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800MW THOR OWF
GEOLOGICAL DESK STUDY – GEOARCHAEOLOGY

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CONTENTS

1. INTRODUCTION

As part of the Energy Agreement 2018, all political parties stood behind a decision to build three new offshore wind farms in Denmark before 2030. On February 28th, 2019, the parties to the Energy Agreement decided that the first of the three offshore wind farms should be located in the North Sea west of Nissum Fjord, and at a distance of min. 20 km from the shore. The new offshore wind farm (OWF) is named "Thor" after Thorsminde, the nearest village on the shore of Jutland. The offshore wind farm will have a capacity of min. 800 MW and max. 1.000 MW.

Energinet has as part of the Energy Agreement been instructed by the Danish Energy Agency (ENS (Energistyrelsen)) to carry out marine pre-investigations and EIAs for the OWF and the planned export cable routes.

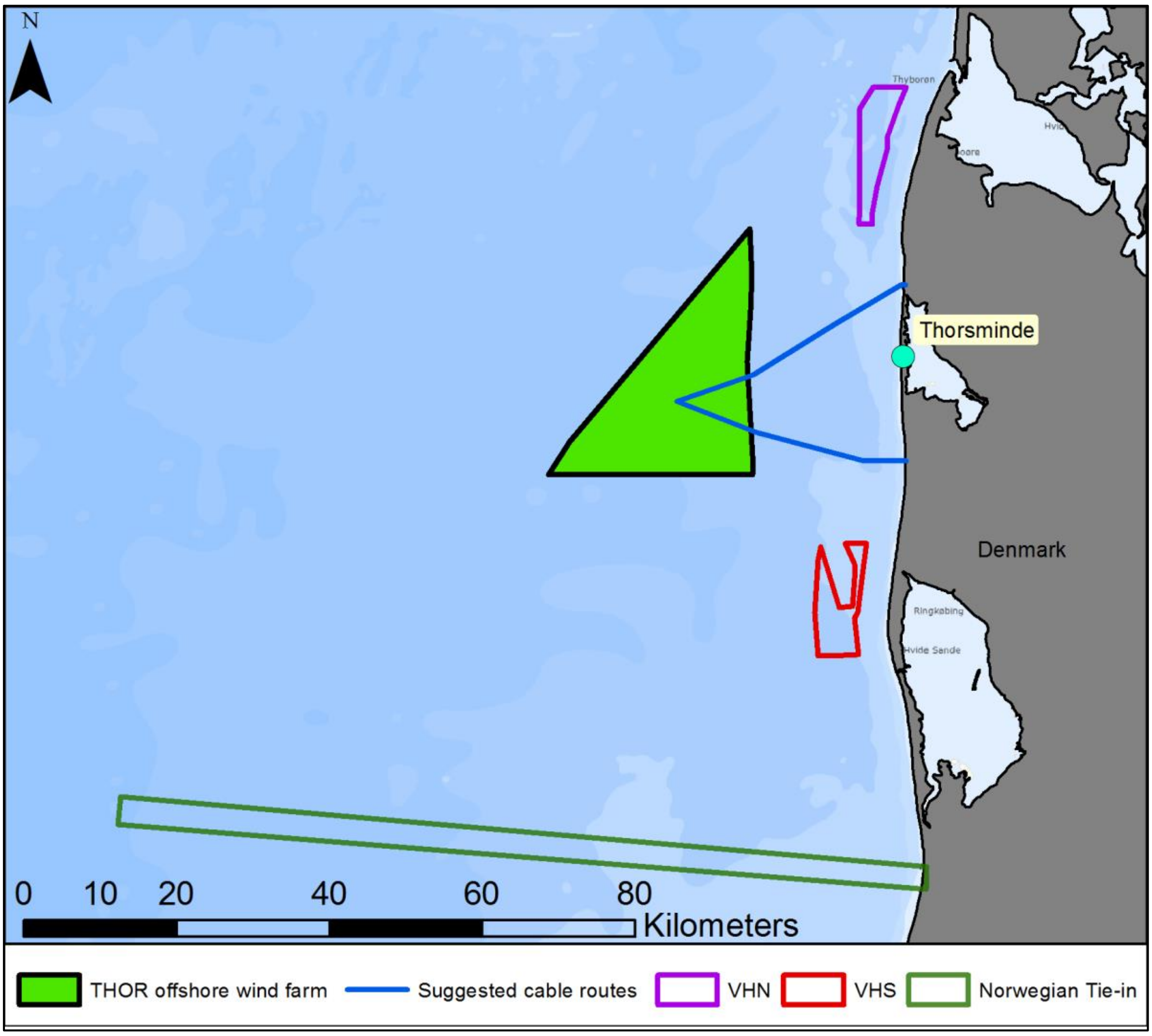

Figure 1-1 Overview of the Thor OWF area related to other offshore projects in the area. Marine projects in the region: OWF Vesterhav Nord (VHN), OWF Vesterhav Syd (VHS) and the planned Baltic Pipe route (Norwegian Tie-In).

Rambøll has as part of the initial stages of these pre-investigations prepared this Geological Desk Study (DTS) to support Energinets planned geoscience-focused surveys (geophysical, geotechnical etc.) of the Thor OWF pre-investigation area and the associated planned export cable routes, and also to support the geoarchaeological assessments of the area.

With respect to the latter, Energinet must ensure that the relevant archaeological museum – Strandingsmuseum St. George in Thorsminde – carries out archaeological assessments of the marine project area as part of the pre-investigations and as part of the EIA. Regarding the planned geoscience-focused surveys, it is expected that geophysical and geotechnical cable route surveys and site investigations for the Thor OWF will be carried out in 2019-2020.

It has been agreed with Energinet to split the DTS into 2 different reports:

- Report 1: This Geoarchaeological report primarily intended for the marine archaeologists
- Report 2: The Geological model report primarily indented for preliminary interpretations of the planned geoscience-focused surveys, particularly the planned seismic surveys.

However, the relevant stakeholders are encouraged to consult both reports, as the Geoarchaeological report contains detailed information about the Late Glacial and Holocene relative sea level history in the area, while the Geological model report will contain a conceptual geological model and descriptions of the regional geology, depositional and erosional history and expected sediments in the area.

In Figure 1-1 is presented the location of the net 800 MW Thor OWF pre-investigation area (in short: the OWF area) and the associated potential export cable routes (CR). In the figure are also shown selected relevant marine projects in the region, that are being referred to in the DTS: OWF Vesterhav Nord (VHN), OWF Vesterhav Syd (VHS) and the planned Baltic Pipe route (Norwegian Tie-In).

The Thor OWF project area covers approximately 440km^2 with water depths expected to range from ca. 25m LAT to 35m LAT (Lowest Astronomical Tide). The OWF area extends from c. 20km to c. 48km from shore. The two CRs, which both origin at the same location in the approximate center of the OWF, are approximately 31 and 34km long of which c. 10km are within the OWF area.

As can be seen from Figure 1-1 OWF VHN is situated c. 14 km to the NE of the Thor site while VHS is located c. 14 km to the SE. The Norwegian Tie-in part of the planned Baltic Pipe is located c. 51km S of the Thor site. Ramboll carried out a Geoarchaeological DTS for that project in 2017. The HR3 OWF (not shown) is located a further c. 6 km more to the south of the planned Baltic Pipe route.

2. METHODOLOGY – REPORT 1

2.1 Geoarchaeological DTS relevant for the marine archaeologists

The applied methodology is similar to methods used internationally, e.g. /7/, /8/, /9/, /16/, which in general describe that a geoarchaeological study for preliminary assessments of the likelihood of encountering submerged Stone Age sites should as a minimum focus on the following items:

- Relative sea level fluctuations during relevant period of Late Glacial and especially Post Glacial
- Bathymetry
- Expected maximum installation depths
- Archaeological habitat and research model(s) for Stone Age settlers
- Geology in terms of expected geological setting, layering and erosional behaviour for the relevant geological layers on which the Stone Age people may have lived.

Energinet in 2016 agreed a Best Practice /6/ for large-scale marine projects with the Agency for Cultural Monuments and Palaces (SLKS (Slots- og Kulturstyrelsen)) – the authority in regards of cultural heritage issues in Denmark. The Best Practice also describes in general terms the methodology described in this chapter.

The primary purpose of the Geoarchaeological DTS is to form a geoarchaeological basis for the preparation of a so-called 'Archaeological analysis' as set out and defined in Energinet's and SLKS' joint Best Practice.

2.2 Relative sea level fluctuation curves

Relative sea level fluctuation curves are used for identification and assessment of the most relevant existing shoreline displacement curve(s), aka relative sea level (RSL) curve(s), if available, for the relevant marine area during Late Glacial and especially Post Glacial periods with special focus on the time slot for which the archaeological habitat and research model is relevant. Thus, sea level models and curves should be consulted if available and should be treated as a general guideline for presenting depth to age ratios and coastal environmental change.

2.3 Bathymetry

Bathymetry here means an existing Digital Terrain Model (DTM) of the seabed. Knowledge of bathymetry, seabed erosion and deposition along the routes will be improved during the planned pre-investigations, however at the current stage, the present seabed terrain is the best available data source to estimate theoretical former land areas from.

2.4 Expected installation depths for turbines, substation(s) and cables

The final installation depths for the export cables will depend on various circumstances such as geology, engineering aspects, water depth, vessel traffic, trenching methods, crossing infrastructure, fishing, etc., and has not been finally defined yet; however, an expected burial depth of 1,5 m is used in this DTS.

The expected maximum foundation depths of wind turbines may extend down to 60m below seabed dependent on the local geological setting plus the foundation type

2.5 Archaeological habitat and research model(s) for Stone Age settlers

A survey and investigation strategy should include a model for prehistoric settlement practices, e.g. /6/, /10/. Thus, when assessing submerged Stone Age landscapes, focus for marine archaeologists are most likely the following parameters:

1. The sea level potential for pre-historic settlement; former dry land area making the area inhabitable; or inundated area during the archaeological period of interest making the area uninhabitable.
2. Habitat / Settlement model / Subsistence economy, including basic principles of human survival which dictate where people live, such as availability of fresh water and food procurement; well-known settlement patterns for the period enabling tracking through (paleo-)topographic models.

The habitat and settlement model used in this report is the internationally renowned 'fishing site model', e.g. /2/, /3/, /6/, /7/, /10/, which argues that pre-historic sites exploiting marine resources were placed by the coast in immediate proximity to positions where these resources appear/pass in larger quantity. The concept of the fishing site model is to use topographical predictive modelling for mapping of prehistoric hunter-gatherer coastal settlements by tracing attractive coastal landscape elements such as coves, fjords, bays, indents, dire straits, river inlets/shores. Typical settlement positions for prehistoric hunters utilising marine resources according to the fishing site model are marked in.

Other models for locating settlements exist in sketch form - and will possibly be detailed, verified and made operational in the coming years. However, the 'fishing site model' is at present the best-tried topographic model for identifying archaeological interests on the seabed and has proven successful as remains of many coastal Stone Age settlements have been found using the concept of this model.

According to literature, e.g. /6/, /16/, focus in Danish waters is primarily on the archaeological period of the Stone Age called Mesolithic, c. 11,000-5,900 years before present (BP), where hunter-gatherers primarily lived close to the coasts finding food from the sea, see Table 2-1.

Findings according to the fishing site model are in Denmark primarily known to be of Late and Middle Mesolithic age, e.g. /3/, /10/, thus associated with the 'Kongemose culture' and the 'Ertebølle culture', c. 8,400 BP – c. 5,900 BP, see Table 2-1. However, recently a relic from a submerged prehistoric site was dated to c. 8,500 BP, thus the youngest part of the older 'Maglemose culture', /11/ and /16/.

Table 2-1 **Cultural, archaeological, climatic and geological periods, and approximate time intervals. compiled by Ramboll from various sources, e.g. /3/ and /16/.**

Period	cal. ka BP (Thousand calendar years before present (BP))				
	>11	c. 11.0 – c. 8.4	c. 8.4 – c. 7.4	c. 7.4 – c. 5.9	< c. 5.9
Cultural	Ahrensburg	Maglemose	Kongemose	Ertebølle	NA
Archaeological	Paleolithic	Early Mesolithic	Mid Mesolithic	Late Mesolithic	Neolithic
Climatic	NA	Preboreal (c. 11.0-9.8) Boreal (c. 9.8-9.0) Atlantic (c. 9.0-8.4)	Atlantic	Atlantic	Subboreal Subatlantic

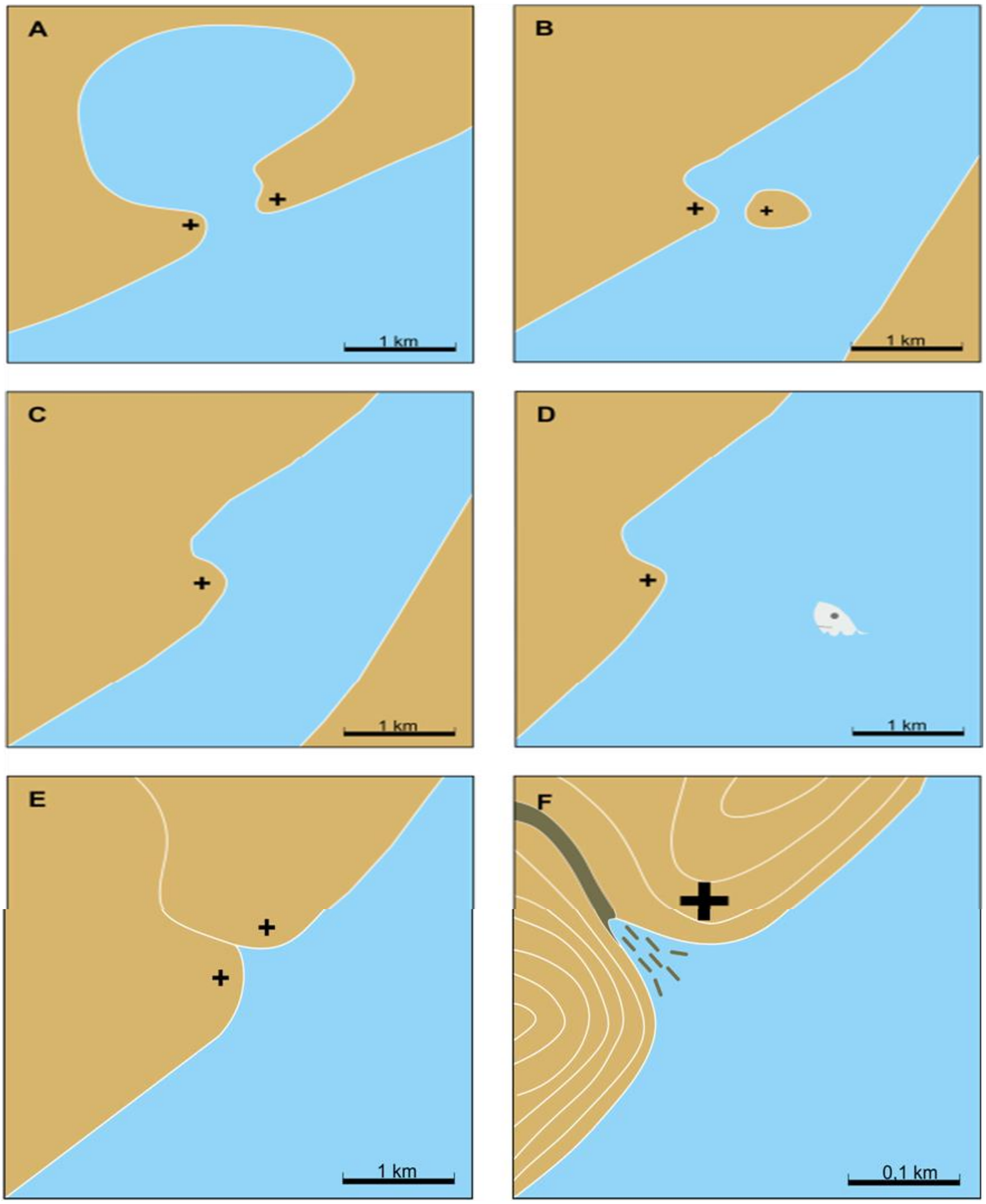

Figure 2-1 The principle of the 'fishing site model' where the placement of the x'es, and the sizes of the X'es mark the most attractive settlement areas for the Stone Age 'fisherman'. A: By the mouth of a cove or inlet, especially when the mouth is narrow, and channel like with a large 'hinterland' on both sides. The greatest probability is thought to be immediately adjacent to the channel. B: By a channel between a small island and a larger land area. Here the probability is thought to be greatest on the land side. C and D: By a projecting headland. Here the probability is considered greatest if the projecting headland is in sheltered waters. E and F: At the mouth of a watercourse. Here the probability is thought to be greatest where the settlement could be located on relatively flat terrain. After /2/, /3/.

2.6 Geology

In Report 2 an interpretation and description of the geological setting will be provided. Of particular relevance for the geoarchaeological part is the depositional and erosional history during Late Glacial and Postglacial (Holocene).

2.7 Summary of the expected outcome of the applied methodology

The above-mentioned integrated assessments are carried out to preliminary evaluate if, when, and where former dry land areas, e.g. coastal zones attractive for former Stone Age settlements, in theory are expected to be crossed within the installation depths. This shall later be correlated with the findings in the 2'nd report containing the geological examination and conceptual model.

3. DATA

The preparation of the Geological DTS has followed these steps:

1. Data collection
2. Report 1: Selection of most relevant shore level displacement curve(s), Integration of shore level displacement curve with existing bathymetry and expected installation depths for the OWF and CRs
3. Report 2: Assessment, interpretation and description of relevant geology in the area. Construction of conceptual geological model and profile for the area
4. Reporting

The data sources for both Report 1 and Report 2 include public data sources and proprietary data from Ramboll and Energinet:

3.1 Bathymetry

Several databases contain lists of depths to seabed (bathymetry), and/or bathymetric models, such as for instance the European (EU) funded 'EMODnet Bathymetry'. For the purpose of this report, EMODnet is applied.

According to the official webpage of EMODnet, /1/, bathymetric survey data and aggregated bathymetry data sets have been collated from public and research organisations. These have been processed, quality assured and used to produce regional Digital Terrain Models (DTM). Thereafter, these have been integrated into the EMODnet DTM (Digital Terrain Model) for European seas.

The EMODnet DTM has a grid size of 1/16 arcminute. Each grid cell has a variety of information, including x,y coordinates and average water depth in metres, which is applied in this report. For metadata, please refer to the website of EMODnet, /1/. Bathymetry based on EMODnet data is presented as seabed maps and as seabed profiles.

The relevant nautical map, ”93-Nordsøen” provided by Energinet, has been consulted as well.

3.2 Shore level displacement curves

In Denmark sea level fluctuations aka shore level displacements during Late Glacial and Postglacial periods have evolved quite differently during the global sea level rise (eustasy) depending on the geography. These differences in shore level displacements are mainly due to geographical differences in uplift (isostasy), but at times also possible local barriers/thresholds impeding the general sea level rise until that local threshold eventually was inundated. The latter is particularly relevant for inner Danish waters.

The magnitude of Late Glacial and Postglacial isostatic uplift decreases from the northern parts of Denmark (and Scandinavia) towards the south/southwest; i.e. has had less effect, the farther away from the centre of the Weichselian ice sheet. This has had a significant impact on local relative coastline changes as illustrated by a map of Denmark showing the isobars for the highest registered shoreline of the Littorina Sea in Denmark, Figure 3-1. The isobases for instance illustrate that the highest shore line in northern part of Jutland is situated c. >12m above the present sea level. The Thor site is situated near the 0 m isobase.

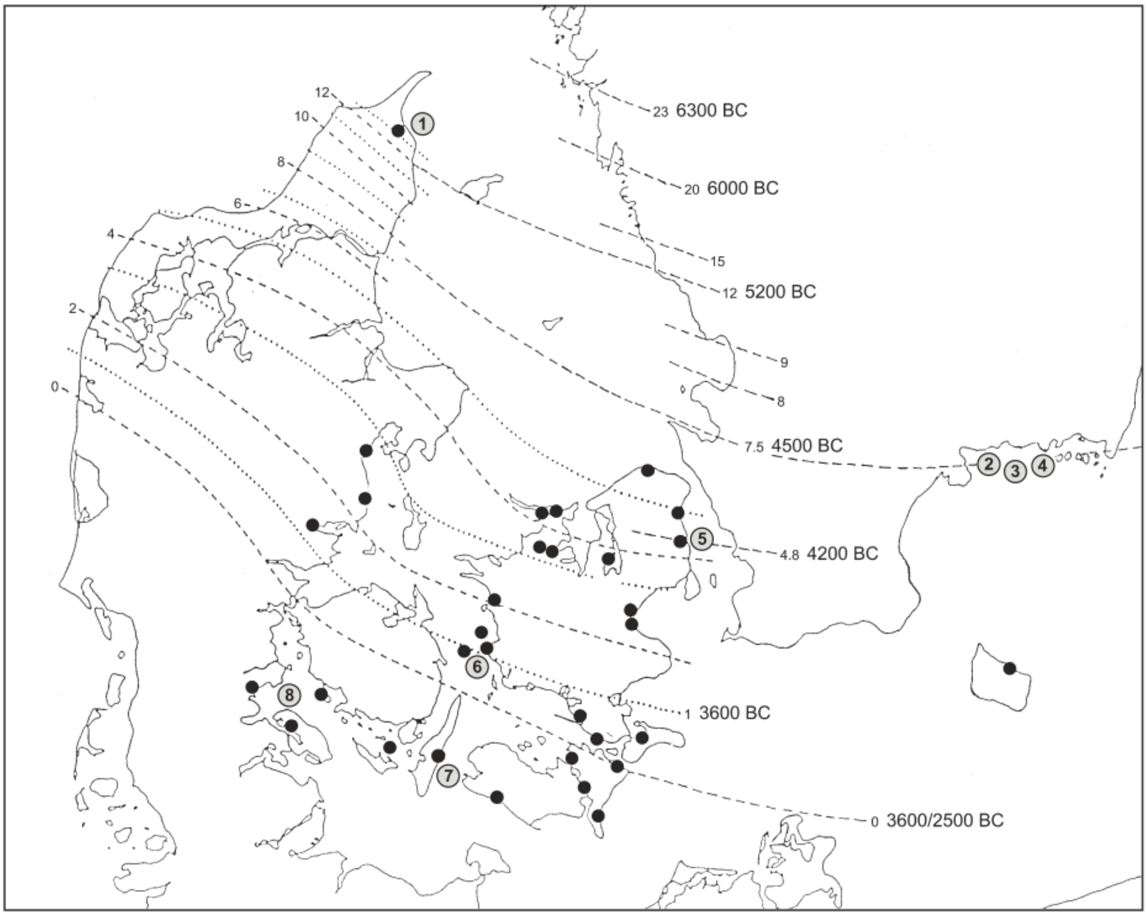

Figure 3-1 Isobases for the highest shore lines of the Littorina Sea in Denmark. The highest shorelines are diachronic, approximate ages are shown. The circles with number 1-8 indicate the geographies of calculated shoreline displacement curves /12/.

There are a lot of dated material representing shorelines in the Scandinavian area. The resulting existing shoreline displacement curves are typically established by way of numerous radiocarbon dates for tree stumps or other organic components during archaeological and geological investigations both on- and offshore.

Based on such data Påsse and Andersson have in an empirical model calculated shoreline displacement curves throughout the Scandinavian area /13/. The accuracy of these calculated shore-levels is in general high, and they can be used carefully along the highest coastline of the isobars in Figure 3-1.

The most relevant curve will help identify periods and levels of regression and transgression during the Late Glacial and Postglacial periods for the relevant area. Furthermore – in connection with a habitat model - it will assist in establishing the 'time slot' for, for example, potential coastal zones and hence the archaeological periods where coastal settlements may have occurred. Multiple shore level displacement curves have been found for the North Sea area and are displayed in Figure 3-2:

- "Storebælt" displacement curve described in Påsse and Andersson 2005 /13/, which follow the 1 m isobar, as shown in Figure 3-1. The curve has for instance been applied to the geoarchaeological study of the VHN area /14/.

- "Germany, North Sea" displacement curve described in Påsse and Andersson 2005 /13/, which correlate to an area off the coast of Germany. The curve has for instance been applied to the geoarchaeological study of the VHS area /15/ and to the Baltic Pipe Norwegian Tie-In /4/.

- An updated displacement curve for the above-mentioned Baltic Pipe Norwegian Tie-in route /18/. This curve is based on new and existing dated samples, including AMS (C14) dated sediments/samples from the Baltic Pipe project.

In addition to the above existing curves, which all have been digitized as part of this study a 4th potentially relevant 'curve' – the GIA-Thor curve – is also presented in Figure 3-2. However, the quote mark around 'curve' indicates that this curve is not a reconstruction of an existing curve. Instead it is Ramboll's representation of so-called Glacio Isostatic Adjustment (GIA) variation isolines deducted from a new book called "Sea-level change in Mesolithic southern Scandinavia – long-and short-term effect on society and the environment", /16/.

In that book numerous so-called sea-level index points (SLIPs), which are new and existing C14 dated sediments and samples covering southern Scandinavia focusing on Denmark, including the North Sea, have been compiled and analysed into a model. Based on these SLIPs isostatic uplift variations have been analysed within the study area, and 8 Glacio Isostatic Adjustment (GIA) variations maps – representing relative sea levels - have been modelled for 500-year intervals from the period 8,000-7,500 BC to 4,500-4,000 BC (before Christ). The values for the GIA 1m isolines centred at the Thor site have been digitized, see Figure 3-2.

In section 4.2 the most relevant RSL curve of the 4 mentioned will be recommended.

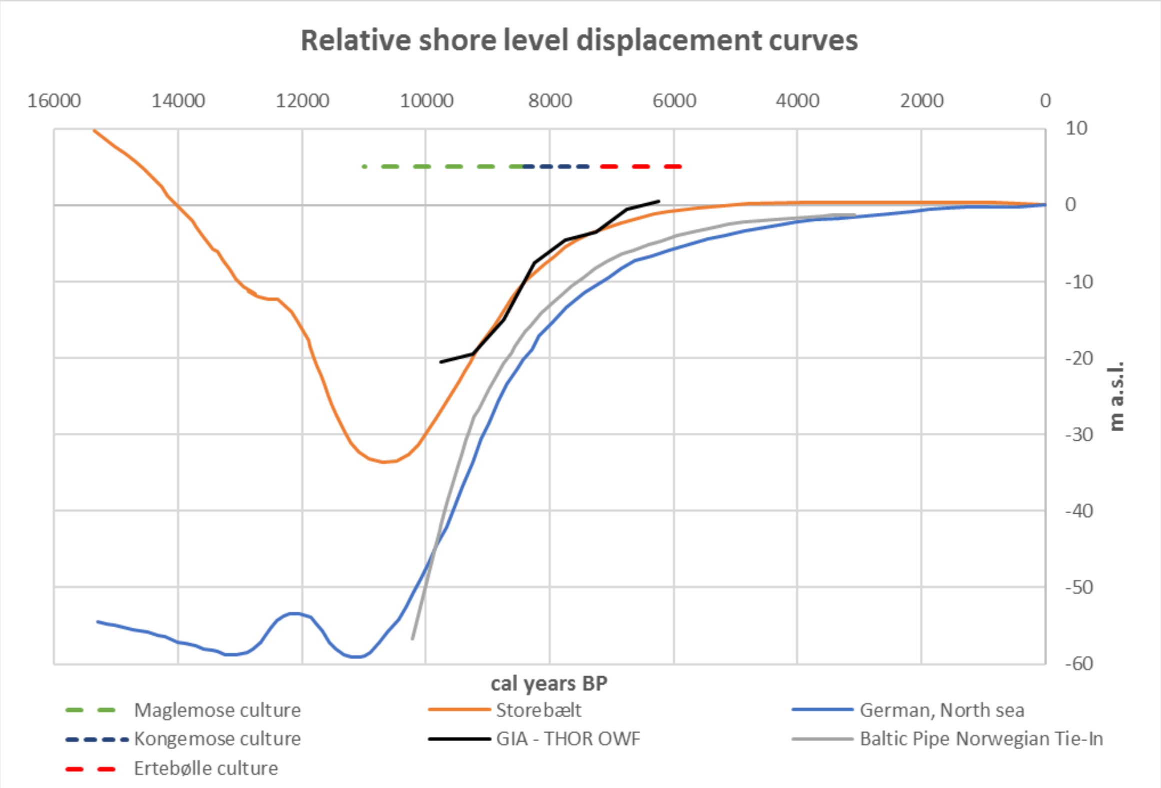

Figure 3-2 RSL curves for the North Sea. The orange curve is the Storebælt RSL /13/, the blue curve is the German – North Sea RSL /13/, grey curve is the updated Baltic Pipe Norwegian Tie-in RSL /18/, while the black curve is the approximated GIA-Thor RSL /16/. The dotted line shows the temporal extend of the different Mesolithic cultures.

3.3 Other data

The national public database of Historic property / Cultural Heritage has been consulted for possible objects/sites classified of being of pre-historic Stone Age /17/.

Contact has also been made to the following institutions in order to investigate whether new unpublished geoarchaeological investigations including C14 dated samples have been conducted in the region relevant for the Thor project. Contact has been made to the following institutions:

- GEUS, Marine geological department, Aarhus
- Strandingsmuseet St. George in Thorsminde and Moesgaard Museum in Aarhus

Neither of the interviewed archaeologists/geoarchaeologists at the above institutions know of any new unpublished geoarchaeological investigations in the vicinity of the Thor site, however at both museums the updated RSL curve for the Baltic Pipe, Norwegian Tie-In was mentioned, although regarded to be potentially located too much to the south of the Thor investigation area.

3.4 Geological and geophysical data

Data and reports from the following databases have been assessed in order to be able to describe shallow geology along the planned routes and OWF area:

- the national well / borehole database 'Jupiter' maintained by GEUS
- the marine raw materials database 'MARTA' maintained by GEUS, including overviews of various marine shallow geology surveys and reports thereof
- the national seabed sediment map developed and maintained by GEUS
- the national "groundwater reports' database developed and maintained by GEUS

In Figure 3-3 is shown an overview of the reported geophysical survey projects and lines in the investigation area. In addition to these, the VHN and VHS pre-investigation reports, including reports /14/ and /15/, have also been consulted (these are not available via Marta). The collected data will be discussed and interpreted in Report 2.

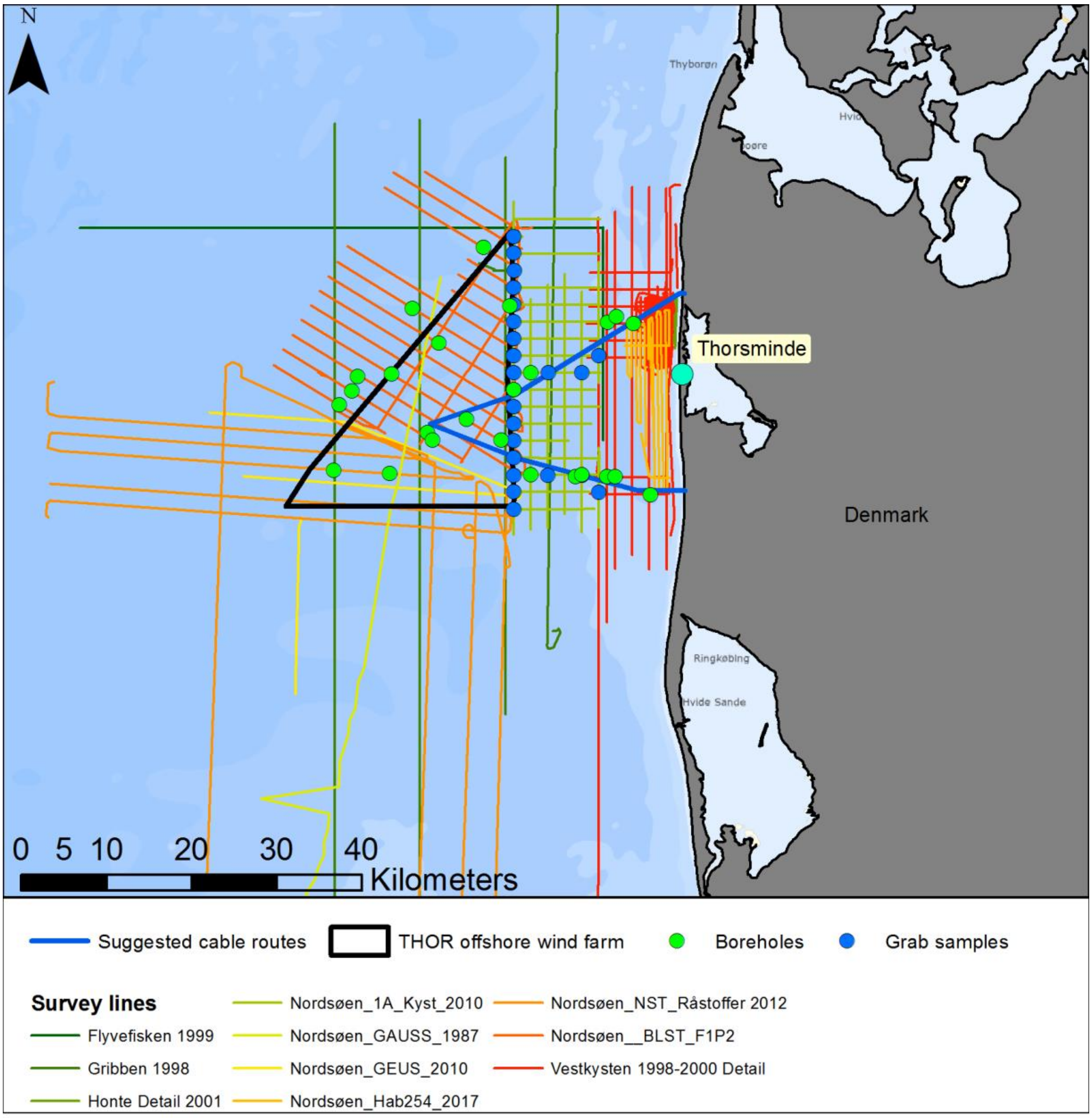

Figure 3-3 Overview of reported shallow seismic/geophysical surveys in the area plus existing boreholes (typically vibrocores and seabed samples) and grab samples.

4. RESULTS

4.1 Bathymetry

In Figure 4-1 is shown the general bathymetry off the coast of Jutland based on EMODnet along with the OWF area and in principle also the two planned CRs, however see the notes below.

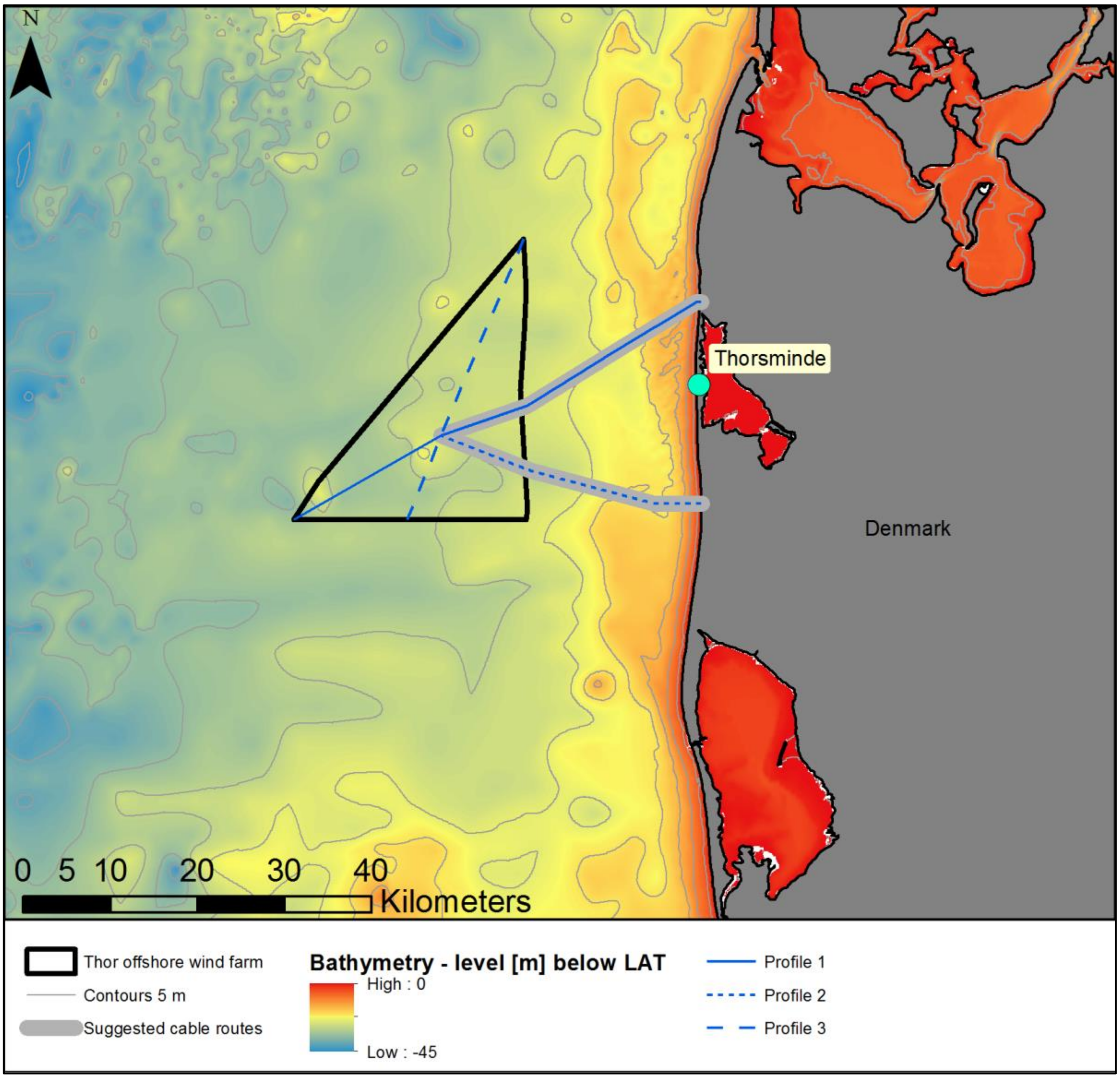

Figure 4-1 Overview Thor OWF and connected cable routes with the general bathymetry based on EMODnet.

In the Thor OWF area the water depth ranges from c. -24 m to c. -34 m LAT with a mean depth of -29,9 m and with the greatest depths in the southwestern part of the OWF.

3 cross-section profiles have been generated across the OWF area and along the planned cable routes, see Figure 4-1 for their location. The cross-sections are displayed and described below.

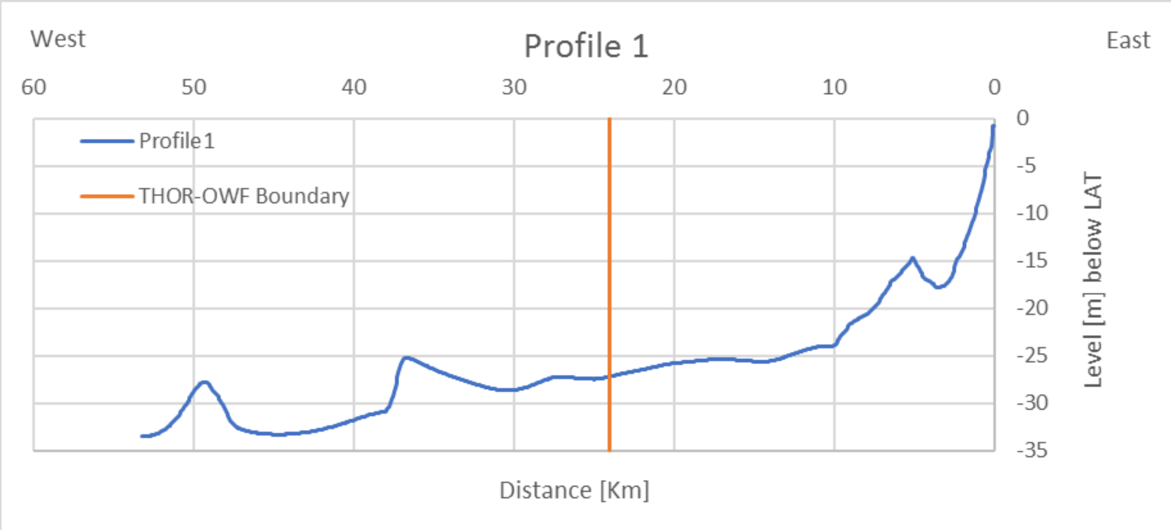

Figure 4-2 Seabed elevation profile along the northern cable route to Thor OWF with the general bathymetry based on EMODnet. The profile is extended c. 20km towards SW to incorporate the western most part of the OWF.

A seabed elevation profile has been prepared along the northern cable route and is extended c. 20km towards SW to also display the western most part of the OWF, see Figure 4-2. The cable route is approx. 34 km from the centre of the OWF to landfall. The eastern delineation of Thor OWF is also shown in the figure.

Seen from land, the seabed along the northern cable route has a rapid increase of 17 m in depth on the first 4 kilometres until a local bathymetric high is being crossed, which results in a slight lowering in water depth. Approx. 5,5 km from land the rapid increase in depth resumes and continues until c. 10 km offshore, where the increase in depth reaches a more level and smooth inclination. From 10 km offshore to the centre of the OWF area 34 km offshore the seabed increases in depth from 24 m to 27,5 m. At the boundary to the OWF area a depth of c. 27 m is reached.

Along the remaining cross-section from 34 – 53 km offshore a general increase in depth in seen from 27,5 m to 33 m. Two rises in bathymetry is seen along this part of the profile, both structures have a height of c. 5 m and ends with a steep increase in depth. As seen in Figure 4-1 and Figure 4-2, the 2 structures have a small geographical extend and do not describe the area in general. In the geological conceptual model (Report 2) the origin of these structures will be described.

Figure 4-3 Seabed elevation profile along the southern cable route to Thor OWF with the general bathymetry based on EMODnet.

Seen from land, the seabed along the southern cable route, Figure 4-3, has a rapid increase of 21 m in depth on the first c. 5 kilometres; here a small and relict longshore through and bar is met. The vertex point of the bar is c. 8,5 km offshore from where a moderate increase in depth continues until c. 19 km offshore, where the lowest point along the cable route is encountered at a depth of 31 m below LAT. From this point to the centre of the OWF area 31 km offshore, an overall, however small, decrease in depth is seen, with the endpoint being at a depth of 27,5 m. At the boundary to the OWF area c. 21 km offshore, a depth of c. 29 m is reached.

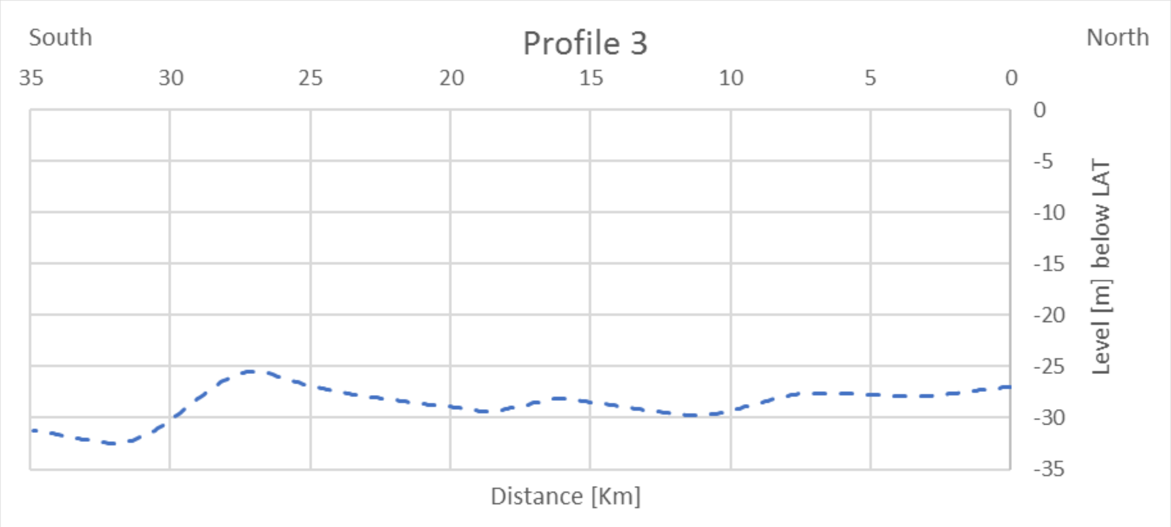

Figure 4-4 Seabed elevation profile along N-S oriented through the THOR OWF with the general bathymetry based on EMODnet.

Along the North-South cross-section on Figure 4-4 a relative stable bathymetry is seen, varying between 25,5 and 29,5 m depth along the first 25 km of the profile seen from north. Along the last 10 km of the profile a small rise in bathymetry is seen, followed by a through where the depth varies from c. 25,5 to 32,5 m

4.2 Most relevant shore level displacement curve and comparison with bathymetry

The GIA RSL, which is approximated directly from the Thor OWF area, is seen to correlate very well with the Storebælt curve between c. 6,000 BP to 10,000 BP and supports the fit of the Storebælt RSL. However; the GIA RSL 'curve' has not been chosen as the most relevant curve because of the rough estimation of values manually read from the original book, and since background data is not readily available for this DTS.

Thus, the Storebælt RSL has been chosen because it is situated close to the 0,5m isobase as shown in Figure 3-1, and because OWF Thor lies close to however a bit to the south of that isobase. The Storebælt RSL curve was also used by GEUS as part of the VHN offshore wind farm project in regards of geoarchaeological assessment /14/.

As can be deduced from Figure 3-2 and as expected due to geography, the updated Baltic Pipe, Norwegian Tie-In curve in general lies immediately above the German, North Sea curve in terms of seabed levels, however both the German North Sea RSL and the updated Baltic Pipe RSL is markedly different from the Storebælt RSL, which indicates that these curves represent a different area too far away towards south, marked by a marked change in glacioisostasy.

In Figure 4-5 is shown 4 different highlighted time slots and/or relative sea level markers:

- "Sea level minimum 10,700 BP": This time slot marks the maximum regression level at the approximate beginning of the Mesolithic (the Maglemose culture) and has a corresponding water level c. -34m, which by coincidence also marks the lowest existing seabed levels in the investigation area.

- "Kongemose 8,400 BP: This time slot, with a corresponding water level of c. -10m, marks the beginning of the Mid Mesolithic, thus the Kongemose culture, which also marks the approximate end of the most rapid part of the Littorina transgression
- "Maglemose 9,500 BP" and "Maglemose 9,000 BP": Intermediate time slots with corresponding water levels of c. -24m and -17m, respectively.

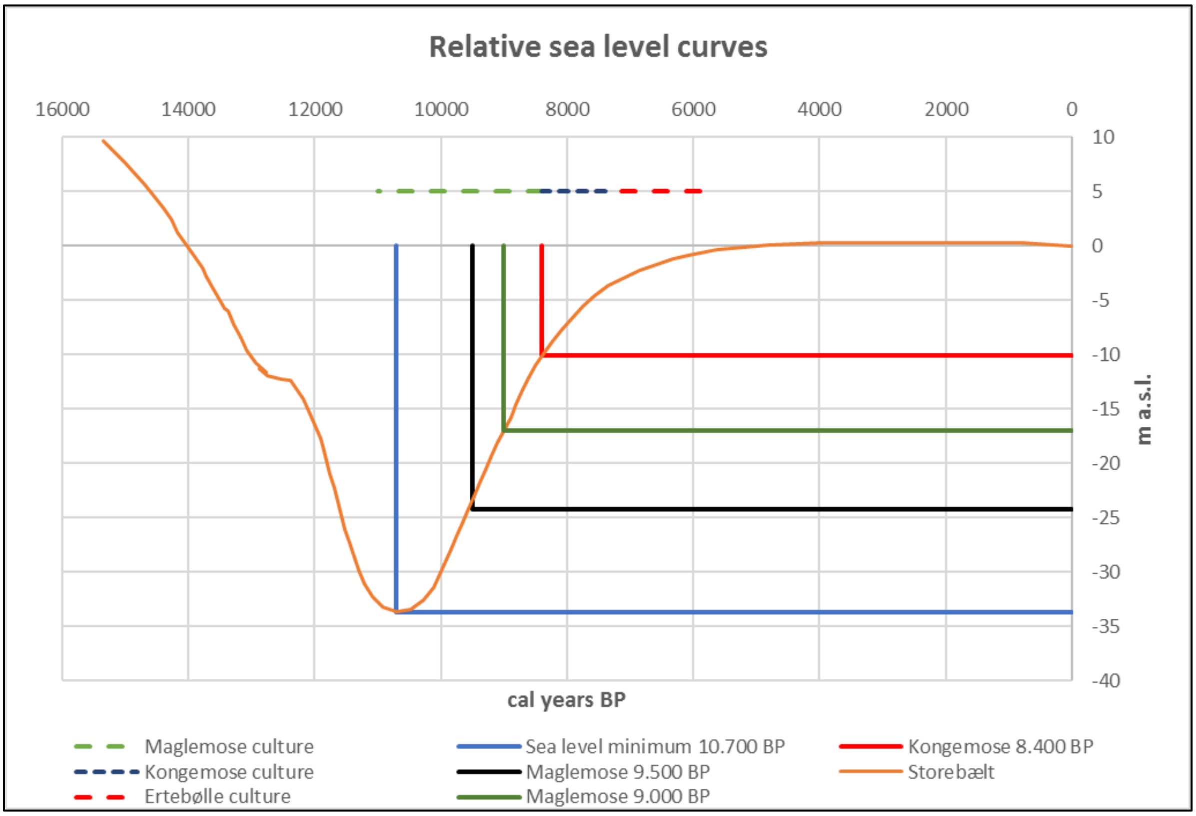

Figure 4-5 Calculated shoreline displacement curve for Storebælt, selected as being the most relevant for THOR OWF. From /13/. NB: The x-axis is age cal. BP. and metres above sea level.

A fifth highlighted time slot could have been 5,900 BP, which marks the end of Mesolithic, the Ertebølle culture, however in this part of Denmark, the whole area was almost entirely flooded due to the Littorina transgression.

By examining the selected shore level displacement curve and highlighted time slots and corresponding water levels, Figure 4-5 indicates, that all/almost all of the Thor investigation area was dry land at c. 10.700 BP at the approximate beginning of the Mesolithic period (the Maglemose culture). From c.10,500 BP the area experienced pronounced transgression.

In the time slots representing the transition from Preboreal to Boreal climate, and from Boreal to Atlantic climate (c. 9,800/9,500 BP and 9,000 BP) the RSL curve is still defined by a period of rapid transgression. The rapid transgression continues until the beginning of the Kongemose culture at c. 8.400 BP, where a decline in the transgression slowly begins.

To summarize: Provided the unlikely circumstance that no sedimentation or erosion has occurred since the surface of the current seabed was formed, this in theory 'relict' land surface's deepest levels within Thor OWF, was transgressed at c. 10,700 BP as mentioned earlier, while areas having a depth of c. 24 m and c. 17m was transgressed c. 9,500 BP and 9,000 BP, respectively. Areas at a depth of 10 m was transgressed at the beginning of the Kongemose culture at c. 8,400 BP. From 8,400 BP to 5,900 BP the shore level changed only approx. 9 m, but with only small geographical changes to the current coastline of today. In the last c. 5,900 years sea level changes have been minor.

4.3 Theoretical paleogeographic maps and existing pre-historic findings

In Figure 4-6 a selection of theoretical paleogeographic maps are presented. The maps are representative for different relevant sea levels, during the archaeological period withheld in the coastal 'fishing site model'.

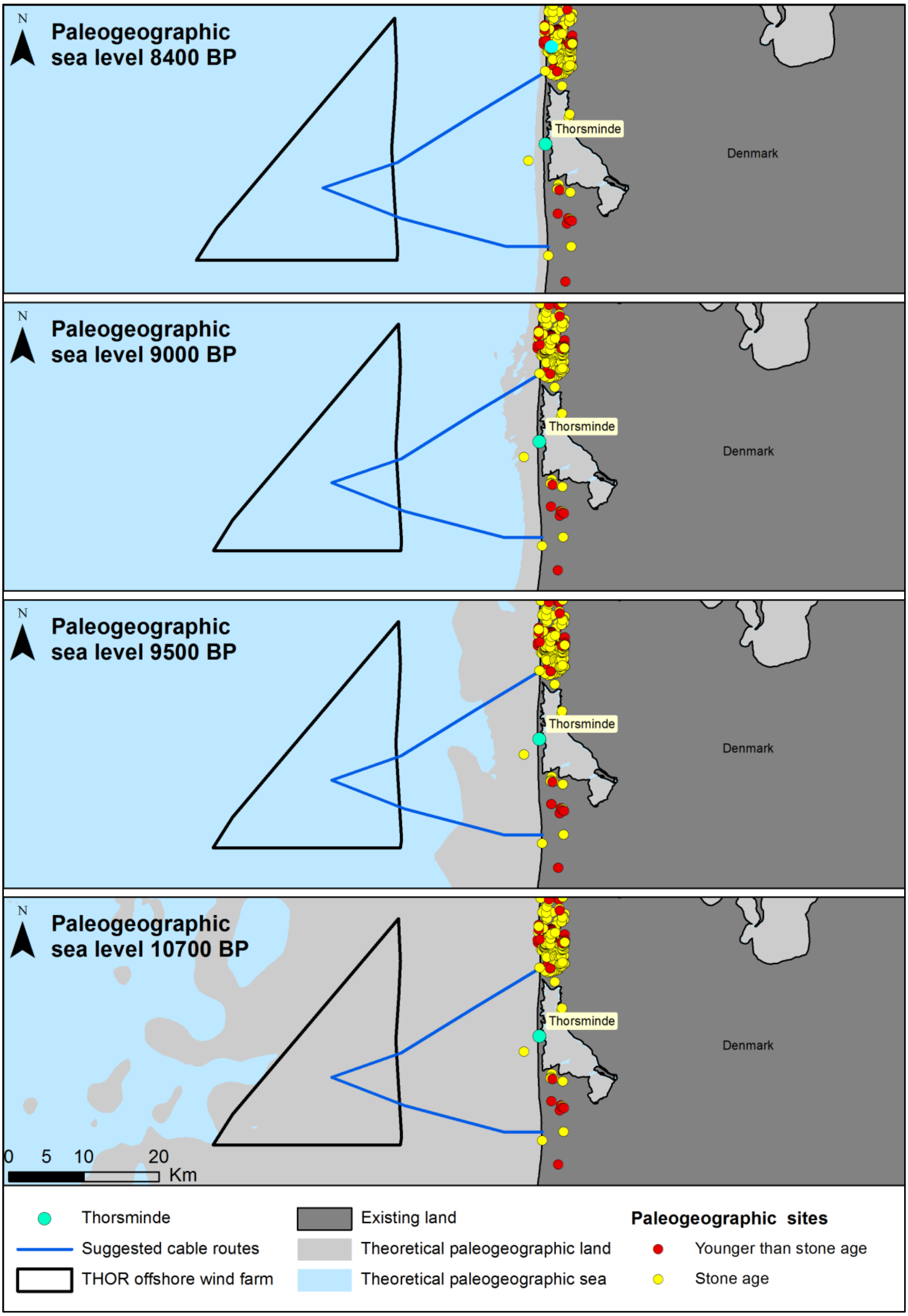

Figure 4-6 Theoretical paleogeographic maps for the investigation area, constructed for selected seabed levels, corresponding to selected ages between 10,700 BP to 8,400 BP.

On these theoretical paleogeographic maps are shown published prehistoric sites (older than c. 800 BP), including Stone Age sites (older than c. 4,000 BP) according to 'Fortidsminder' – a GIS layer, maintained by SLKS. The majority of discovered prehistoric and stone age sites in the area have been found onshore. A single marine Stone Age site has been discovered SW of Thorsminde, c. 2 km offshore. The finding has been dated to be older than 7400 BP /17/.

4.4 Integration of shore level displacement curve with expected installation depths for the OWF and CRs

A comparison of the paleo sea levels at 10,700 BP and 9,500 BP with the profile along the northern cable route and OWF area can be seen in Figure 4-7 and Figure 4-8.

At the maximum shore level at 10,700 BP, the beginning of the Maglemose culture, can theoretically be found within any area of the OWF. It can be seen on Figure 4-7 that former land surface can theoretically be found to a maximum depth of c. 7 m below the current seabed within the OWF, where the bottom of the OWF installations can be as deep as 60 m below seabed. By taking into account that the Maglemose culture might have used primitive shallow marine fishing traps etc., the theoretically depth where archaeological remains can be found, might be slightly deeper then 7 m below the current seabed.

For the cable route an approximated burial depth of 1,5 m below the seabed shows, that archaeological remains can theoretically be found along the entire length of the cable route.

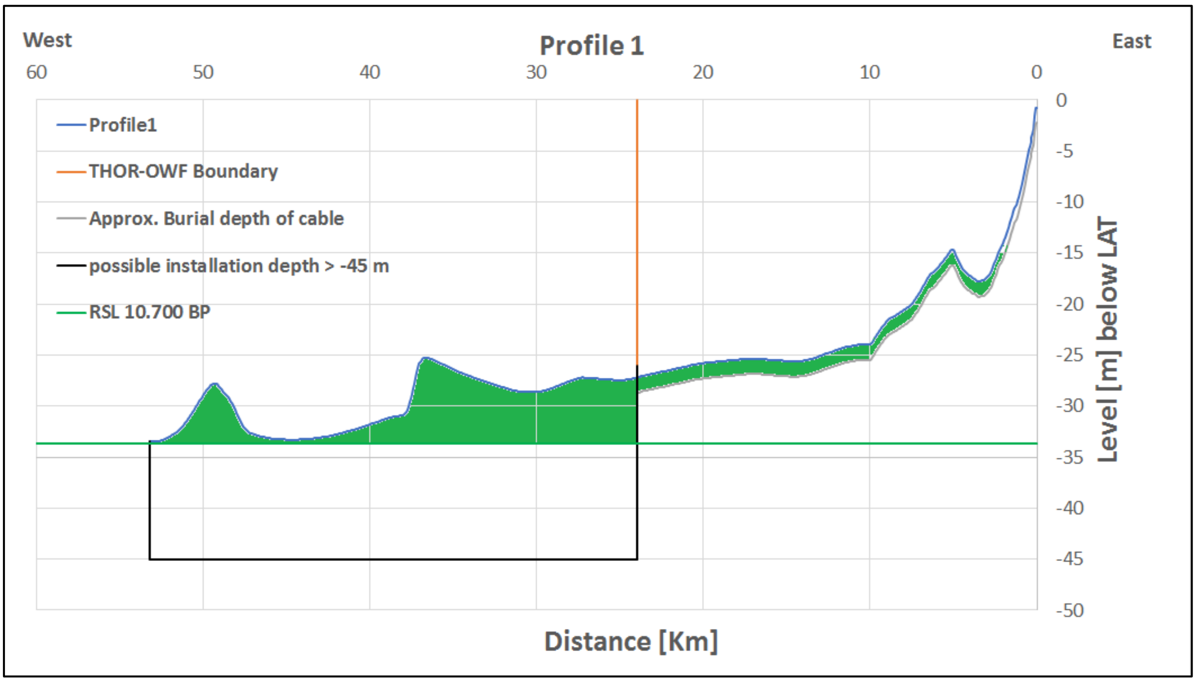

Figure 4-7 Comparison of theoretical paleogeographic coastline to installations depth of OWF and CRs at 10,700 BP. Area marked with green colour illustrate the depth to which archaeological remains in theory can be found.

A similar figure has been constructed for the time slot c. 9.500 BP. As can be seen in Figure 4-8 archaeological findings from this period should theoretically only be expected on the first 10 km of the (northern) cable route but to the full installation depth of c. 1.5m.

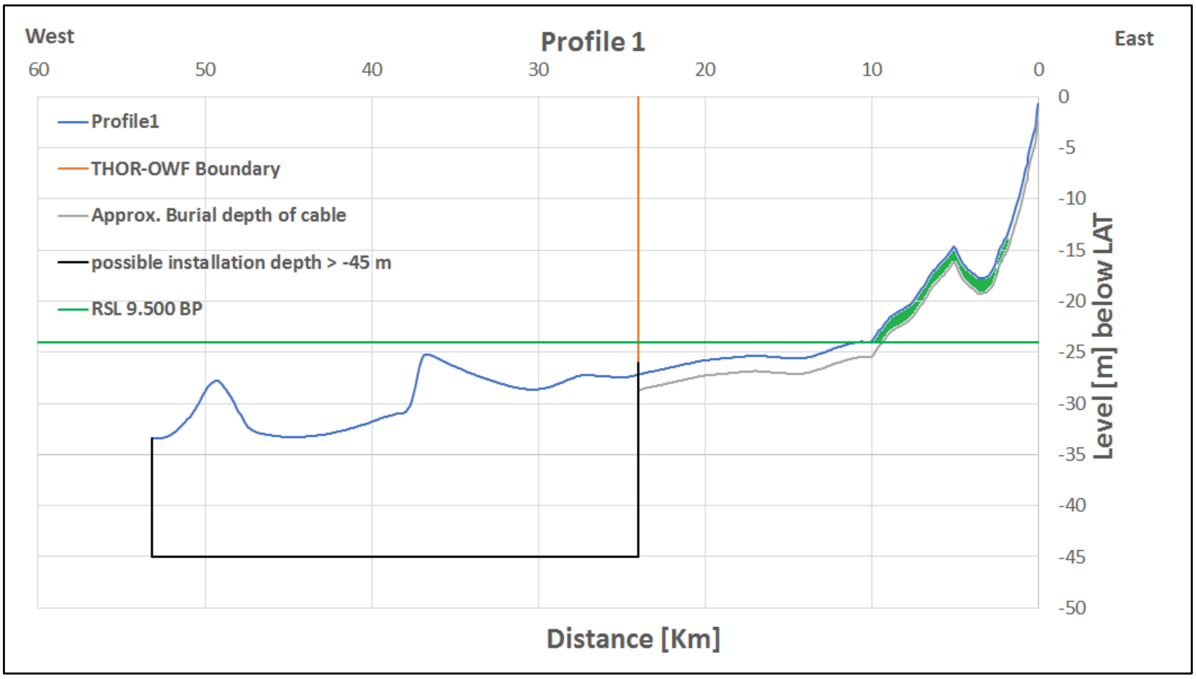

Figure 4-8 Comparison of theoretical paleogeographic coastline to installations depth of OWF and CRs at 9,500 BP Area marked with green colour illustrate the depth to which archaeological remains can be found.

5. PRELIMINARY CONCLUSIONS IN REGARDS OF POTENTIAL STONE AGE LANDSCAPES

The bathymetry in the Thor OWF and CRs combined with the recommended shoreline displacement curve indicate that the submerged landscape in the entire / almost entire OWF investigation area in theory may have had an environment that could have hosted pre-historic settlers from the early Maglemose culture c. 10,700.

Transgression of the former land surface happened fast during the the Maglemose culture, and at the beginning of the Kongemose culture at 8.400 BP, the coastline was in general very similar to current day coastline.

For example, at 9,500 BP the relic shore level would have been c. 24 m below the current sea level LAT. This encompass only the first 10 km of the cable routes closest to land, as possible areas with pre-historic settlers, while the entire OWF area would have been submerged.

The above assessments are theoretical, since they assume the unlikely condition that the current seabed was the same that has been gradually transgressed since c. 10,700 years BP, and that no sedimentation or erosion has occurred during and after transgression.

Based on previous findings, it shall be noted that within southern Scandinavia, including the North Sea, no archaeological coastal sites older than 8,500 BP have been found to date.

A description of the expected geology based on existing data and literature as well an assessment of the magnitude and whereabouts of erosion and sedimentation will be provided in the 2nd report (the Geological model report).

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