is called Zeeland and Zuid-Holland must already have been intensive. Epigraphic information from altar stones, archaeological finds and building materials found in Domburg and Colijnsplaat suggest that grain, salt, wine, fish sauce and other bulk goods were transported both ways between the southern North Sea basin (via Zeeland) and the Rhineland. The two Roman military fleets based on the Rhine and in coastal Britain also saw action in this area. Major military stations were situated at Oudenburg in Western Flanders and at Aardenburg in present Zeeuws-Vlaanderen.

Later on, in medieval times, trade in the southern North Sea area was even more intensive. The wind farm zone is situated more or less on the main route for wool traders from England towards the mouth of the Zwin and Scheldt estuary and the trade centres of Bruges, Gendt and Antwerp. From the late 16$^{th}$ century onwards the Dutch harbours of Vlissingen, Veere and Middelburg also became important centres for intercontinental trade and military and commercial shipbuilding. The merchant ships, especially on their way in from the English Channel attracted pirates, notorious amongst them those from Dunkirk. In that light it can be easily assumed that in general ship movements and the chance of incidents in the area of the wind farm zone will have been more than average.

It is assumed that prior to the introduction of accurate sea maps and modern navigational instruments, ships sailing the sea will for the most part have followed the shorelines. Although keeping the shore in sight aided navigation, coastal waters could be treacherous. In earlier and later times alike, in-depth knowledge of the coastal waters with its shallows, rocks and channels, would be vital to successful navigation and the approach of ports and harbours. The compass was introduced in Europe during the 12th century and nautical charts appeared by the end of the 13th century. These so-called portolan charts were navigational maps based on compass directions and estimated distances. An example of a late medieval portolan chart of the southern North Sea is shown in *figure 5*. England is situated on the left

31 Moree/Sier (eds.) 2014, 289.
32 Moree/Sier (eds.) 2014, 300-301.

and the French, Flemish and Dutch coast on the right, with cities like Boulogne, Bruges, Dordrecht and Utrecht.

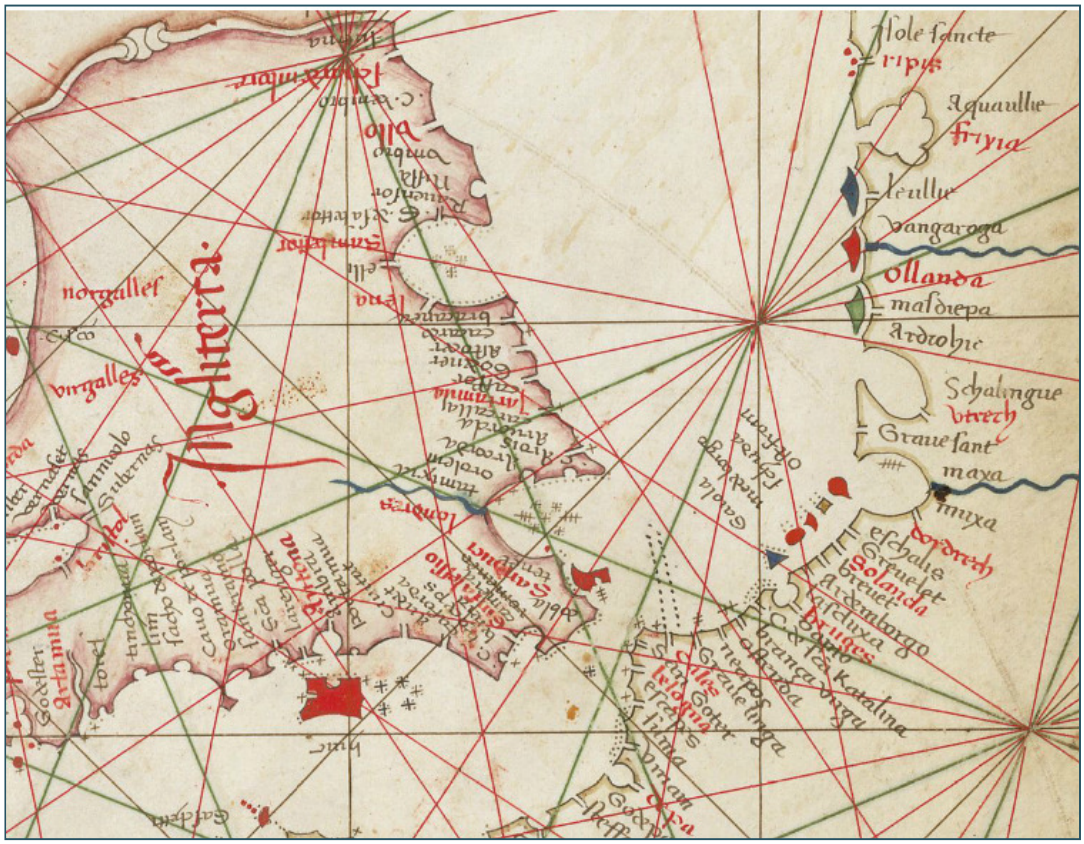



Figure 5 Part of a nautical chart of Western Europe from 1473 by Grazioso Benincasa (British Library), wind farm zone not indicated due to inaccuracy of the chart

Sea charts from the 16th century onwards show the many sand banks flanking the Flanders coast and the coast of the Dutch province of Zeeland in the vicinity of the wind farm zone *(figures 6-8)*. Although smaller ships and fishing boats can pass these banks without much hindrance, for larger vessels this area can be treacherous. Modern shipping lanes are therefore situated west of this area, in historic times however inshore sailing was much more common and must have led to many accidents in the area.


Figure 6 Part of a chart from the Spiegel der Zeevaerdt by Lucas Janszoon Waghenaer from 1588 with the north in the left bottom corner (Biblioteca Digital Hispánica - Biblioteca Nacional de España), wind farm zone not indicated due to inaccuracy of the chart

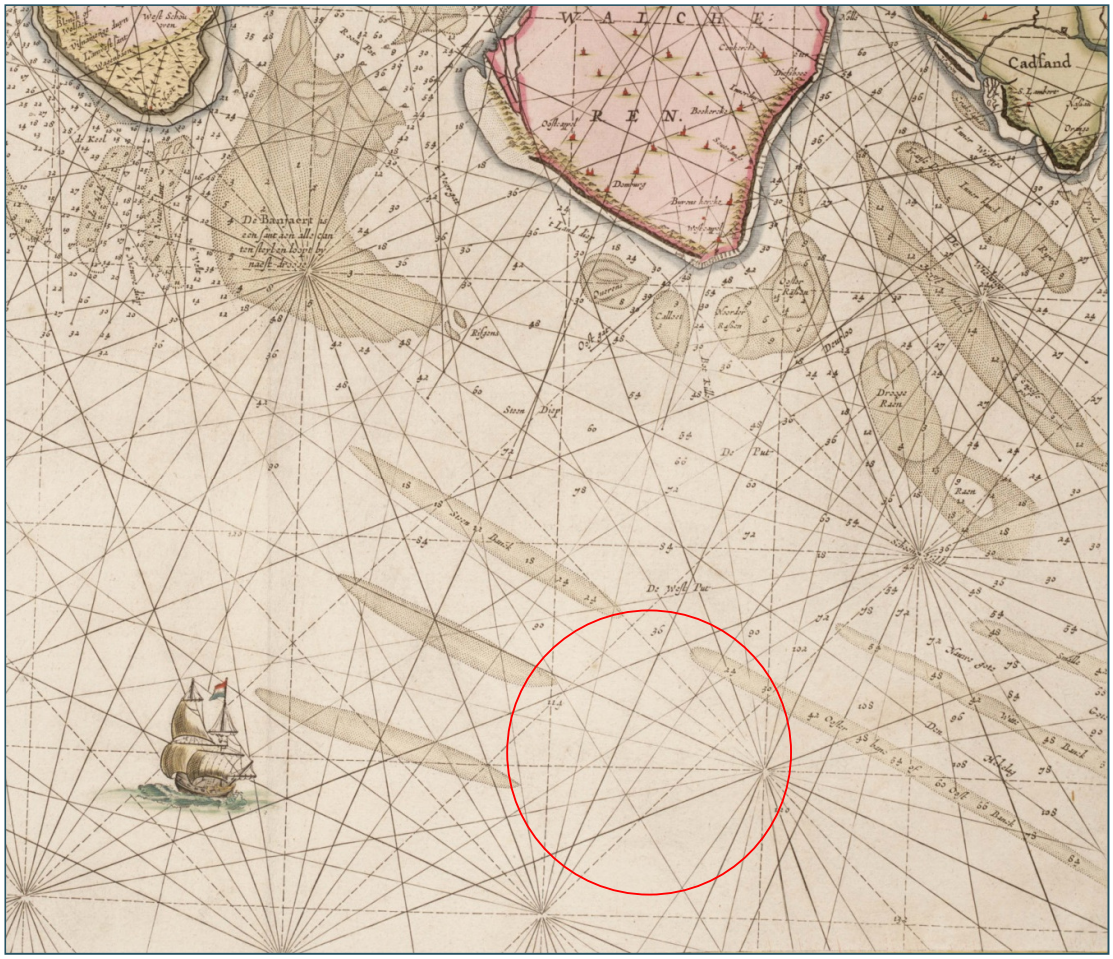



Figure 7 Part of the map of Zeeland by Pieter Goos from 1666 with the north in the left bottom corner and the wind farm zone roughly indicated in red (Geheugen van Nederland)

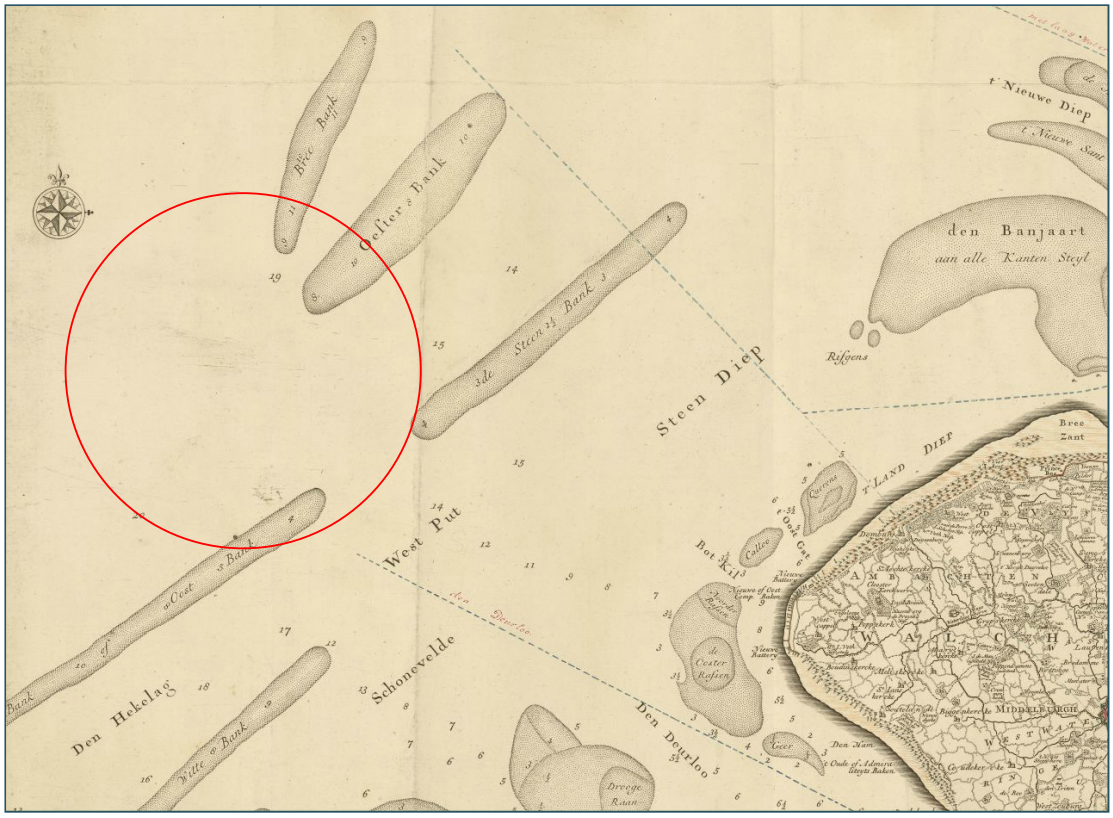



Figure 8 Part of a map from 1781 with the north above and the wind farm zone roughly indicated in red (Nationaal Archief)

According to Article 1 of the United Nations' Convention on the Protection of the Underwater Cultural Heritage, underwater cultural heritage concerns "all traces of human existence having a cultural, historical or archaeological character which have been partially or totally under water, periodically or continuously, for at least 100 years."[33] In the Netherlands, where the Convention has not been ratified, no such age limit has been established to determine whether a shipwreck is of historic value. In practice, however, wrecks and objects dating from the 20th century will normally not be selected for *in situ* protection or further documentation or excavation. An exception is made for wrecks and objects related to World Wars I and II, because of their specific historic context, and because they can also be considered as possible war graves. The same is true for crashed warplanes, in majority dating from the World War II.

The wind farm zone belongs to a part of the North Sea where in both World Wars multiple naval actions and naval manoeuvres have taken place. Apart from many smaller incidents and manoeuvres, two large scale operations draw attention in relation to the wind farm zone:

1) During World War I, in April and May 1918, the docks of Oostende and Zeebrugge were attacked several times from the sea by British naval forces. During the gun battles several British ships were damaged and sunk.
2) In October and November 1944 Operation Infatuate took place, which was part of the Battle of the Scheldt (*figure 9*). It was an attempt by the allied forces to drive the Germans from the mouth of the Scheldt river, by assaults on the coast of Walcheren in combination with heavy

[33] http://www.unesco.org/new/en/culture/themes/underwater-cultural-heritage/2001-convention/official-text/.

naval bombardments and air attacks. Several naval units were stationed in the Borssele wind farm zone during bombardments and the following assault.

The wind farm zone also seems to be located under one of the regular flight routes used by the allied air forces for attacks on Germany. Especially fighter escorts taking off from airfields in southeast England regularly flew over the area en route to join the bombers based in East Anglia and Lincolnshire over the Dutch coast.

Summing up, the chances to encounter ship wrecks or plane wrecks and other relics from both World Wars can be considered greater than average for this part of the North Sea. No records are available about systematic recovering or salvage operations in the area during or after World War II.

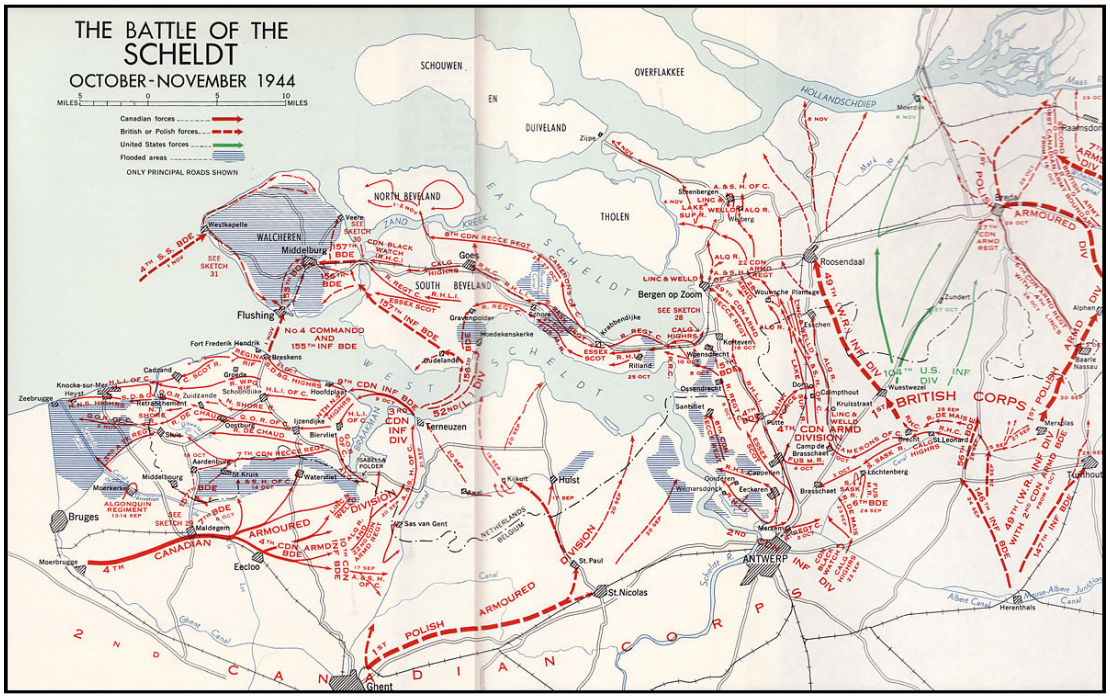



Figure 9 Visualization of the Battle of the Scheldt from *Official History of the Canadian Army in the Second World War: Volume III. The Victory Campaign, The Operations in North-West Europe 1944-1945* (1960)

### 3.3 Recorded shipwrecks and other obstructions

For this desk study Vestigia has used a number of sources. In below subparagraphs the data from each source will be discussed.

#### 3.3.1 Archis

The Dutch Cultural Heritage Agency (*Rijksdienst voor het Cultureel Erfgoed - RCE*) keeps track of an elaborate database of archaeological monuments and finds within the Netherlands, including the Dutch North Sea. This database is named 'Archis'. No historic shipwrecks from the wind farm zone or its immediate surroundings are registered in this database. *Table 2* and *map 4* show the finds registered in Archis within a 10 km distance of the wind farm zone and its 1 km buffer.

Table 2 Finds registered in Archis in the greater vicinity (10 km) of the wind farm zone

| Number | Found | Find | Archaeological period | Remarks |
|---|---|---|---|---|
| 46,694 | 1986 | U-boat | AD 1850-1950 | UB 13 |
| 46,767 | 1982 | wooden ship | AD 1650-1850 | VOC ship *'t Vliegend Hart*, sunk on February 3 1735 |
| 46,730 | 1986 | iron ship | AD 1850-1950 | SS Vecht |
| 47,907 | 2000 | wooden ship part | AD 1500-1650 | Dekknecht |
| 48,186 | 1992 | iron ship | AD 1850-1950 | SS Tubantia |

The oldest find registered in Archis (Archis-number 47,907) in de greater vicinity of the wind farm zone, is a so-called *dekknecht* carved to resemble a man with moustache and turban (oak; 85 cm high). A *dekknecht* (literally: 'deckhand') is a large wooden block that sits on the deck and which is part of a hoisting mechanism. It is thought to date to the sixteenth or first half of the seventeenth century and was fished up by a fishing vessel. The 18th-century ship *'t Vliegend Hart* will be discussed in paragraph 3.3.2 (Archis-number 46,767). The steamer *SS Vecht* was a iron cargo carrier (Archis-number 46,730). It sank in the night of March 7 1940, after it was torpedoed by the German U-boat U-14, despite the fact that it carried neutrality-signs.[34] None of the crew of 22 survived the attack. The ship was built in the Netherlands in 1917. But before it was called the *SS Vecht* and owned by a Dutch ship owner, it had been owned by a Swedish one and was called *SS Graakallen*. This is the name that can be seen on the ship's bell. The wreck is 80 meters long and 12 meters wide an protrudes 6 meter from the seabed. Another casualty of a German torpedo, but during a different war, is the *SS Tubantia*. This passenger steamer was built in 1913 and sank on March 15 1916. When it sank, 50 miles from the coast, it was on route from Rotterdam to Buenos Aires. All passengers and crew were rescued.[35] From the wrecksite, an anchor, Chinese porcelain, 25 bottles of gin and a chamber pot have been lifted Archis-number 48,186). The German U-boat UB-13 (built in 1915) was lost to a mine on April 25 1916 (Archis-number 46,694). All 19 hands were lost.[36] All the wrecks that have been discussed so far, are still present on the seabed.

### 3.3.2 MACHU

The MACHU database consists of combined information by both the Dutch Cultural Heritage Agency (*Rijksdienst voor het Cultureel Erfgoed - RCE*) and Rijkswaterstaat (part of the Dutch Ministry of Infrastructure and the Environment), as well as limited information from the Flemish Cultural Heritage Agency (*Agentschap Onroerend Erfgoed*). In the MACHU database there are no records of shipwrecks within the Borssel wind farm zone. *Table 3* and *map 4* show the finds registered in Archis within a 10 km distance of the wind farm zone and its 1 km buffer.

Table 3 Shipwrecks recorded in MACHU in the greater vicinity (10 km) of the wind farm zone

| MACHU no. | Type | Name | Built | Lost |
|---|---|---|---|---|
| NL_46,694 | submarine | UB-17 (Noordzee NCP blok S7) | 1850-1950 | 1850-1950 |
| NL_46,730 | wreck | *SS Vecht* (Schouwenbank 1 NCP blok S4) | 1850-1950 | 1850-1950 |
| NL_46,767 | East Indiaman | *'t Vliegend Hart* (Noordzee Westpit) | 1729 | 1735 |
| BE_W792 | fishing vessel | *Jeannine André* Z.442 (B129/306a) | 1941 | 1961 |
| BE_W1026 | East Indiaman | 't Vliegend Hart (B129/306B) | 1729 | 1735 |

34 http://www.wrecksite.eu.
35 http://www.wrecksite.eu.
36 http://www.wrecksite.eu.

Obviously, as far as the wrecks in Dutch waters are concerned, the records from Archis and MACHU overlap. However, there is a discrepancy in the descriptions. According to Archis, record 46,694 indicates the location of U-boat 13. According to MACHU this record (same number, same location) refers to UB-17. However, UB-17 wrecked off the British coast.[37] The most famous wreck from the greater vicinity of the wind farm zone is that of *'t Vliegend Hart* (also known also '*t Vliegend Hert*).[38] The vessel dates from 1729 and belonged to the Dutch East India Company. On February 3 1735 it sank after hitting a sandbank. The complete crew of 256 sailors drowned. In September 1981 the wreck was rediscovered and various objects were salvaged from the vessel, including its treasure chest with 7,000 gold and silver coins. In MACHU both the Dutch record 46,767 and Belgian BE_W1026 are related to this wreck. The other Flemish record in MACHU refers to the 20th-century fishing vessel Jeannine André Z.442 (record BE_W792).[39]

### 3.3.3 Dutch Cultural Heritage Agency

Additional data have been received from the Dutch Cultural Heritage Agency.[40] These data largely overlap with the data from the other datasets discussed here. Therefore, the data will not be discussed in full here and most of the data are not shown on *map 5*. The additional information from this dataset mostly concerns the names of ships, information that is for the most part lacking for example in the received dataset from the Hydrographic Services of the Dutch Royal Navy. Based on the data received from the Cultural Heritage Agency the name of the wreck with HLHO no. 1738 (*table 5*) is the *SS Cito*. This cargo ship was built in 1899 and it was sunk during World War I on 17 May 1917, causing 11 people to lose their lives.[41] The data also indicate that the wreck with HLHO no. 2902 (*table 6*) could be the British destroyer HMS Simoom. This ship was built in 1916 and was torpedoed by German destroyers on 23 January 1917. This caused the ship's magazine to explode. The Simoom carried a complement of 90. Many lives were lost.[42] A wreck that does not feature in any of the other datasets is that of the German submarine UC-10 (*map 5*). This vessel was built in 1915 and torpedoed on 21 August 1916. All hands were lost.[43] Because the reported location of UC-10 does not correspond to any sonar contact in the datasets of the Hydrographic Services of the Dutch Royal Navy or of Rijkswaterstaat, the location has not been verified.

### 3.3.4 Flemish Cultural Heritage Agency

On the other side of the border, in the Belgian Exclusive Economic Zone, there are several known shipwrecks in the greater vicinity (10 km) of the wind farm zone (*map 5*). The wrecks are shown in *table 3*. Not all records relate to shipwrecks per se. Some may refer to an unknown object (such as number 2171) or to an event. In case of number 2419 the reported event was nets getting caught behind something. The data were received from the Flemish Cultural Heritage Agency (*Agentschap Onroerend Erfgoed*).[44] *Table 4* and *map 5* show the wrecks, obstructions and events registered in the database of the Flemish Cultural Heritage Agency within a 5 km distance of the wind farm zone and its 1 km buffer.

37 http://www.wrecksite.eu.
38 Termote/Termote 2009, 307-310.
39 Termote/Termote 2009, 305-306.
40 E-mail from Johan Opdebeeck, 3 September 2014.
41 http://www.wrecksite.eu.
42 http://www.wrecksite.eu.
43 http://www.wrecksite.eu.
44 E-mail from Ine Demerre, 3 September 2014.

Table 4 Shipwrecks, obstructions and events recorded in Belgian waters in the greater vicinity (5 km) of the wind farm zone

| HLHO no. | Type | Name | Built | Lost |
|---|---|---|---|---|
| 1788 | fishing vessel | Jeannine André Z.442 | 1941 | 1961 |
| 1935 | fishing vessel | Normandie Z.511 | 1955 | 1977 |
| 1937 | submarine | UC-62 | - | 1917 |
| 2108 | East Indiaman | 't Vliegend Hart | 1729 | 1735 |
| 2168 | cargo carrier | Grutto SS | 1925 | 1940 |
| 2171 | other | - | - | - |
| 2172 | ship | ZZB 146/241 | - | - |
| 2419 | event (net stuck) | - | - | - |
| 2660 | ship | ZZ 136/252 | - | - |
| 3025 | ship | Grote Rede 1 | - | between 1900 and 1950 |
| 3063 | ship | ZH 139/247 | - | between 1700 and 2000 |
| 3107 | ship | ZH 140/252 | - | between 1900 and 1950 |

Records 1788 and 1935 refer to the 20th-century fishing vessels *Jeannine André* Z.442[45] (also in MACHU) and *Normandie* Z.511[46] that have sunk near the wind farm zone. The record 2108 refers to the already mentioned wreck of *'t Vliegend Hart*. *SS Grutto* (record 2168) was a Dutch steam freighter of 920 tons. The vessel was torpedoed March 5 1940 by the German U-boat U-17, while on voyage from Rotterdam to Gravesend. There were 18 casualties.[47] Record 1937 is a wreck of such German U-boat: the UC-62, sunk in 1917.[48] Other records refer to unidentified shipwrecks such as 2172, 2660, 3025, 3063 and 3107 with only limited additional information. The wreck of an iron vessel found on the Grote Rede (named *Grote Rede 1*, record 3025) probably dates from the first half of the 20th century. The ship in record 3107 probably dates from the same period. The ship in record 3063 is likely older; in this case some wooden beams have been found.[49]

### 3.3.5 Data from the Hydrographic Services of the Dutch Royal Navy

The Hydrographic Service of the Royal Netherlands Navy (*Hydrografische Dienst*) also maintains a database with wrecks and obstructions located on the bottom of the sea (*map 5*). The Hydrographic Service data used for this project have been received through the Netherlands Enterprise Agency[50] as well as through REASeuro, the company that executed the unexploded ordnance desk study.[51] Because both received datasets differ from each other, they have been combined on *map 5*. The data that have been received do not include an elaborate description of the recorded obstructions. The Hydrographic Service database contains a number of records that fall within the boundaries of the wind farm zone (*table 5*), and several records in the greater vicinity (*table 6*). *Map 5* and *table 6* show the records from the obstruction database that lie within 5 km of the wind farm zone and its 1 km buffer.

There are a few records in the received digital dataset from the obstruction database that stand out because their HLHO numbers cannot be related to any wreck numbers in the printed wreck registry of the Hydrographic Service from 2011 or any subsequent published additions and amendments.[52] These are obstructions 39-44 (*map 5*). It is unclear what the nature of these obstructions is, or where these data

45 Termote/Termote 2009, 305-306.
46 Termote/Termote 2009, 331-332.
47 Termote/Termote 2009, 322-323.
48 Termote/Termote 2009, 325-328.
49 Termote/Termote 2009, 331.
50 E-mail from R.ein de Wolf, 17 September 2014.
51 E-mail from Marco Taks, 23 September 2014.
52 Dienst der Hydrografie, Koninklijke Marine 2011.

originated from. Although the Hydrographic Service database holds wrecks with such numbers, these can not in any way be related to the wind farm zone or its greater vicinity and have therefore been omitted from *tables 5 and 6*.

Table 5 Wrecks and obstructions recorded in the Hydrographic Service database within the wind farm zone

| HLHO no. | Type | Name | Built | Lost |
|---|---|---|---|---|
| 1703 | wreck | Alca Torda (Z587) | 1966 | 1973 |
| 1723 | wreck | - | - | - |
| 1738 | wreck | Cito SS | - | - |
| 3644 | remains | - | - | - |
| 3645 | remains | - | - | - |
| 3646 | remains | - | - | - |
| 3657 | remains | - | - | - |
| 3658 | remains | - | - | - |
| 3666 | remains | - | - | - |
| 3671 | remains | - | - | - |

Table 6 Wrecks and obstructions recorded in the Hydrographic Service database in the greater vicinity (5 km) of the wind farm zone

| HLHO no. | Type | Name | Built | Lost |
|---|---|---|---|---|
| 1322 | unknown | - | - | - |
| 1667 | unknown | - | - | - |
| 1683 | wreck | Grethe Dania | 1969 | 1981 |
| 1693 | unknown | - | - | - |
| 1704 | unknown | - | - | - |
| 1714 | unknown | - | - | - |
| 1715 | unknown | - | - | - |
| 1716 | wreck | - | - | - |
| 1746 | wreck | - | - | - |
| 1747 | wreck | Frans | - | - |
| 1758 | wreck | OD 5 | - | - |
| 1769 | wreck | Tubantia | - | - |
| 2595 | wreck | Copenhagen? | - | - |
| 2730 | wreck | - | - | - |
| 2736 | wreck | - | - | - |
| 2902 | wreck | HMS Simoom? | - | - |
| 2952 | unknown | - | - | - |
| 3139 | obstruction | - | - | - |
| 3140 | obstruction | - | - | - |
| 3638 | remains | - | - | - |
| 3647 | obstruction | - | - | - |
| 3652 | wreck | - | - | - |
| 3659 | remains | - | - | - |
| 3660 | remains | - | - | - |
| 3661 | obstruction | - | - | - |
| 3662 | remains | - | - | - |
| 3668 | obstruction | - | - | - |
| 3672 | remains | - | - | - |

The only identified wreck from this database within the wind farm zone is the *Alca Torda*, a steel fishing vessel built in 1966 (record 1703). It was lost in November 1973, with all crew saved. It lies reasonably intact, only the upper part of the bridge is gone.[53] Its wreck of about 54 tons lies at about 35 meters below sea level. Records 1723 and 1738 both refer to a wreck, but no further information is available. The other records in *table 4* deal with wreck remains. These locations are no longer dangerous for ships on the surface, but are to be avoided during anchoring and fishing etcetera.[54] Again, no further information is available on the nature of the remains.

Of the contacts outside the wind farm zone, 11 have been identified as a wreck. Of these, only 5 have been identified. One of those is the Danish coaster *Grethe Dania*, that sank on the 10th of July 1981 (record 1683).[55] Another is the Dutch tugboat *Frans*, which lies at about 31 meters below sea level (record 1747). Record 1758 apparently refers to a fishing vessel OD-5. The previously mentioned *SS Tubantia* is represented by record 1769. Record 2595 mentions *Copenhagen* as possible name of the wrecked ship. However, no further information is available.

### 3.3.6 Rijkswaterstaat

Rijkswaterstaat maintains its own database of sonar contacts recorded in Dutch waters. These are not necessarily all historic (ship)wrecks, but due to the resolution of the Rijkswaterstaat surveys, all contacts constitute major obstructions. As the dataset for the wind farm zone overlaps completely with the Hydrographic Service dataset, it will not be discussed further here.

### 3.3.7 Crash sites World War II airplanes

During World War II many airplanes, both Allied and German, were shot down and crashed in the North Sea. Records were kept of crashed airplanes of both sides, though usually without a precise location of the site of the crash. The crash site is often simply referred to as 'North Sea', with only in some cases a more precise geographical description. The planes were usually completely destroyed or disintegrated on impact; there was no need for keeping precise records for retrieving the wrecks. The Dutch Air War Study Group 1939-1945 (SGLO: *Studiegroep Luchtoorlog 1939-1945*) keeps records of the sites within the Netherlands. In *table 6* only the records are shown that can be traced back to the coastal waters near Zeeland (Zeeuws-Vlaanderen, Walcheren or Schouwen) and/or near the Belgian coast. Records with the mere indication 'North Sea' were not selected. Since no precise locations are given, the information is not included in the maps of this desk study. It bears reference to the vast number of planes that crashed in the North Sea during World War II, and also may be found within the wind farm zone.

Table 6 Possible DAS crash sites in or in the greater vicinity of the wind farm zone

| DAS nr | Date | Time | Location | Aircraft |
|---|---|---|---|---|
| T0693 | 17 May 40 | | Crashed North Sea (near Kapelle) | He111 |
| T0707A | 21 May 40 | | Crashed North Sea (near Belgium) | He111 |
| T0858 | 3 Oct 40 | | Crashed North Sea off Schouwen | Ju88 |
| T1284 | 3 Oct 41 | 15.47 | Crashed North Sea (20 km n of Oostende) | Spitfire |
| T1353 | 7/8 Dec 41 | 06.40 | Ditched North Sea off Walcheren | Hampden |
| T1405A | 12 Feb 42 | | Crashed North Sea near the Schouwen Coast | Beaufort |
| T1406 | 12 Feb 42 | 17.40 | Crashed North Sea near Walcheren | Blenheim |
| T1410 | 12 Feb 42 | | Crashed North Sea near Walcheren | Wellington |
| T1505 | 8 May 42 | | Crashed North Sea 15 km w of Walcheren | Bf109 |
| T1522 | 27 May 42 | 16.32 | Crashed North Sea n of Walcheren | Spitfire |

53 http://www.wrecksite.eu/wreck.aspx?304.
54 Dienst der Hydrografie, Koninklijke Marine 2011.
55 http://www.wrecksite.eu

| DAS nr | Date | Time | Location | Aircraft |
|---|---|---|---|---|
| T1534 | 31 May 42 | 15.48 | North Sea (near Walcheren) | Spitfire |
| T1557 | 1/2 June 42 | 02.05 | Crashed North Sea off Haamstede | Wellington |
| T1592 | 8/9 June 42 | 02.18 | Crashed North Sea sw of Haamstede | Halifax |
| T1605A | 19 June 42 | 11.35 | North Sea (near Vlissingen) | Fw190 |
| T1730A | 29 July 42 | 15.35 | Crashed North Sea 50 km wnw of Walcheren | Mustang |
| T1743 | 31 July/1 Aug 42 | 03.56 | Crashed North Sea near Haamstede | Wellington |
| T1852 | 21 Sep 42 | 14.52 | North Sea (near Haamstede) | Spitfire |
| T1901 | 7 Nov 42 | 15.09 | Crashed North Sea w of Vlissingen | Ventura |
| T1912A | 19 Nov 42 | 15.08 | North Sea (6 km ZW Zoutelande) | Spitfire |
| T1912B | 19 Nov 42 | 15.00 | Crashed North Sea 16 km sw of Vlissingen) | Fw190 |
| T1923 | 29 Nov 42 | 11.40 | North Sea (near Schouwen) | Mustang |
| T1925 | 29 Nov 42 | | North Sea (near Schouwen) | Mustang |
| T1926 | 29 Nov 42 | 11.43 | Crashed North Sea off Walcheren | Spitfire |
| T1927 | 29 Nov 42 | 11.43 | Crashed North Sea off Walcheren | Spitfire |
| T1931 | 6 Dec 42 | 12.52 | Crashed North Sea off Ducth Coast near Nrd-Beveland | Boston |
| T1934 | 6 Dec 42 | 12.17 | Crashed North Sea off Oostkapelle | Ventura |
| T1944 | 10 Dec 42 | 11.45 | North Sea off Vlissingen | Spitfire |
| T1945 | 10 Dec 42 | 11.45 | North Sea off Vlissingen | Spitfire |
| T1947 | 13 Dec 42 | 16.34 | North Sea 30 km w of Schouwen | Spitfire |
| T2047 | 5 Feb 43 | 12.00 | Crashed North Sea off Walcheren | Spitfire |
| T2059 | 14/15 Feb 43 | 21.48 | North Sea 20 km w of Schouwen | Wellington |
| T2103 | 8 Mar 43 | 07.33 | North Sea 30 km w of Walcheren | Spitfire |
| T2173 | 3/4 Apr 43 | 21.37 | Crashed North Sea 25 km w of Westkapelle | Ju88 |
| T2176 | 4 Apr 43 | | Crashed North Sea w of Vlissingen | Do217 |
| T2200 | 16 Apr 43 | 14.30 | North Sea 6 km w of Vlissingen | Spitfire |
| T2220 | 29 Apr 43 | | Crashed 18 km w of Zeeland in the North Sea | P-47 |
| T2231 | 2 May 43 | 19.40 | North Sea 10 km w of Vlissingen | Spitfire |
| T2237 | 2 May 43 | 19.50 | Crashed North Sea w of Vlissingen | Fw190 |
| T2256 | 4 May 43 | 19.00 | Crashed North Sea 10 km sw of Haamstede | Spitfire |
| T2283 | 12/13 May 43 | 02.16 | Crashed North Sea 60 km w of Walcheren | Halifax |
| T2314 | 14 May 43 | 13.26 | Crashed North Sea w of Schouwen | Mustang |
| T2329 | 16 May 43 | 13.18 | North Sea off Vlissingen | Fw190 |
| T2411 | 10 June 43 | 18.59 | North Sea of Domburg | Spitfire |
| T2436 | 11/12 June 43 | 00.38 | North Sea (22 km n of Westkapelle) | Wellington |
| T2474 | 16/17 June 43 | 01.25 | North Sea 10 km n of Renesse | Beaufighter |
| T2480 | 17 June 43 | 09.45 | Crashed North Sea s of Vlissingen | Fw190 |
| T2509 | 22 June 43 | | Crashed North Sea near Vlissingen | Spitfire |
| T2510 | 22 June 43 | 09.20 | North Sea off Walcheren | Spitfire |
| T2544 | 22/23 June 43 | 02.39 | Crashed North Sea w of Walcheren | Halifax |
| T2545 | 22/23 June 43 | 03.25 | North Sea (30 km nw of Oostende) | Halifax |
| T2560 | 22/23 June 43 | 02.29 | North Sea (20 km w of Walcheren) | Stirling |
| T2565 | 24/25 June 43 | 02.56 | Crashed North Sea 20 km wnw of Vlissingen | Halifax |
| T2587 | 25/26 June 43 | 01.00 | Crashed North Sea w of Westkapelle | Defiant |
| T2614 | 28 June 43 | 05.20 | Crashed North Sea near Westkapelle | Hurricane |
| T2628 | 28/29 June 43 | 02.47 | Crashed North Sea 25 km w of Schouwen-Duiveland | Stirling |
| T2761 | 30 July 43 | 10.50 | Crashed North Sea 2 km sw of Haamstede | Fw190 |
| T2789 | 15 Aug 43 | 11.58 | Crashed North Sea 6 km n of Domburg | Spitfire |

| DAS nr | Date | Time | Location | Aircraft |
|---|---|---|---|---|
| T2853 | 28 Aug 43 | 19.59 | North Sea 14 km w of Vlissingen | Typhoon |
| T2924 | 3/4 Oct 43 | 00.30 | Crashed North Sea 4 km n of Vlissingen | Lancaster |
| T2930 | 7 Oct 43 | | Crashed North Sea near Zeeland | Hurricane |
| T3025 | 24 Oct 43 | | Crashed North Sea off Walcheren | Mitchell |
| T3052 | 5 Nov 43 | 14.44 | Crashed North Sea w of Domburg Walcheren | B-24 |
| T3054 | 5 Nov 43 | 14.30 | Crashed North Sea near Westenschouwen | P-47 |
| T3076 | 11 Nov 43 | 15.15 | Crashed North Sea 30 km w of Westenschouwen | B-17 |
| T3099 | 15 Nov 43 | | Crashed w of Schouwen | Ju88 |
| T3320 | 21/22 Jan 44 | 04.48 | Crashed in the North Sea w of Walcheren | Halifax |
| T3334 | 28/29 Jan 44 | | Crashed in North Sea near Zoutelande | Mosquito |
| T3335 | 29 Jan 44 | | North Sea off Walcheren | Typhoon |
| T3478B | 25 Feb 44 | 11.26 | 'Jessie''Crashed in the North Sea 30 miles w of Westkapelle Walcheren | B-26 |
| T3524 | 11 Mar 44 | 11.15 | Crashed North Sea 1 km w of Haamstede | B-17 |
| T3601A | 19 Apr 44 | | Crashed North Sea 35 km nw of Zeebrugge | Ju88 |
| T3604 | 20/21 Apr 44 | 03.02 | Crashed North Sea nw of Westkapelle | Lancaster |
| T3640 | 29 Apr 44 | 14.14 | Ditched North Sea 15 km w of Haamstede | B-17 |
| T3726 | 25 May 44 | 10.08 | North Sea off Vlissingen | P-38 |
| T3753 | 31 May/ 1 June 44 | | Crashed in the North Sea off Zeebrugge | Stirling |
| T3834 | 21/22 June 44 | 02.32 | Crashed North Sea near Walcheren | Lancaster |
| T3890 | 20/21 July 44 | 01.59 | Crashed North Sea off Renesse | Lancaster |
| T3911A | 2 Aug 44 | 20.11 | Ditched North Sea 10 km w of Cadzand | B-17 |
| T3962 | 30 Aug 44 | | Crashed North Sea w of Walcheren | Halifax |
| T4003 | 11 Sep 44 | 13.13 | Crashed North Sea 15 km sw of Vlissingen | Spitfire |
| T4048 | 17 Sep 44 | 12.30 | Crashed North Sea or Schelde near Schouwen | Tempest |
| T4469 | 5 Oct 44 | 13.05 | Ditched North Sea w of Schouwen | P-51 |
| T4580 | 28 Oct 44 | | Crashed North Sea off Westkapelle | Halifax |
| T4590A | 29 Oct 44 | | Crashed North Sea near Zoutelande | Lancaster |
| T4712 | 23 Nov 44 | | Crashed North Sea w of Walcheren | Lancaster |

# 4 Answers to the research questions

Based on the above desk top study, the research questions can be answered as follows:

1. Define an overview of the archaeological aspects on which basis the wind farm zone will be assessed.

The wind farm zone has been assessed based on available geological and archaeological data, as well as several governmental obstruction/contact databases.

2. Assess whether there are (indications for) areas with specific archaeological interest (wrecks and prehistoric life) at the Borssele wind farm zone.

The Borssele wind farm zone has been assessed for two types of archaeological remains:

- early prehistoric sites and finds, either directly on the seabed, or covered by later sediments buried under the seabed; and
- historic wrecks and other objects, such as lost equipment or cargo and crashed airplanes.

In respect to the first type of archaeological remains: early prehistoric sites or finds have not been identified within the wind farm zone itself. The nearest location or find spot of early prehistoric remains lies 9 miles south-east of the wind farm zone. Remains, of some non-eroded Pleistocene and early Holocene landscape(s) and stratigraphic levels, however seem to be present within the wind farm zone. It is possible, that these levels and elements of palaeo-landscapes within the wind farm zone contain *in situ* early prehistoric sites. However, they are located at a depth of about 30 to 40 meters below present day sea level. This means that around the transition from Late Palaeolithic to early Mesolithic, (or at least by c. 7000 BC), most, if not all, of the area in and around the wind farm zone had been submerged by the expanding North Sea. It can therefore be concluded that within the wind farm zone most - if not all - early prehistoric sites - if present - should date from the Middle and Upper Palaeolithic periods. These sites are extremely low in density and widely dispersed within North-western Europe as a whole. Further, any possible Upper Palaeolithic to Early Mesolithic sites in the area can only have been situated on higher parts of the landscape, which consequently were also more exposed to later North Sea erosion. General expectancy of well-preserved early prehistoric sites with in situ remains should therefore be considered as extremely low, albeit not completely lacking.

In respect to the second type of archaeological remains: so far, only three objects have been identified as a shipwreck within the boundaries of the wind farm zone. Only one has been sufficiently identified. It originates from the late 20$^{th}$ century and can be considered of no archaeological value. Next to these, there are a number of other obstructions reported within the wind farm zone that are categorised as 'remains'. These could be wrecks, part of wrecks, but also lost objects (e.g. anchors, chains), cargo, industrial waste and garbage etc. They may also be the remains of aircrafts, lost during World War II. In the immediate vicinity of the wind farm zone several historic wrecks are attested, most from the 19$^{th}$ of 20$^{th}$ century. Among these, the best known wreck, and of high archaeological importance, is the East Indiaman *'t Vliegend Hart*, sunk in 1729. Considering the other objects identified directly outside the wind farm zone, these appear to be mainly recent steel vessels, and only a limited number of (possibly older) wooden vessels. This is caused by the fact that steel objects are in general easier to detect by regular sonar and other search techniques. Remains of for instance deck areas of (possibly older) wooden vessels will mostly have already eroded, and can therefore only be traced by using specialised equipment.

Vestigia has found no records of systematic surveys with side-scan sonar or other geophysical techniques within the wind farm zone. Recorded finds of historic wrecks and other objects mentioned in the present desk study should therefore be considered as accidental and more or less random discoveries. The low number of find spots is therefore not necessarily a reflection of the actual density of historic

archaeological finds, including World War I and II shipwrecks and warplanes. It is merely caused by the absence of systematic surveys, which are normally concentrated within the main shipping lanes. More undiscovered shipwrecks and other historical objects are therefore very likely present within the wind farm zone.

Overall, the chance to encounter prehistoric archaeology within the wind farm zone is small (=low sensitivity). Due to the small chance to encounter early prehistoric archaeological sites within the wind farm zone and the limited possibilities for further research and knowledge gain, once encountered, further archaeological survey with the intention to establish prehistoric sites is not recommended.
The chance to encounter historic archaeology (shipwrecks, airplanes, etc.) is average (=medium sensitivity). Unfortunately it is not possible at this stage to further distinguish between areas of low, high and medium archaeological sensitivity within the wind farm zone. In order to do so, a geophysical survey is necessary (see also bullets 3 and 6).

3. If present, define expected location, size and dating of the areas with specific archaeological interest.

As stated above, so far, no definite archaeological sites have been established within the wind farm zone. Unfortunately it is not possible at this stage to distinguish between areas of low, high and medium archaeological sensitivity within the wind farm zone. Archaeological sensitivity expresses how likely it is in a given area to encounter archaeological remains (the chance to encounter archaeology, not the chance that archaeology is present). Overall, the chance to encounter (early) prehistoric archaeology within the wind farm zone is small (=low sensitivity) and the chance to encounter historic archaeology (shipwrecks, airplanes, etc.) is average (=medium sensitivity).

With regard to prehistoric archaeology: the two lithological cross sections from the wind farm zone show a few locations where early Holocene terrestrial deposits seem to cover the Late Pleistocene or Neogene ('Tertiary') deposits. However, due to the low spatial resolution of available data, it is unknown at this point to what extent non-erosive late Pleistocene and early Holocene remnants are present within (and in the vicinity of) the wind farm zone. Although the location of such remnants would constitute the most promising locations to find in situ prehistoric archaeology, it is difficult to establish their predictive value.[56] We know the area was only suitable for human exploitation during the earliest phases of prehistory (i.e. roughly before 8,000 BP = c. 7,000 BC). We know that in some places the early prehistoric landscape has been covered by non-erosive sediments and therefore preserved. But we also know that the population density in North-western Europe during these early stages of prehistory was extremely low. Therefore, the density of archaeological traces of those people is also very low. The chance that these sparse remains happen to be located within the relative few locations where soils from this period have been covered by non-erosive later sediments and hence preserved, is very slim. The chance to actually encounter such remains during surveys or developments in the area, even slimmer.

With regard to historic archaeology: the recorded wreck locations and other objects may or may not be of archaeological significance. It is not possible to determine that at this stage, with the available information. In the mean time, these locations are best avoided during developments. For shipwrecks it is not possible to define areas of higher or lower sensitivity within the wind farm zone on the basis of the available information. There are no clear low sand banks, shallows, or regular shipping lanes within the area, which could be defined as high risk areas for accidents, also no clustering of wrecks can be distinguished, indicating sea battle areas or other incident areas. The chances for finding historic wrecks within the whole wind farm zone is therefore generally average, translating in a medium sensitivity.

[56] For an insight in factors determining the scale and accuracy of palaeogeographical reconstructions in the North Sea area: Cohen et al. 2014.

4. Determine the possible effect of the installation of offshore wind farms on the areas with specific archaeological interest.

*In situ* archaeological remains can be present in areas where the late Pleistocene to early Holocene landscape is still preserved within the geological stratigraphy. The remnants of this landscape - where present in the wind farm zone - are located at a depth of about 30 to 40 meters below present day sea level, and are mostly covered by a thick layer of mid- to late-Holocene marine sediments. These sites - if present - could be damaged by drilling, coring, cabling and foundation work.

As far as shipwrecks are concerned, these may also be affected by drilling, coring, cabling and foundation work. Historic vessels and warplanes, generally situated on or near the sea bed could be damaged by all of these developments.

5. Assess possibilities to mitigate the disturbance of areas with specific archaeological interest as a result of installing offshore wind farms.

Once a wreck or other archaeological site has been identified, in an area were soil disturbing activities are planned, the historic or scientific value of the site should be established, ultimately by the RCE through a so-called *selectiebesluit* (selection decision), taken on the basis of additional research and inspection. In case a wreck or archaeological site is determined as of archaeological significance, the effects of the development can be mitigated by preferably avoiding the site, or otherwise further archaeological interventions. In case of historic wrecks this could involve archaeological excavations underwater, in case of historic airplanes, this could involve the salvage and lifting of the wreck or parts of it, and in case of early prehistoric archaeological sites an archaeological sampling strategy as has, for instance, been used during the building of Maasvlakte II. These archaeological interventions can involve high costs and can only be carried out according the rules and regulations laid out in the Dutch Monuments Act. However, in case of discovery of any of the above-mentioned archaeological sites or objects, first the historic value needs to be established by further research and inspection.

6. 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.

Due to the small chance to encounter early prehistoric archaeological sites within the wind farm zone, and the limited possibilities for further research (and a knowledge increase) once encountered, further archaeological survey with the intention to establish prehistoric sites within the wind farm zone is not recommended (see also bullet 7). In order to define areas of low, medium and high archaeological sensitivity in relation to shipwrecks and airplanes within the wind farm zone, it is recommended to perform a geophysical area survey (side scan sonar or multi beam). Such a survey and the subsequent report should meet the requirements of the KNA *Waterbodems*.

7. Define requirements for any activity carried out in the wind farm zone (investigations or monitoring activities, installation activities, operational activities) that could have an effect on archaeological aspects in the wind farm zone.

*Table 7* gives an overview of activities with a possible effect on, or relation to, archaeological aspects. For each activity stated some recommendations are made, so that the results may fulfil the requirements stated in the KNA and can be used as steps within the archaeological management process, providing useful additional information.

Table 7 Archaeological requirements for the activities to be carried out in the wind farm zone

| Activity | Archaeological requirement |
|---|---|
| Geophysical survey prior to developments | In case of any geophysical (side scan sonar, multi beam, magnetometer etc.) surveys, make sure sufficient data resolution is reached in accordance to archaeological standards, and data are interpreted by qualified marine archaeologists (see below). |
| Cabling and foundation work | Archaeological survey (see 'Geophysical survey') is required for all areas where the seabed will be disturbed, including disturbances by for example the cable laying vessel (anchoring). |
| Identification of archaeological sites during geotechnical or geophysical survey (indicators like pieces of worked wood, metal wreckage of ships or airplanes, boat- or plane-shaped sonar reflections, or concentrations of unworked flint, flint tools, tools made of antler or animal bone, pottery, etc.) | If data from the geophysical surveys are analysed for archaeological purposes, these analyses should result in an archaeological report in compliance with the KNA *Waterbodems*. If the identified find spots are located in areas where developments are going to take place and the areas cannot be avoided, the identified sites need to be evaluated in order to determine, whether further archaeological interventions are deemed necessary. |
| Identification of archaeological sites during the installation of the wind farms (indicators like pieces of worked wood, metal wreckage of ships or airplanes, boat- or plane-shaped sonar reflections, or concentrations of unworked flint, flint tools, tools made of antler or animal bone, pottery, etc.) | If possible archaeological remains are encountered during the installation of the wind farms, in locations that have not been identified during prospection (geophysical survey or other surveys), these finds need to be reported immediately to the proper authorities in accordance with the Dutch Monuments Act. |

*Archaeological standards for geophysical surveys*

No standard requirements for side scan sonar, multi beam, and magnetometer surveys underwater are yet officially in place within Dutch archaeology. The Netherlands Enterprise Agency (RVO) is currently considering the scope and moment of execution of a geophysical survey for archaeological purposes. The requirements such a survey should meet are being established in consultation with the Cultural Heritage Agency (RCE).

*Archaeological work protocol*

It is recommended to draft at an earliest stage as possible a protocol and work plan for dealing with the archaeological heritage. Such a protocol should not only explain and lay-out the necessary steps of further archaeological prospection and decision making in relation to the future project stages, but also include a procedure for dealing with 'accidental' archaeological finds during the construction and operational phases of the project.

## References


BEETS, D.J./A.J.F. VAN DER SPEK, 2000: The Holocene evolution of the barrier and back-barrier basins of Belgium and the Netherlands as a function of late Weichselian morphology, relative sea-level rise and sediment supply, *Geologie en Mijnbouw - Netherlands Journal of Geosciences*, 79, 3-16.

BEHRE, K.E./B. MENKE/H. STREIF. H. 1979: the Quaternary geological development of the German part of the North Sea. In: Oele, E./R.T.E. Schüttenhelm/A.J. Wiggers (eds.): *The Quaternary history of the North Sea*. Acta Universitatis Upsaliensis, Symposia Universitatis Upsaliensis Annum Quingentesimum Celebrantis (Uppsala).

BOSCH, J.H.A., 2008: *Archeologische Standaard Boorbeschrijvingsmethode versie 1.1, Op basis van de Standaard Boor Beschrijvingsmethode versie 5.2*, Utrecht (Deltares-rapport 2008-U-R0881/A). [available at: http://www.sikb.nl/upload/documents/archeo/leidraden/Leidraad%20ASB%20versie%205_2%20geactualiseerd%20september%202008.pdf]

BOSCH, J.H.A., 2000: *Standaard Boor Beschrijvingsmethode, versie 5.1*, Utrecht (NITG-rapport 00-141-A). [available at: http://www2.dinoloket.nl/nl/about/dataTypes/bor/resources/sbb51.pdf]

CENTRAAL COLLEGE VAN DESKUNDIGEN ARCHEOLOGIE, 2007: *Kwaliteitsnorm Nederlandse Archeologie (KNA) Waterbodems*, versie 3.1, Gouda (SIKB).

COHEN, K.M./S.C. FINNEY/P.L. GIBBARD/J.-X. FAN, 2013: The ICS International Chronostratigraphic Chart, *Episodes 36, 3*, 199-204.

COHEN, K.M./P.L. GIBBARD/H.J.T. WEERTS, 2014: North Sea palaeogeographical reconstructions for the last 1 Ma, *Netherlands Journal of Geosciences - Geologie en Mijnbouw, 93, 1/2*, 7-30.

DEEBEN, J.H.C. (ED.), 2008: *De Indicatieve Kaart van Archeologische Waarden, derde generatie*, Amersfoort (RAM 155).

DENYS, L./C. BAETEMAN, 1995: Holocene evolution of relative sea-level and local mean high water spring tides in Belgium: a first assessment, *Marine Geology* 124, 1-19.

GANS, W. DE, 2007: Quaternary, in: Wong, Th.E./D.A.J. Batjes/J. De Jager, 2007: *Geology of the Netherlands*, Royal Netherlands Academy of Arts and Sciences.

HAASNOOT, J.K./E. DIEPSTRATEN/C. KLEIBOER, 2014: *Geological desk study windpark Borssele*, Amsterdam (CRUX report RE14254a1), 30 June 2014.

HETEREN, S. VAN/J.A.C. MEEKES/M.A.J. BAKKER/V. GAFFNEY/S. FITCH/B.R. GEAREY/B.F. PAAP, 2014: Reconstructing North Sea palaeolandscapes from 3D and high-density 2D seismic data: An overview, *Netherlands Journal of Geosciences - Geologie en Mijnbouw, 93*, 1/2, 31-42.

HIJMA, M., 2009: *From river valley to estuary, The early-mid Holocene transgression of the Rhine-Meuse valley, The Netherlands*, Utrecht (Netherlands Geographical Studies 389).

HIJMA, M.P./K.M. COHEN/W. ROEBROEKS/W.E. WESTERHOFF/F.S. BUSSCHERS, 2012: Pleistocene Rhine-Thames landscapes: geological background for hominin occupation of the southern North Sea region, *Journal of Quaternary Science* 27 (1), 17-39.

HUBLIN, J-J./D. WESTON/P. GUNZ/ M. RICHARDS/W. ROEBROEKS/L. GLIMMERVEEN/L. ANTHONIS, 2009: Out of the North Sea: the Zeeland Ridges Neandertal, *Journal of Human Evolution* 57, 777-785.

JELGERSMA, S., 1961: *Holocene sea level changes in the Netherlands*. Thesis Leiden University.

JELGERSMA, S., 1979. Sea-level changes in the North Sea basin. In: Oele, E., Schüttenhelm, R.T.E. & Wiggers, A.J. (eds): *The Quaternary history of the North Sea*. Acta Universitatis Upsaliensis, Annum Quingentesimum Celebrantis 2: 233-248.

LUDWIG, G./H. MÜLLER/H. STREIF, 1981: New dates on Holocene sea-level changes in the German Bight. *International Association of Sedimentologists Special Publication* 5, 211-219.

MISSIAEN, T./I. DEMERRE/V. VERRIJKEN, 2012: Integrated assessment of the buried wreck site of the Dutch East Indiaman 't Vliegent Hart, *Relicta* 9 (4), 191-208.

MOREE, J.M./M.M. SIER (EDS.), 2014: *Twintig meter diep! Mesolithicum in de Yangtzehaven - Maasvlakte te Rotterdam: landschapsontiwkkeling en bewoning in het Vroeg Holoceen*, Rotterdam (BOORrapporten 523).
RASMUSSEN, S.O./K.K. ANDERSEN/A.M. SVENSSON/J.P. STEFFENSEN/B.M. VINTHER/H.B. CLAUSEN/M.-L. SIGGAARD-ANDERSEN/S.J. JOHNSEN/L.B. LARSEN/D. DAHL-JENSEN/M. BIGLER/R. RÖTHLISBERGER/H. FISCHER/K. GOTO-AZUMA/M.E. HANSSON/U. RUTH, 2006: A new Greenland ice core chronology for the last glacial termination, *Journal of Geophysical Research 111*, D06102.
RENSINK, E., 2005: Het Midden-Paleolithicum in Zuid-Nederland, In: J. Deeben/E. Drenth/M-F. van Oorsouw/L. Verhart, *De steentijd van Nederland* (Archeologie 11/12), Zutphen, 119-142.
RIJSDIJK, K.F./S. PASSCHIER/H.J.T. WEERTS/C. LABAN/R.J.W. VAN LEEUWEN/J.H.J. EBBING, 2005: Revised Upper Cenozoic stratigraphy of the Dutch sector of the North Sea Basin: towards an integrated lithostratigraphic, seismostratigraphic and allostratigraphic approach, *Netherlands Journal of Geosciences - Geologie en Mijnbouw, 84, 2*, 129-146.
STACEY, C.P., 1960: Official History of the Canadian Army in the Second World War: Volume III. The Victory Campaign, The Operations in North-West Europe 1944-1945, Ottawa (http://www.ibiblio.org).
STAPERT, D., 1981: Middle Palaeolithic finds from the beach at Cadzand (Province of Zeeland), *Berichten van de Rijksdienst voor het Oudheidkundig Bodemonderzoek* 31, 293-305.
TERMOTE, T./D. TERMOTE, 2009: *Schatten en scheepswrakken. Boeiende onderwaterarcheologie in de Noordzee*, Leuven.
TIMMERMAN, M., 2014: *Site Studies Wind Farm Zone Borssele: Scope description Archaeological Desk Study*, Utrecht (RVO), 16 July 2014.
TIMMERMAN, M./R. DE BRUIJNE, 2014: *Site Studies Wind Farm Zone Borssele: Starting points & Assumptions Wind Farm Zone Borssele*, Utrecht (RVO), 18 August 2014.
VAN DE PLASSCHE, O., 1982. *Sea-level change and water-level movements in the Netherlands during the Holocene*. Haarlem (Mededelingen Rijks Geologische Dienst N.S. 36)
VAN DE PLASSCHE, O./TH. B. ROEP, 1989: Sea-level changes in the Netherlands during the last 6500 years: basal peat vs. Coastal barrier data. In: Scott, D.B./P.A. Pirazolli/C.A. Honig (eds.): *Late Quaternary sea-level correlation and applications*. NATO ASI Series, C256, 41-56.
VERHART, L., 2005A: Vuursteenbewerking, In: J. Deeben/E. Drenth/M-F. van Oorsouw/L. Verhart, *De steentijd van Nederland* (Archeologie 11/12), Zutphen, 81-90.
VERHART, L. 2005B: Een verdronken land. Mesolithische vondsten uit de Noordzee, In: L.P. Louwe Kooijmans/P.W. van den Broeke/H. Fokkens/A. van Gijn (eds.), *Nederland in de prehistorie*, Amsterdam, 157-160.
ZAGWIJN, W.H./D.J. BEETS/M. VAN DEN BERG/H.M. VAN MONTFRANS/P. VAN ROOIJEN, 1985: *Atlas van Nederland, deel 13, Geologie*, Den Haag (Stichting Wetenschappelijke Atlas van Nederland).

## Websites

- ARCHEOLOGISCH INFORMATIESYSTEEM (ARCHIS): http://archis2.archis.nl/archisii/html/index.html.
- BEELDBANK UNIVERSITEITSBIBLIOTHEEK VRIJE UNIVERSITEIT AMSTERDAM: http://imagebase.ubvu.vu.nl.
- BIBLIOTECA DIGITAL HISPÁNICA - Biblioteca Nacional de España: http://bdh-rd.bne.es.
- BRITISH LIBRARY: http://explore.bl.uk.
- CONVENTION ON THE PROTECTION OF THE UNDERWATER CULTURAL HERITAGE: http://www.unesco.org/new/en/culture/themes/underwater-cultural-heritage/2001-convention/official-text/
- HET GEHEUGEN VAN NEDERLAND: http://www.geheugenvannederland.nl.
- NATIONAAL ARCHIEF: http://www.gahetna.nl.
- DATABANK VOOR MARITIEM ERFOED: http://www.maritieme-archeologie.be.
- STICHTING INFRASTRUCTUUR KWALITEITSBORGING BODEMBEHEER: http://www.sikb.nl.
- WRECK SITE: http://www.wrecksite.eu.

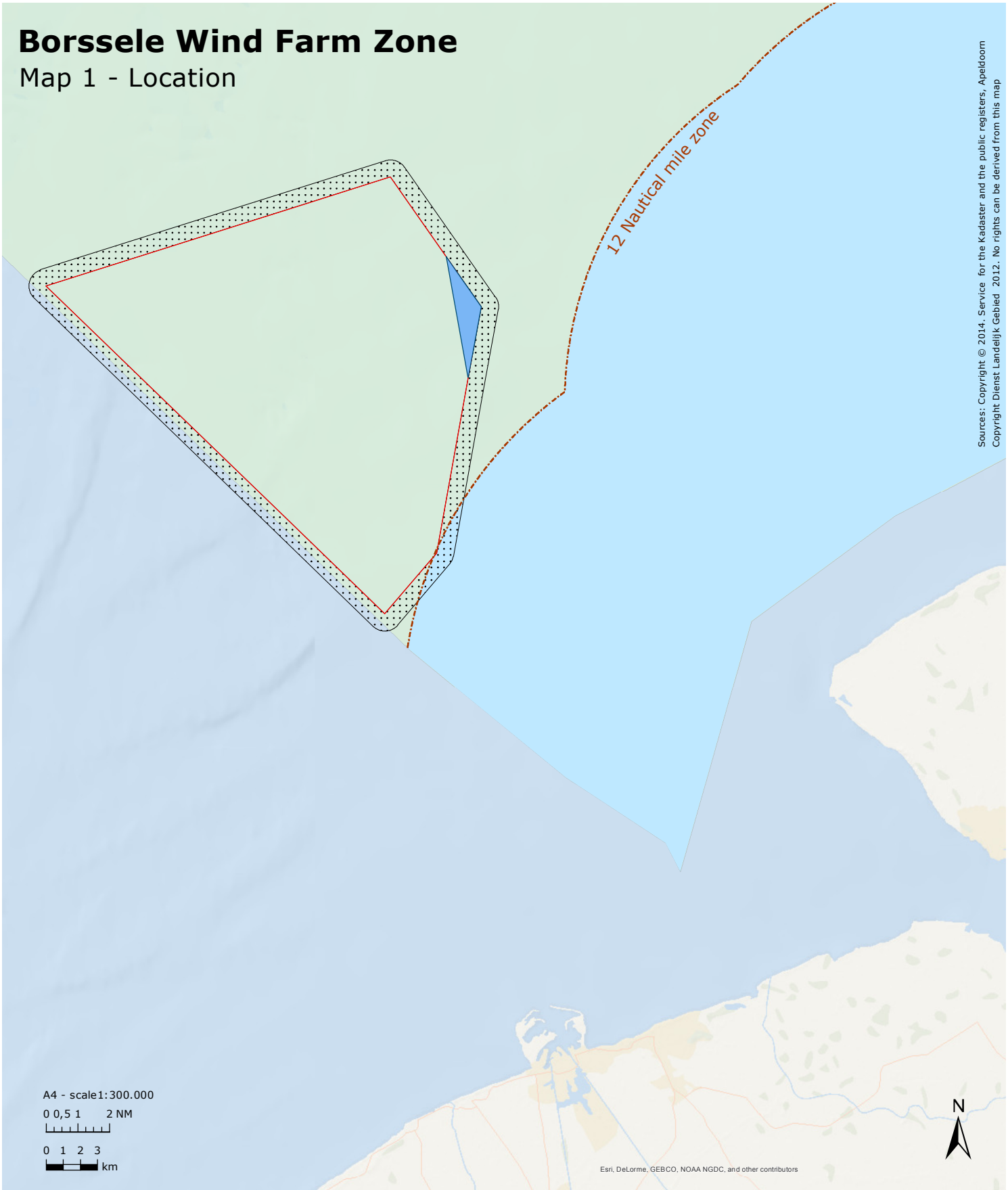
## Maps and Annexes

| | |
|---|---|
| Map 1: | Location Borssele Wind Farm Zone |
| Map 2: | Current use |
| Map 3: | Geology and Bathymetry |
| Map 4: | Archaeology |
| Map 5: | Wrecks and Obstructions |

| | |
|---|---|
| Annex 1: | Overview archaeological and geological periods |
| Annex 2: | Bore logs DINO-loket |
| Annex 3: | Geological cross sections |

# Borssele Wind Farm Zone

## Map 1 - Location






**Legend**

- Territorial sea
- Exclusive Economic Zone of the Netherlands
- Overlap piloting zone
- 12 Nautical mile zone
- Designated Wind Farm Zone

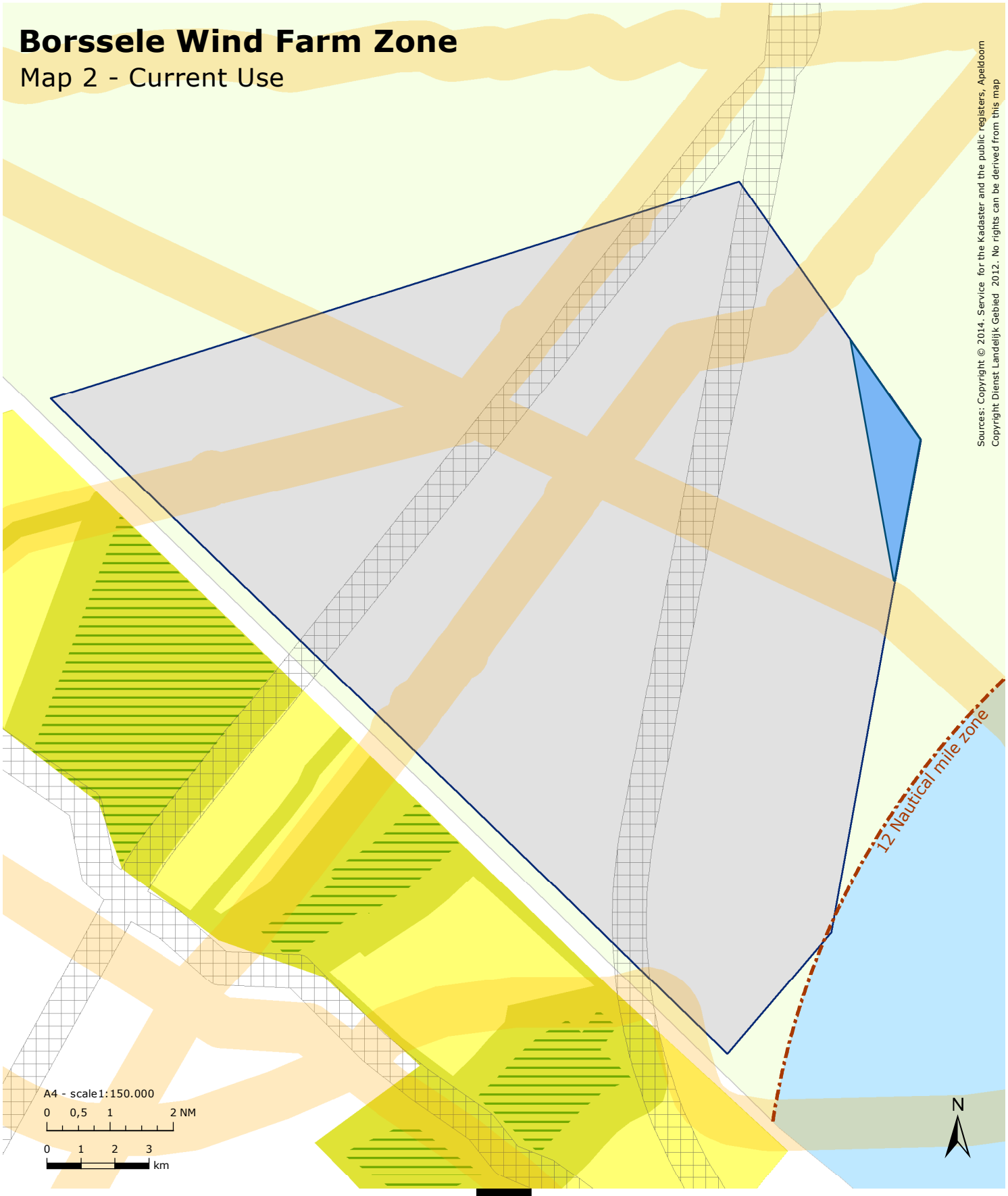
Netherlands Enterprise Agency

Location TenneT platforms, safety zones export cables and helicopter approach routes not yet included
This geographical information is based on the data available on October 28th 2014.
Updates will be made available on www.rvo.nl

Consultant: Vestigia Coastal & River Archaeology
date: 2014-07-22
revisie: 2014-12-08 mapnr: V1199-01

# Borssele Wind Farm Zone

## Map 2 - Current Use






**Legend**

Wind Farm Belgium Status (situation 2014)
- Application
- Licensed
- In operation

- Territorial sea
- Exclusive Economic Zone of the Netherlands
- Cables safety zone 750m
- Pipelines safety zone 500m
- Overlap piloting zone
- 12 Nautical mile zone
- Designated Wind Farm Zone

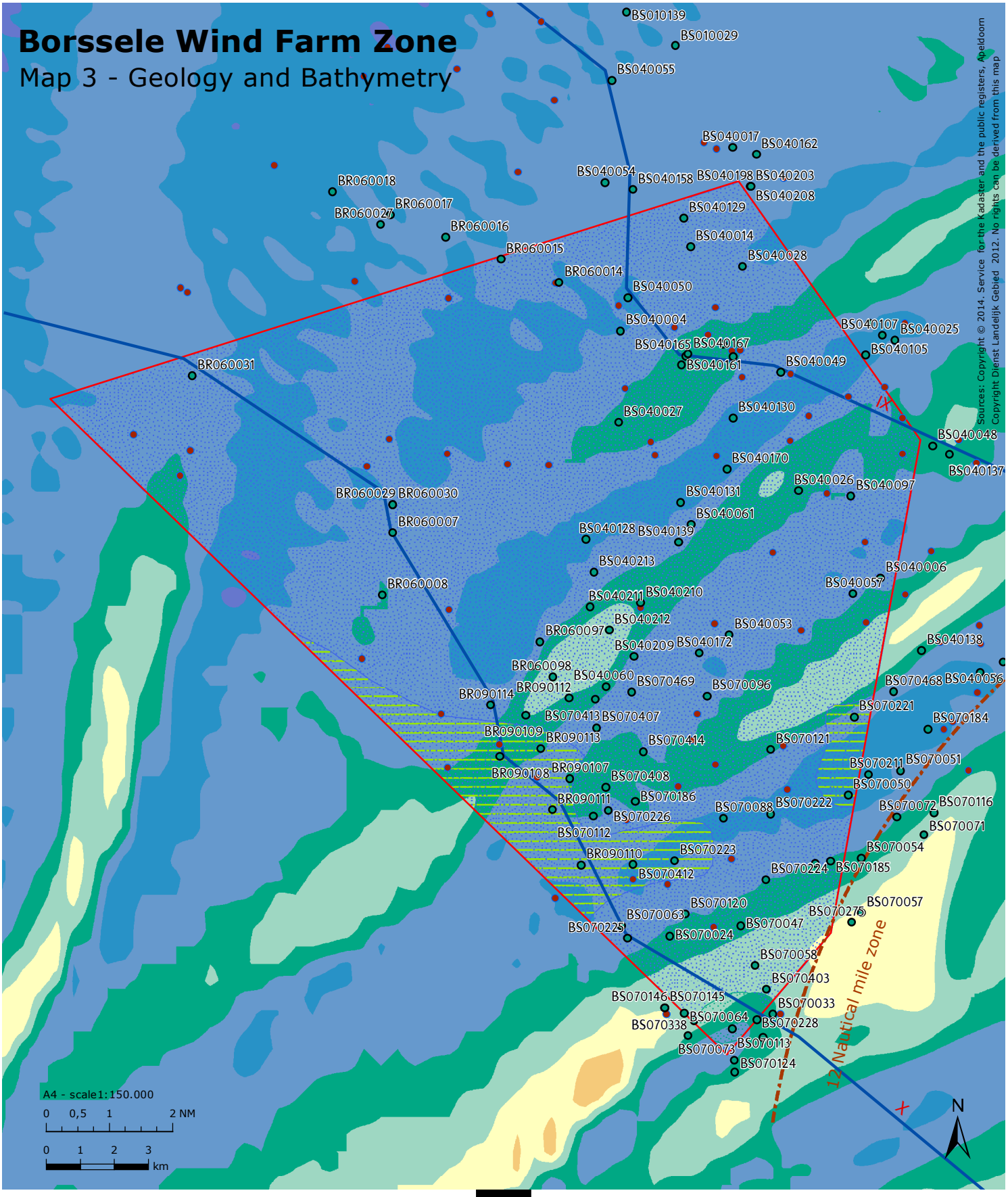
Netherlands Enterprise Agency

Location TenneT platforms, safety zones export cables and helicopter approach routes not yet included
This geographical information is based on the data available on October 28th 2014.
Updates will be made available on www.rvo.nl

Consultant: Vestigia Coastal & River Archaeology
date: 2014-07-22
revisie: 2014-12-08 mapnr: V1199-02

# Borssele Wind Farm Zone

## Map 3 - Geology and Bathymetry






**Legend**

Wind Farm Belgium Status (situation 2014)
- Application
- Licensed
- In operation

- Territorial sea
- Exclusive Economic Zone of the Netherlands
- Cables safety zone 750m
- Pipelines safety zone 500m
- Overlap piloting zone
- 12 Nautical mile zone
- Designated Wind Farm Zone

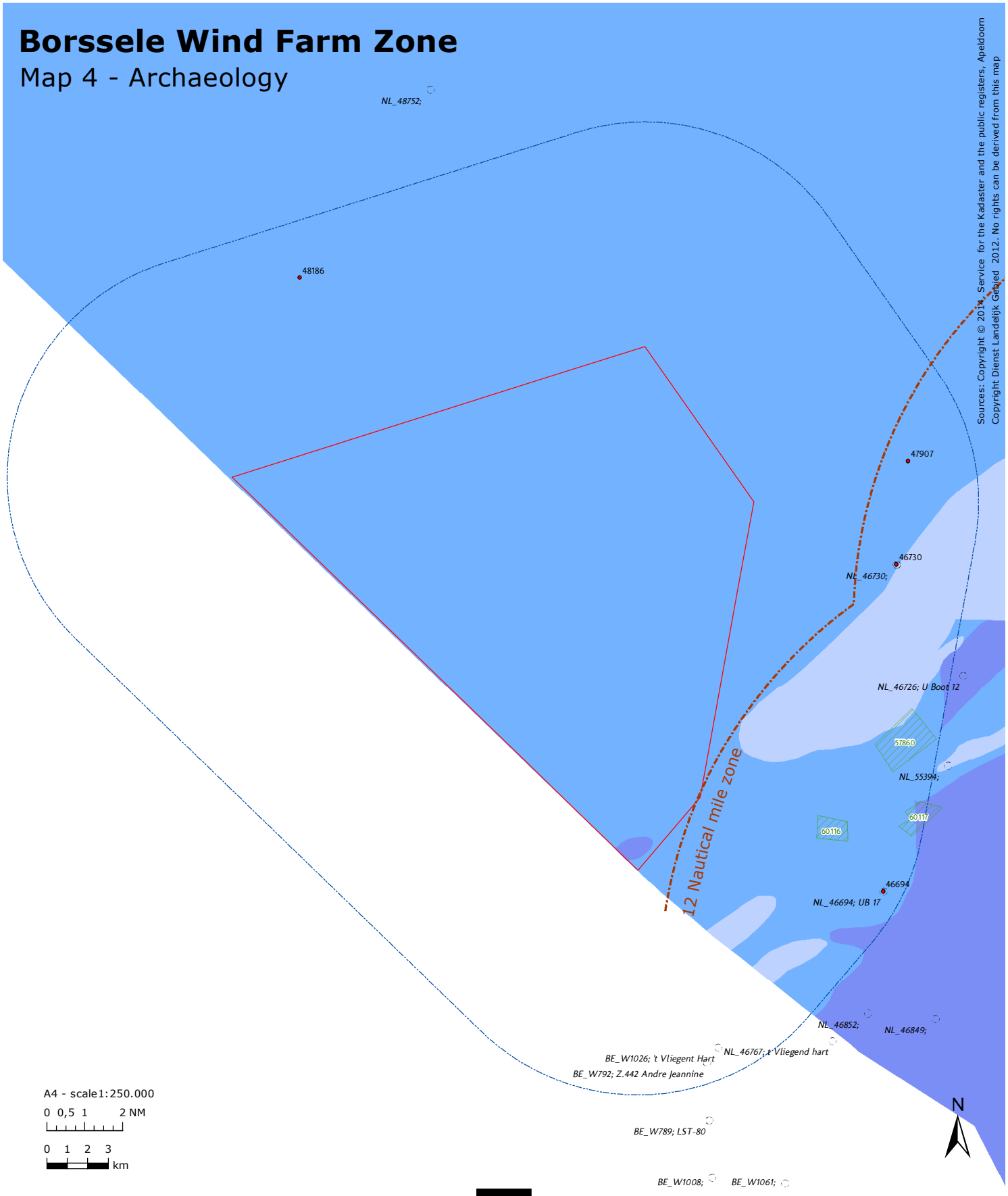
Netherlands Enterprise Agency

Location TenneT platforms, safety zones export cables and helicopter approach routes not yet included
This geographical information is based on the data available on October 28th 2014.
Updates will be made available on www.rvo.nl

Consultant: Vestigia Coastal & River Archaeology
date: 2014-07-22
revisie: 2014-12-08 mapnr: V1199-03

# Borssele Wind Farm Zone

## Map 4 - Archaeology






A4 - scale1:250.000

0 0,5 1 2 NM

0 1 2 3 km

**Legend**

- 12 Nautical mile zone
- Designated Windfarms Zone
- Buffer (11km) around windfarms zone, used for the selection of data from the Archis2 database

**Registered Archaeological research**

- Desk top study
- Geophysical research
- Archaeological objects / features (Archis2) within buffer
- MACHU Objects (number ; name)

Netherlands Enterprise Agency

**Indicative Map of Archaeological Values (IKAW):**

***Globale Archeologische Kaart van het Continentaal Plat***

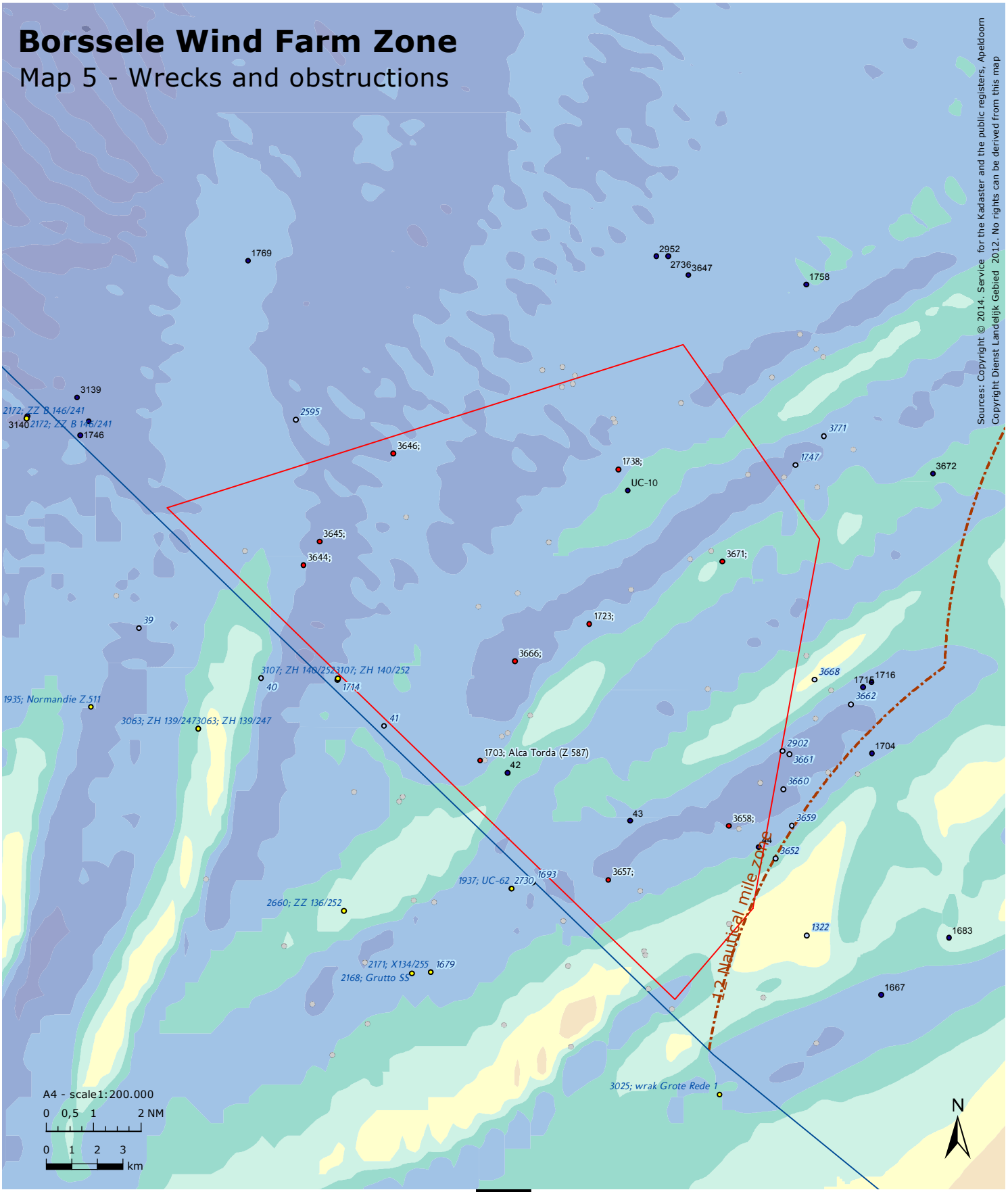
- High sensitivity
- Medium sensitivity
- Low sensitivity

Location TenneT platforms, safety zones export cables and helicopter approach routes not yet included
This geographical information is based on the data available on October 28th 2014.
Updates will be made available on www.rvo.nl

Consultant: Vestigia Coastal & River Archaeology
date: 2014-07-22
revisie: 2014-12-08 mapnr: V1199-04

# Borssele Wind Farm Zone

## Map 5 - Wrecks and obstructions






**Legend**

- 12 Nautical mile zone
- Designated Windfarms Zone
- Maritime boundary with Belgium
- Hydrographic service / Rijkswaterstaat - contacts inside wind farm zone (HLHO number)
- Hydrographic service / Rijkswaterstaat - contacts outside the wind farm zone (HLHO number)
- Wreck sites Belgium
- Other (wreck) sites (REASeuro / RCE)
- Cleared locations: explosives

Netherlands Enterprise Agency

**Bathymetry**

**Depth in meters below sea level**

| | |
|---|---|
| 5 - 10 | 25 - 30 |
| 10 - 15 | 30 - 35 |
| 15 - 20 | 35 - 40 |
| 20 - 25 | 40 - 45 |

Location TenneT platforms, safety zones export cables and helicopter approach routes not yet included
This geographical information is based on the data available on October 28th 2014.
Updates will be made available on www.rvo.nl

Consultant: Vestigia Coastal & River Archaeology
date: 2014-07-22
revisie: 2014-12-08 mapnr: V1199-05

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

Netherlands Enterprise Agency (RVO.nl) | December 2014