Archaeological Handbook for Establishing Offshore Wind Farms in Sweden

Lillgrund Pilot Project

March 2008

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PREFACE

Vattenfall's Lillgrund project has been granted financial support from the Swedish Energy Agency and Vattenfall will therefore report and publish experiences and lessons learned from the project. This report is compiled in a series of open reports describing the experiences gained from the different aspects of the Lillgrund Wind Farm project, for example construction, installation, operation as well as environmental, public acceptance and legal issues.
The majority of the report authors have been directly involved in the Lillgrund project implementation. The reports have been reviewed and commented by a reference group consisting of the Vattenfall representatives Sven-Erik Thor (chairman), Ingegerd Bills, Jan Norling, Göran Loman, Jimmy Hansson and Thomas Davy.

The experiences from the Lillgrund project have been presented at two seminars held in Malmö (4th of June 2008 and 3rd of June 2009). In addition to those, Vattenfall has presented various topics from the Lillgrund project at different wind energy conferences in Sweden and throughout Europe.

All reports are available on www.vattenfall.se/lillgrund. In addition to these background reports, a summary book has been published in Swedish in June 2009. An English version of the book is foreseen and is due late 2009. The Lillgrund book can be obtained by contacting Sven-Erik Thor at sven-erik.thor@vattenfall.com.

Although the Lillgrund reports may tend to focus on problems and challenges, one should bear in mind that, as a whole, the planning and execution of the Lillgrund project has been a great success. The project was delivered on time and within budget and has, since December 2007, been providing 60 000 households with their yearly electricity demand.

Sven-Erik Thor,
Project Sponsor, Vattenfall Vindkraft AB
September 2009

DISCLAIMER

Archaeological Handbook for Establishing Offshore Wind Farms

SAMMANFATTNING

Denna handbok har skrivits av Bohusläns museum på uppdrag av Vattenfall Vindkraft AB i syfte att klarlägga frågor rörande strandnära och under vatten belägna fornlämningar, i samband med planering och byggnation av havsbaserad vindkraft längs Sveriges kuster.

Enligt 1 kapitel 1§ av kulturminneslagen m.m. (1988:950) är bevarandet av kulturarvet ett nationellt ansvar. Hänsyn och aktsamhet till kulturarvet skall visas i samband med planering för att såvitt möjligt undvika eller begränsa skador.

Inom svenskt territorialvatten krävs tillstånd enligt kulturminneslagen (KML) och miljöbalken för att utföra arbeten som kan komma att påverka eller skada kulturarvet. Miljöbalken tillämpas även utanför våra territorialgränser i kombination med lag (1966:314) om kontinentalsockeln. Tillstånd enligt KML (1988:950) erhålls av länsstyrelsen vilken även handlägger tillståndsfrågor inom Sveriges territorialvatten. Inom den ekonomiska zonen handlägger regeringen tillståndsfrågor under konsultation med länsstyrelsen.

För att erhålla tillstånd krävs underlag som visar arbetsföretagets påverkan på kulturarvet. Sådant underlag utförs av antikvarier med marinarkeologisk kompetens. Framförhållning beträffande kulturarvsfrågor är viktigt för att undvika förseningar eller problem längre fram under tillståndsprocess och byggnadsfas. Erfarenheter från vindkraftsparken vid Lillgrund visar att mer ingående och kvalitativa marinarkeologiska undersökningar kan begränsa kostnader ur ett längre tidsperspektiv och att det kan löna sig att utföra dessa på ett tidigt stadium.

Genom att tidigt ta kontakt med länsstyrelse och sakkunning marinarkeolog, kan stora tids- och kostnadsbesparingar göras, främst genom bättre framförhållning och samordning. De undersökningsmetoder som används i arkeologiskt syfte kan till exempel ofta samordnas med geologiska eller marinbiologiska undersökningar eller karteringar, om dessa ändå skall utföras inom projektet.

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1 INTRODUCTION

Underwater cultural remains constitute a rich and important source of information about past human life and society. As a result of various biological and environmental factors, organic material, such as wood, bone and textiles may lie protected and preserved for later generations in a way that is seldom, if ever, found on land sites. Thus the potential knowledge obtained through the archaeological study of such material is invaluable.

In the southern part of the Baltic Sea region spectacular archaeological discoveries have been made in connection with submerged settlements, most of which date from between 8,000–2,000 BC. They have provided a fundamental new understanding of how people lived and interacted and of their technological knowledge, as well as their adaptation to a changing environment [1].

The Kattegat, Baltic, and Skagerrak Seas, including the Sound (the Öresund strait), are some of the most heavily trafficked sea areas in the world, with a seafaring history that goes back several thousands of years. The number of registered losses at sea within Swedish territorial waters alone counts to more than 3,500 in modern time, i.e. since the registers began in earnest in the 19th century [2]. Thus, the actual number must be many times larger. Ships are generally considered to have been the most advanced technical constructions a society could produce, and shipwrecks are often referred to as 'closed finds' or 'time capsules' as they have often remained untouched since the time of the wrecking.

The Swedish cultural heritage act states that preservation and protection of cultural heritage, including archaeological remains under water and on land, is of national importance, the responsibility of which is shared by each and everyone [3]. It must not be disturbed, altered or removed without special permission [4].

Following the increased need for renewable energy sources, the establishment of offshore wind farms has become an important option for the future. It is often preferable to locate such farms in shallow bank areas at sea, where their visual impact is less intrusive and the winds steadier. As a result, the building and maintenance of wind farms often has the potential to interfere with cultural heritage. Therefore, the impact of such establishments must be thoroughly assessed in order to avoid causing any damage – an approach that will not only protect the underwater cultural heritage for generations to come but also minimise costs for the contractor interested in building offshore wind farms.

1.1 Purpose

The purpose of this handbook is to provide a structured guide for contractors interested in establishing offshore wind farms within Swedish territorial waters and its extended economical zone, in relation to Underwater Cultural Heritage (UCH). It is also applicable to UCH in inland waters.

Therefore, this handbook seeks to provide information on;

- The management structure of underwater/maritime cultural heritage in Sweden, including institutions and units with maritime antiquarian expertise,

- The different types of archaeological remains that can be found around the Swedish coast – in offshore, coastal areas and on the foreshore – which can potentially be affected by offshore wind farm projects,

- The laws that underwater archaeological remains are subject to – within the National Maritime Boundary as well as within the contiguous and exclusive economical zones - and the necessary archaeological investigations that need to be considered in order to avoid and/or protect the cultural heritage provided by those remains,

- Archaeological standards and methods for assessing and evaluating the potential for finding archaeological remains under water,

- The steps that need to be to considered during the planning process of establishing offshore wind farms, and how the contractor and archaeologist can work together in order to make the process more cost effective, and

- Considerations for the future.

Furthermore, this handbook includes a presentation of archaeological finds made during archaeological surveys in connection with the Lillgrund project (see chapter 6.2).

The handbook does not make references to any investigations that may be required in relation to land based archaeological sites other than those which are undertaken close to the shoreline (situated on the foreshore), nor does it consider the visual impact sea-based wind farms might have on cultural heritage.

1.2 Background

Bohusläns museum has, on behalf of Vattenfall Vindkraft AB, been commissioned to write an archaeological handbook for establishing offshore wind farms in Sweden. The work was carried out between December 2007 and March 2008.

The handbook is the result of governmental investment support and pilot support, given to Vattenfall AB for their establishment of the wind farm at Lillgrund in the Sound (Öresund) between the Swedish south coast and Denmark. The overall purpose of the pilot support is to facilitate the establishment of future offshore wind farms and to increase their cost effectiveness. As a result, Vattenfall AB is to pass on knowledge and experiences obtained during the Lillgrund wind farm project as part of a project named “Pilotutredningar Lillgrund” (abbreviated LLG Pilot) or Pilot Investigations Lillgrund. The LLG Pilot project is divided into the following subsections:

1. Economy and Bidding
2. Design and Technical layout
3. Installation and Start-up
4. Environmental Impact
5. Running and Maintenance
6. Production Analysis
7. Communication and Acceptance

This archaeological handbook falls under subsection 4. Environmental Impact.

2 METHOD OF APPROACH

The handbook is based on literature and archive studies of material from primarily Sweden but also from Denmark and the UK, as well as interviews with representatives from all major institutions and museums dealing with underwater cultural heritage in Sweden. Danish experts have been consulted because they have more than 10 years of experience with archaeological investigations in connection with offshore wind farms. In addition, representatives from Vattenfall AB with experience of planning and executing wind farm projects around the Swedish coast, including those at Kriegers Flak and Lillgrund, have also been consulted.

The following individuals and institutions/organisations have been interviewed or consulted:

Institution/Museum	Individuals
Bohusläns museum	Staffan von Arbin/Thomas Bergstrand
Kalmar Läns Museum (Kalmar County Museum)	Lars Einarsson
Malmö Kulturmiljövård	Jan Öijeberg
Riksantikvarieämbetet, RAÄ (Swedish National Heritage Board)	Peter Norman/Ylva Othzén/ Håkan Slotte
Statens Maritima Museer, SMM (Swedish National Maritime Museum)	Andreas Olsson
Länsstyrelsen i Skåne (County Administration Board of Scania)	Anders Wihlborg
Vikingeskibsmuseet, (Viking Ship Museum) Denmark	Jørgen Dencker
Contractor	
Vattenfall Vindkraft AB	Göran Loman/ Arne Floderus

Swedish terms are used where appropriate but English terms are generally being used. The glossary in the back of the handbook (chapter 13) includes terms in both languages.

3 UNDERWATER CULTURAL HERITAGE MANAGEMENT IN SWEDEN

Riksantikvarieämbetet (RAÄ), or the National Heritage Board, has the overall and centralised responsibility for cultural heritage management in Sweden (figure 1) [5]. This responsibility includes the maintenance of the national sites and monuments register (FMIS) as well as providing information and consultation on all matters regarding cultural heritage.

On a regional level, 21 Länsstyrelser, or County Administration Boards, are responsible for supervising laws and regulations within the cultural heritage sector. Thus, they decide on

all matters that might interfere with cultural heritage and issues related to planning permissions. In the event that archaeological investigations are required, it is the County Administration Board that determines the scope and extent of such investigations, and which organisation should undertake them. The County Administration Board may decide that no archaeological investigation is needed. However, under guidelines issued by the National Heritage Board, archaeological investigations are likely to be demanded in relation to sea-based wind farms [6].

The regional and district museums co-operate with the County Administration Boards in supervision and management of cultural heritage matters. These are also the bodies to which proposed measures from municipalities and cultural administration boards are submitted to for consideration.

Consultation on maritime archaeological issues is currently provided by seven organisations in Sweden, which also offer underwater archaeological services (see figure 1).

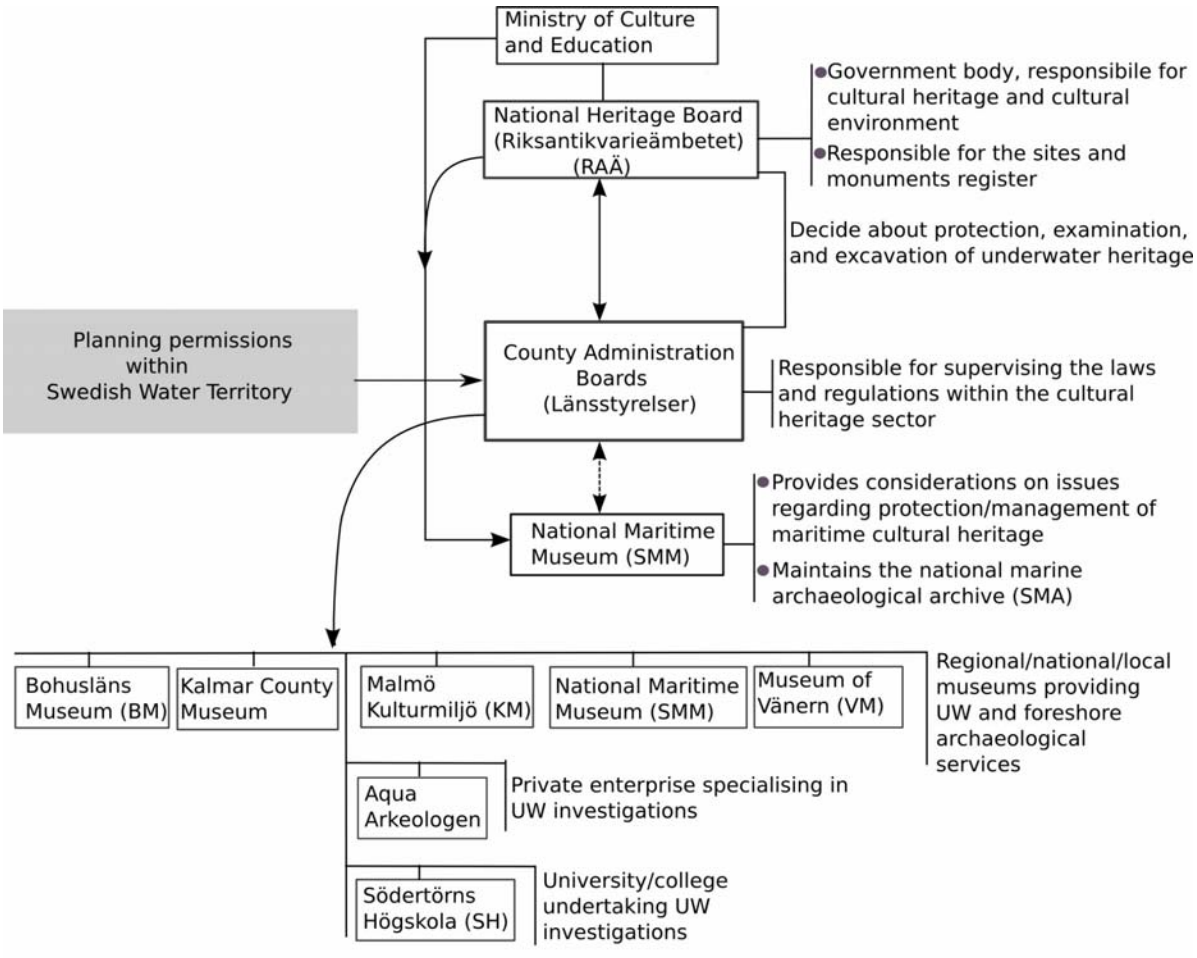

Figure 1. A flowchart providing a simplified view of the management structures of underwater cultural heritage in Sweden.

3.1 Definitions in the Heritage Conservation Act (1988:950)

The Swedish Heritage Conservation Act (1988:950), states, as mentioned in the introduction of this manual, that the protection and preservation of cultural heritage is of national importance. In addition, it regulates how individuals and authorities should conduct themselves when handling all matters in relation to heritage protection. Some of these aspects, as for example how the management of Swedish UCH is handled, have already been addressed in chapter 3.

However, a key part of this Act deals with the issue of what cultural heritage actually consists of and how it is defined;

3.1.1 Archaeological Sites and Monuments

Archaeological sites and monuments include all remains of past human activity, which have been permanently abandoned, and, are protected under chapter 2, 1§ of the Heritage Conservation Act.

In the legal text a broad spectrum of specific types of protected sites and monuments are listed, but here it is sufficient to mention those that might apply to the underwater cultural heritage as well as on the foreshore, that is:

- The remains of buildings, settlements or work areas, and cultural layers that derive from the use of such buildings or areas, as well as the remains deriving from working life or subsistence.

- Roads and bridges, harbour installations, beacons, road signs, seamarks and similar sites related to communication as well as boundary marks and mazes.

- Shipwrecks, if more than one hundred years have passed since the ship foundered.

3.1.2 Protection Area Surrounding a Site or a Monument

In addition to specifying what different types of sites and monuments are protected under the law, the Act stipulates that a sufficiently large area surrounding each monument should be protected in order to ensure the preservation of its art and significance [7].

The size of the protection zone is thus decided by the Country Administration Board on a case by case basis.

3.2 National Maritime Borders

The Heritage Conservation Act applies within the Swedish National Border and its Territorial Waters. At present the Swedish Territorial Waters extend to within 12 nautical miles off its coastal base line. So far, Sweden has not extended its jurisdictional rights with respect to Underwater Cultural Heritage (UCH) to the 24 nautical mile zone, or the contiguous zone, as stipulated in the UN Convention on the Law of the Sea 1982. However, Government bill 1995/96:140, indicates that this is under consideration, and already it has become common practice to try and apply the same rules and regulations concerning planning permissions within the 24 mile zone, with regard to UCH, as within the national border and the territorial 12 mile zone.

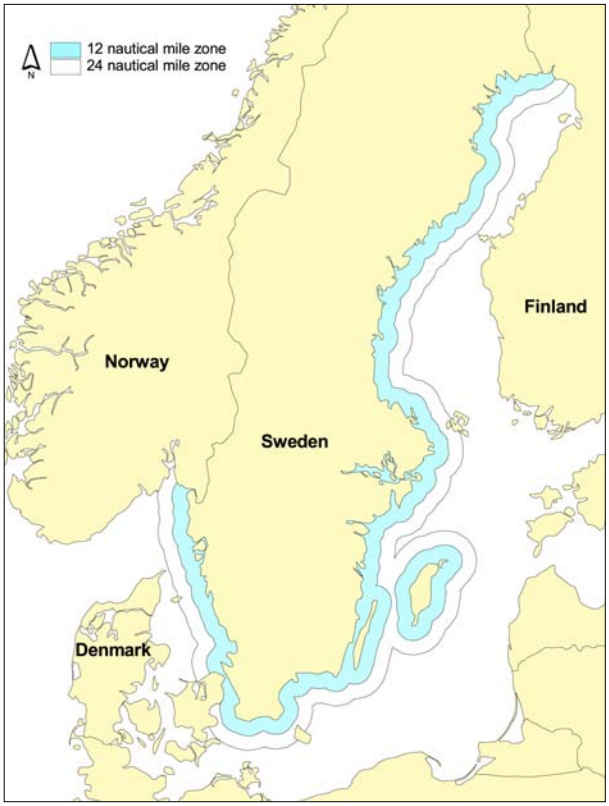

Figure 2. The generalised limitations for the 12 and 24 nautical mile zones of Sweden.

Outside territorial waters, objects of cultural or scientific value, are subject to several international conventions, offering more limited protection. At present, these conventions are;

1. UN Convention on the Law of the Sea 1982, articles 149 and 303,

2. European Convention on the Protection of the Archaeological Heritage, Valetta 16.I.1992,

3. ICOMOS 1996 Charter on the Protection and Management of the UCH.

Beginning with the Law of the Sea (1982), article 149 of this convention states that “all archaeological and historical objects” in the sea “shall be preserved or disposed of for the benefit of mankind as a whole”. Under article 303(1) of the same convention, it is the duty of every state “to protect objects of an archaeological and historical nature found at sea”, and every state “shall co-operate for this purpose”.

Under the Valetta Convention (1992) the EU states agree to protect the archaeological heritage as “a source of the European collective memory”... “situated on land and under water” (Article 1, §1,3), and to “prevent any illicit excavation or removal of elements of the archaeological heritage” (Article 3, §ia).

The ICOMOS charter (1996), characterises underwater cultural heritage as an international resource “contributing to the formation of identity” which can “be important to people's sense of community”. Article 1 of this charter, states that *in-situ* conservation should be considered as a first option regarding the preservation of UCH. Articles 2-15 provide clear instructions as to how archaeological investigations should be managed.

Additional conventions and codes that might come into effect are:

- The UNESCO "Convention on the Protection of the Underwater Cultural Heritage", adopted in Paris in 2001. Articles 8, 9 and 10 of this convention offer more comprehensive protection of UCH in the contiguous and extended economical zones, and on the continental shelf, in an effort to bridge the limited protection offered with the previous mentioned conventions. In northern Europe, only Lithuania has so far ratified this convention.

- The Baltic Sea Region's (BSR) "Code of Good Conduct", the work of which is made within the 'Baltic Sea States Working Group on Heritage Co-operation'. This Code is based on the UNESCO 2001 Convention but adapted for the BSR and the Baltic Sea States, and is currently being presented to governing bodies within the region.

3.3 Likely Archaeological Remains in Offshore Waters

In Swedish offshore waters, two types of archaeological remains are mainly to be encountered: shipwrecks and submerged settlements. Of these, shipwrecks may be found anywhere, whereas submerged settlements are primarily located in water depths of up to 20 meters (although some submerged settlements have been discovered 45 meters deep off the eastern coast of Scania in southern Sweden) [8].

3.3.1 Shipwrecks

Exactly where a shipwreck might be found is hard to predict as any unprepared vessel might founder due to sudden squalls or rough waves. Some shallow sea areas far off shore have a reputation for being a danger to seafarers, but whether a ship might be found in its proximity is not always certain, even if it has been recorded as having foundered there. Wind direction, waves, how hard the ship ran aground, how it was built etc., all have a distinct bearing on where, and in what state, it might end up on the sea bed.

Most shipwrecks that were lost a hundred or more years ago, and therefore are protected under the Heritage Conservation Act, were wooden, although metal steam ships began to come in use from around the mid 19th century. However, with respect to shipping, wooden vessels dominated well into the 1930s.

Other than how intact a wreck is at the time of sinking, the most important factors that determine how well a wreck site is preserved are typically:

1. The salinity of the surrounding water and the presence of wood boring organisms. Currently, shipworm is one of the worst enemies of wooden wreck sites, and has been detected as far into the Baltic Sea as the Sound. Its existence fluctuates with prevailing winds and currents and the influx of saltier water from the North Sea. Along the west coast, wood boring organisms are a real and continuous threat to wooden shipwrecks.

2. Depth of burial – if a wreck is covered in sand dunes or has sunken into soft seabed sediments, its chances of preservation is greatly increased.

3. The water depth – the deeper it is, the less likely it is to have been affected by moving waters, biological life and human activity.

4. The length of time that has passed since it sank.

3.3.2 Submerged Settlements

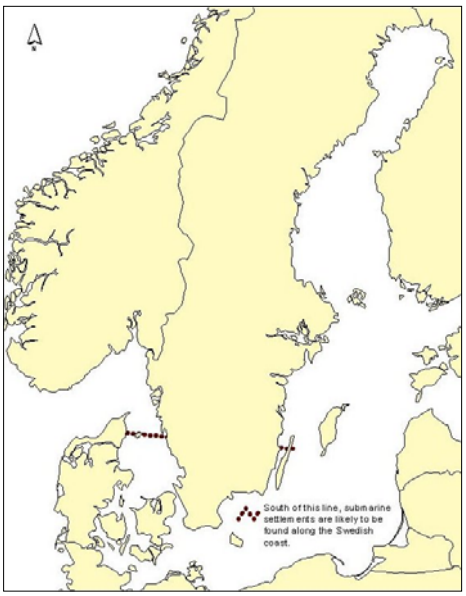

Figure 3. Approximate delineation for the potential presence of submerged settlement sites off the Swedish coast.

Submerged settlements are found in areas where former land bridges or islands existed due to the large amounts of water bound in the ice sheets some 4,000 to 11,000 years ago (although land bridges probably existed during inter-glacial periods some 30,000 years ago). This period in time coincides with the earliest traces of human activity in Scandinavia, when a lifestyle of fishing, hunting and gathering was prevalent with seasonal settlements in between inland and coastal areas. It also coincides with many of the shallow offshore areas that are currently being developed for wind energy.

In order to detect former settlement areas, archaeologists need to reconstruct the former landscape and pinpoint areas of high potential. After this work, an assessment is made of the particular preservation conditions provided by the type of seabed. Chances of encountering well preserved submerged settlement sites increases with the presence of peat layers and sand layers overlaying the former shoreline of moraine.

On the surface of the seabed, occurrences of knapped flint and/or stone tools are obvious tell tale signs of past human occupancy and possible settlement areas. However, more often than not, most remains lay hidden. Knapped flint and/or stone tools have been found in shallow areas (in depths down to about 20 meters, although as mentioned above, occasionally down to depths of 45 meters) along the southern part of the west coast, all the way around the south coast (figure 3), and along the southern parts of the east coast. In these areas submerged settlement sites are likely to be found [9].

3.4 Likely Archaeological Remains in Coastal and Foreshore Areas

Closer to land, in archipelagos and shallower coastal areas, evidence of past human activity increases, as does the likelihood of encountering other types of archaeological remains.

3.4.1 Wrecks, Submerged Settlements, Harbours, Fish Traps etc.

Shipwrecks and submerged settlements, discussed in chapter 3.3, as well as a whole range of other types of archaeological remains can be encountered in areas closer to land, in some cases also on the foreshore. Such remains include, for example harbours, associated cultural layers (sediment containing matters such as pot shards, charcoal and other evidence of human activity) and/or ballasts, fish traps, seamarks and stone enclosures [10]. Other examples of archaeological remains include remnants from the great herring fishing periods, of which the latest (and largest) were recorded in the mid 18th and early 19th centuries, as well as underwater sites connected to military activities, such as defensive structures or barriers.

3.5 Other Objects of Cultural Importance

In addition to those remains specifically protected under the Heritage Conservation Act (1988:950), 'objects of cultural historical importance' represent another type of object of archaeological interest that need to be considered by the contractor prior to installing a wind farm. This type of object is not protected *per se*, but is regarded as being worth safeguarding because of its intrinsic value as a monument to a specific event – be it from a historical, technical, social or even personal perspective. The value of such an object might also depend on how it is experienced from, for example, a symbolic perspective [11]. Many of these aspects are mentioned in relation to international laws and conventions in chapter 3.2.

3.5.1 Shipwrecks Younger than 100 Years, Airplanes etc.

In the sea, typical examples of objects that might be considered to have special cultural historical importance are the many wrecks from the first and second World Wars. Other types of shipwrecks might be the remains of vessels that in any way were unique at their time of building, or represent a specific moment in history, huge losses of life or the like. Equally, airplanes can also be considered to be cultural relics (figure 4).

Figur 4. The wreck of a DC3, a type of airplane, located with a side scan sonar. © MMT AB

3.6 Assessing Archaeological Potential

The archaeological potential for a given area is generally assessed through an evaluation of how it has been used in the past, taking into account particular resources available and the character of the landscape. Clues of past activities might be found through looking at what types of archaeological remains have already been found in an area of interest. On land, such an assessment is relatively easy, mainly due to the many systematic archaeological surveys that have been carried out in Sweden since the 1930s, the results of which have been compiled in the now fully digital National Sites and Monuments register, systemet för fornminnesinformation, FMIS.

The assessment of the archaeological potential of underwater or offshore areas is a much more complicated task, primarily due to the lack of any systematic archaeological surveys comparative to those having been undertaken on land. SjöMIS, the underwater archaeological sites and monuments register is a start but it is still very limited (information on this register is found in chapter 3.6.1).

An archaeological assessment of coastal and foreshore areas is based on an appreciation of how the coast has been utilised throughout history. For example, the presence of coastal towns with a known shipping history increases the likelihood of finding shipwrecks or other archaeological finds. Records of past wreckings in an area might also indicate the possible occurrence of shipwrecks, as does the presence of historical shipping routes. However, as mentioned in chapter 3.3.1, it is often impossible to accurately pinpoint where a particular ship might have foundered, as well as to say with any authority that shipwrecks are unlikely to be present in any particular area at sea.

For prehistoric sites, the presence of graves or settlements on land or nearby islands can be used as an indication that further sites might also be found underwater. It is of course important in this context to include a general assessment of palaeographic changes in the coastal landscape, taking into account factors such as local land elevation or submergence and changes in the local sea level and transportation of sediment.

As an aid to finding submerged settlement sites, archaeologists have constructed models based on the knowledge that many of those sites were once located near peninsulas or at river mouths. These locations offered favourable conditions for shelter and fishing as well as a source of running water (figure 5) [12]. As mentioned in chapter 3.3.2, this requires an analysis of the changes in the seascape in order to locate these past river mouths, peninsulas or similar seascapes.

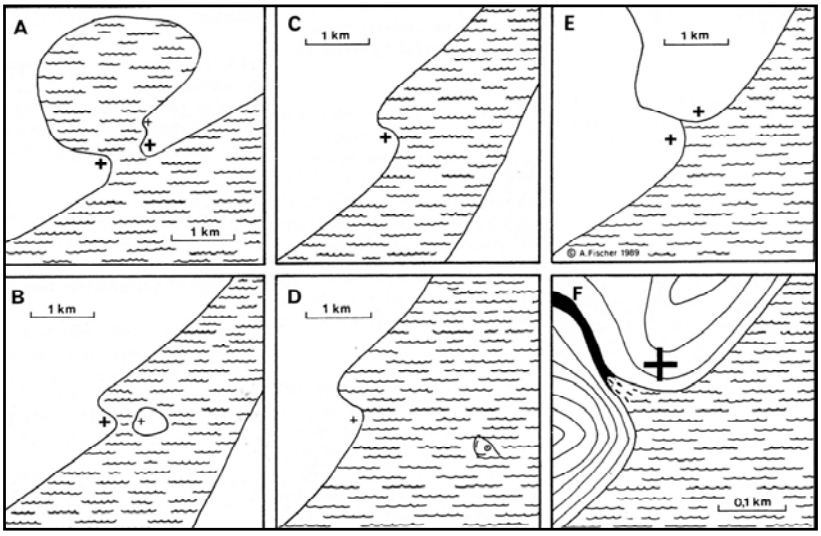

Figure 5. Example of a model for locating Mesolithic settlement sites (indicated with crosses) in the landscape when sea levels were 4-5 metres lower than today (after Fischer 1989). Likely places include areas with a combination of shelter and streaming water such as the mouth of a bay (A), where there water is streaming in-between land and a small island (B), on near peninsulas (C-D), or at the mouth of small rivers or streams (E-F).

The seascape of southern Sweden is generally described in geological terms as being characterised by either erosion or the removal of sediment, often due to strong currents, or the accumulation of sediment, which occurs in areas where sediment can settle without further transportation, which happens in areas of backwater or at the entrance of river mouths. Neither type of seabed can entirely exclude the possible presence of prehistoric settlements, although those found in areas with a high level of erosion are often less well preserved.

3.6.1 Underwater Sites and Monuments Register

The Swedish underwater sites and monuments register, what is now called SjöMIS, is planned to be fully integrated with the FMIS and available on-line by May 2008. The SjöMIS register originates from the SMA (Svenskt marinarkeologiskt arkiv), an archive compiled since the 1960s at the National Maritime Museum. The information available in this register includes salvaging records dated between 1745 and 1831, information on historical losses at sea from about 1720 to 1920, other confirmed underwater sites and finally protected sites and monuments. Currently, the register contains information of almost 15,000 sites of which;

- 8,300 are confirmed sites that are not protected
- 3,200 are protected monuments
- 3,218 are unconfirmed historical losses within Swedish territorial waters

In comparison, there are approximately 1,000,000 registered land sites of which about 800,000 are protected [13].

4 ARCHAEOLOGICAL REMAINS AND PLANNING PERMISSIONS

Prior to allowing any form of construction work, or other commercial activities that will alter the physical appearance of the sea front or the sea bottom, most national legislations regulate that certain procedures are followed with regard to the cultural heritage. This is to ensure that, where possible, cultural heritage is not damaged.

There are primarily two pieces of legislative frameworks that affect the protection of cultural heritage in Sweden - the Heritage Conservation Act and the Environmental Code. A third piece of important legislation is the Town and County Planning Act.

4.1 The Heritage Conservation Act and Planning Permissions

The core legislation is the Heritage Conservation Act, which specifies definitions of what constitute archaeological, remains (see chapter 3.1) and the scope of the law and regulations that these are subject to. For a developer the main things to consider are:

1. This Act prohibits the moving, removal, excavation and the covering of, or any actions that might lead to the alteration or damage of archaeological sites and monuments, without permission from the relevant authorities – generally the regional County Administration Boards (figure 1) [14].

2. Permission must be obtained to interfere or remove an archaeological site or monument.

3. Swedish legislation puts more responsibilities on the applicants themselves compared to many other countries, in that “applicants wishing to undertake construction work must, well in advance of an application for a permit, carry out research on how such work might affect the cultural heritage” [15].

4. Should an archaeological site or monument be detected during the course of work, this should be reported to the authorities at the earliest possible opportunity and work shall cease until further notice [16].
5. If, despite all efforts, it is unavoidable that a cultural monument is affected, full excavation under acceptable archaeological standards might be the only solution. Such work is paid for by whoever requires the monument to be moved [17].
6. The County Administration Board can decide on archaeological investigations under this Act, details of which is presented in chapter 4.6.2–4.6.4.

4.2 The Environmental Code and Construction Permits

The second piece of legislation, the Environmental Code, aims to encourage a sustainable development of the environment for present and future generations [18]. Put into practice, this represents an aim to protect and safeguard valuable natural and cultural environments. For a developer the main things to consider are:

1. An environmental impact assessment (EIA) is compulsory when applying for permit according to the Environmental Code for offshore wind farms.

2. An EIA, forms the basis for whether permission is obtained or not and must include an assessment of the direct and indirect impact the planned activity might have on the relevant cultural heritage, and possible strategies for the mitigation of any impact.

3. The Environmental court or Miljödomstolen issues permits under this Code.

4.3 The Town and County Planning Act and Building Permits

The third piece of legislation, the Town and County Planning Act, (PBL), governs local area development and redevelopment with respect to the use of land and water [19]. The law is of municipal concern, and is overseen by the County Administration Board. The main aspects of this Act for a constructor to consider are:

1. A building permit is required from the local government for any construction or demolition work, excavation work, filling work or the felling or replanting of trees, [20].

2. In order for the local government to issue such a permit, the planned work has to be assessed in the light of the comprehensive plan of land and water use for the local area, and will, through necessity, require an EIA as referred to under section 2 above [21].

4.4 Planning/Construction Permits outside Territorial Waters

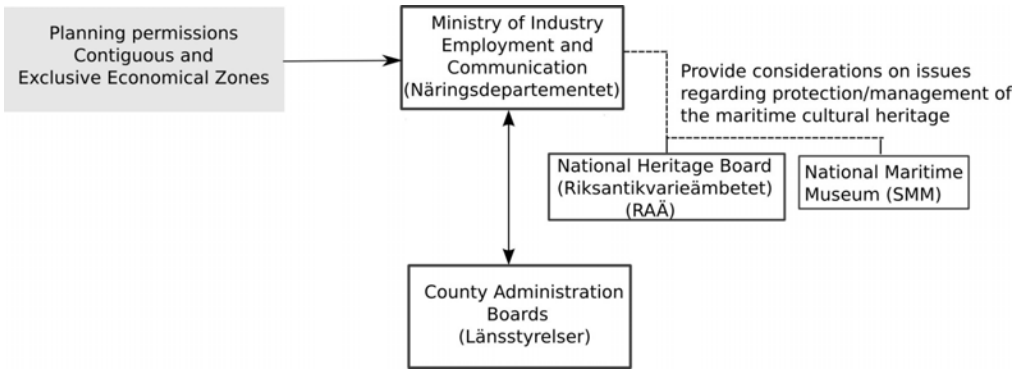

Figure 6. A flowchart over the applications route for planning permissions/construction permits within the Contiguous and Exclusive Economical Zones under the Continental Shelf Act; Lag (1966:314) om kontinentalsockeln, in relation to Cultural Heritage.

In areas outside Swedish territorial waters, within its Contiguous and Exclusive Economical Zones, two pieces of legislation apply in connection with applications for the planning and construction of wind farms; the Continental Shelf Act or Lag (1966:314) om kontinental-sockeln, and the Environmental Code (see chapter 4.2). For a developer the main thing to consider is:

- According to 3a§ of Lag (1966:314) om kontinentalsockeln, an application for obtaining a licence to explore the continental shelf through drilling or the use of explosives must include an EIA.

Permissions are granted by the government, in this case the Ministry of Industry, Employment and Communication, Näringsdepartementet, following consultation with the appropriate County Administration Board (figure 6).

4.5 Wind Farm Construction Work and Archaeology – Assessment/Mitigation

There are several phases within the lifespan of an offshore wind farm project that might have an impact on the cultural heritage, on land as well as under water. These phases include; test drilling, construction, maintenance and deconstruction (see left column in figure 7). Figure 7, represents a guide as to which phases might affect cultural heritage under water, on land and on the foreshore, including a potential visual impact.

As a general rule, it is strongly advised that contact is made with an archaeologist with maritime expertise as well as the local County Administration Board in order to ensure a smooth planning application process.

Stages within lifespan of offshore Wind farms	Affect UCH?	Affect sites on the foreshore?	Visual affect?
1. Test drilling	Might affect UCH		
2. Consultation Process			
3. Licence Process			
4. Purchasing and Building Period	Might affect UCH	Might affect CH	Might affect CH
5. Maintenance	Might affect UCH		Might affect CH
6. Deconstruction	Might affect UCH		

Figure 7. A guide to phases within the lifespan of an offshore wind farm project which might affect the cultural heritage on land and under water. Where there might be an impact, a full assessment of possible damages and a mitigation plan should be included in an application for planning permission.

4.5.1 The Test Drilling Phase

Although the areas of the seabed directly affected by the drilling phase are relatively limited, the possibility that it might interfere with, and potentially harm an underwater archaeological site or monument, cannot be ignored. Things to consider are:

- An archaeological assessment should be included in the EIA (see chapter 4.5).
- The local County Administration Board would normally ask for an archaeological survey to be carried out prior to the consent to such an application. An archaeological desk-based assessment would enable better judgement.
- Early communication with appropriate archaeologist and/or the local County Administration Board can be both time and cost effective, especially if the wind farm project moves into the consultation and licence phases.

4.5.2 The Building, Maintenance and Deconstruction Phases

The building phase involves the construction of foundations for each of the intended wind generators, the laying down of cables between the generators, as well as the connecting cable to a land-based transformer station (figure 8). Thus, archaeological remains lying on the seabed or the surface on land, or buried therein, might be affected and potentially harmed. A planning application must, therefore, include an EIA of the potential affect of the wind farm on the cultural heritage on land, as well as in the sea.

Throughout the construction phase, and during the continuous maintenance period thereafter, as well as during a potential deconstruction phase, large vessels suitable for the task are used. These vessels use propellers, anchors, supporting legs and other similar methods in order to stay in position during work. As a result, they can seriously damage archaeological remains, especially if the remains are lying on the surface of the seabed.

Scour effect is something that also needs to be considered in relation to underwater archaeological remains. This is potentially caused by the water flow change around each of the bases of the wind generators, and can lead to alterations in the surrounding seascape, sometimes over surprisingly large areas. Thus, buried or partly buried archaeological remains can become uncovered where they will suffer from an increased level of erosion.

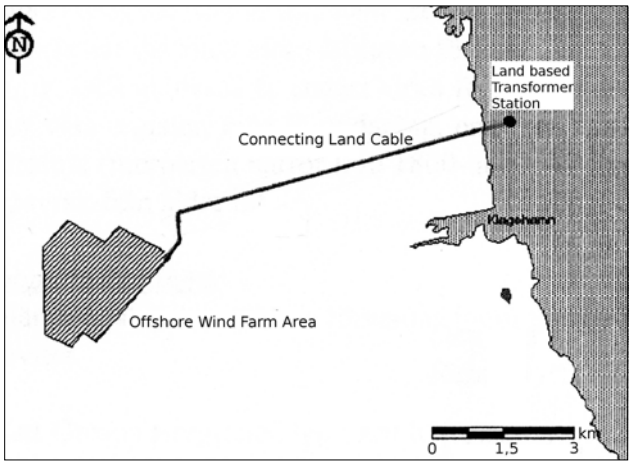

Figure 8. Map over the layout of the wind farm at Lillgrund off the Swedish south coast, showing the offshore wind farm area as well as the connecting land cable. The city of Malmö is located just north of this map (Öijeberg 2002:1).

A developer should therefore consider the following:

- An archaeological assessment of the actual offshore wind farm area, corridors for connecting cables on land and underwater, should be included in the EIA.
- An assessment should include potential damage that might occur during the maintenance and deconstruction phase, including the use of large scale vessels and scouring effects and possible strategies for their mitigation.
- The local County Administration Board requires archaeological surveys to be carried out prior to any licence for a planning application being given.
- The need to contact an appropriate archaeologist and/or the local County Administration Board at an early stage to ensure a smooth assessment/mitigation process.

4.6 Archaeological Investigations

There are several different types of archaeological surveys or investigations that can be carried out, depending on the type of development and the area in which it is intended to be undertaken. All of the above mentioned surveys/investigations, except an archaeological

assessment can be requested by the local County Administration Board [22]. As mentioned in chapter 4.1, the developer or contractor pays for this work to be carried out. However, it is the County Administration Board that decides on the level of any such work, as well as who will carry it out. A contractor can bypass the decision process by ordering an archaeological survey before a formal decision is made by the County Administration Board. This is not possible for any other types of archaeological investigations.

Archaeological assessments, surveys and investigations should be carried out by, or in collaboration with, an archaeologist with relevant maritime expertise. The local County Administration Board will be able to provide guidance on suitable organisations.

4.6.1 Kulturhistorisk förstudie – Desk based Archaeological Assessment

An archaeological assessment is carried out in order to identify areas where archaeological remains are likely to occur, their possible nature, and highlight areas where cultural heritage might come into conflict with the planned development. This information enables a contractor to assess the options available at an early stage and come up with possible solutions that can also be used as a basis for an EIA. A desk-based archaeological assessment is based mainly on archival studies.

As always, the better the background material available, the better the assessment is going to be. Given the relatively limited information available in the underwater sites and monuments register (see chapter 3.6), and the fact that local County Administration Boards, almost without exception, will ask for an archaeological survey to be carried out before approving a planning permission for the construction of an offshore wind farm, a contractor can save both time and money by commissioning such a survey themselves - without waiting for a decision from the County Administration Board.

Thus, a desk-based archaeological assessment can:

- Help identify areas with a high potential/risk for encountering archaeological remains and provide strategies for their mitigation.

- Save time and money as areas identified can be avoided and the data be used in an EIA.

However, it is worth bearing in mind that an archaeological survey, Särskild arkeologisk utredning, will probably still be required prior to the County Administration Board consenting to a planning permit (see chapter 3).

4.6.2 Särskild Arkeologisk Utredning – Archaeological Survey

An archaeological survey or, Särskild arkeologisk utredning (AU), is normally commissioned by the County Administration Board in order to provide it with satisfactory background information on which to base a decision on a planning application [23]. This type of survey is often divided into two phases, etapp 1 and etapp 2, and aims at determining the existence of yet unknown archaeological remains within a targeted area or areas.

Phase (etapp) 1, is basically an archaeological assessment (see previous chapter) of where within a given area a conflict might occur between archaeology and the planned work. The assessment will provide possible strategies for the mitigation of any such conflict and will be based on archival studies as well as geophysical data, (see chapter 5.1). The latter is used

to identify objects that might be of archaeological interest, either buried in the sediment or lying on the seabed.

Phase (etapp) 2, normally involves field work where objects and areas identified in phase 1 are examined through visual inspection or more intrusive sampling methods for the identification of potentially buried objects (see chapter 5.2 and 5.3).

The methods employed depend on the nature of the area of investigation and the type of archaeological remains expected. For a contractor, it is worth considering contacting an archaeologist with maritime expertise to ensure that any geophysical surveys carried out at an early stage of an offshore wind farm project, are of use also for an archaeological assessment and indeed any other types of investigations.

Thus, a contractor should consider the following:

- Phase 1 of an archaeological survey provides a more qualitative archaeological assessment, which can greatly improve the quality of an EIA.
- An archaeological survey will be required by the County Administration Board and will be used as a basis upon which to approve or dismiss a planning application.
- The need to contact an appropriate archaeologist at an early stage as to ensure any geophysical survey undertaken is of a standard and quality that is acceptable for archaeological purposes.
- The potential time gained through going straight into a phase 1 survey without a decision from the County Administration Board is considerable. It is however advisable to consult with the Board prior to such a survey undertaking.
- The better the resolution and quality of the archaeological methods employed, in particular regarding the geophysical data, the higher the chance of avoiding problems further on in the project.
- The primary aim for the archaeological survey is to identify possible archaeological remains and provide strategies for the mitigation of any damage to such remains.

4.6.3 Arkeologisk Förundersökning – Preliminary Investigation

On the rare occasions when a conflict of interest arises between archaeology and a particular development, the developer can apply to remove the archaeological object [24]. If this happens, the County Administration Board can commission a preliminary investigation, a so-called Arkeologisk förundersökning (FU), in order to assess the exact nature and scale of the object in question [25].

The standard and costs of such an investigation as well as who undertakes it, is decided by the County Administration Board. The developer or contractor however, pays the cost.

Should the investigation show the site to be of a nature and/or scale that justifies its preservation, the County Administration Board may decide that amendments to the designated planning area for the development in question must be made.

In view of the above, the contractor should consider the following;

- It is always better, if possible, to avoid interfering with archaeological objects. If interference appears to be justified in relation to the scale of the project, a decision may then be taken to apply to have it removed, and to pay the additional associated costs.

4.6.4 Särskild Undersökning – Archaeological Excavation

An archaeological excavation or Särskild undersökning is, in effect, the removal of an archaeological site or object. Excavation is a last resort solution, which depending on the nature of the archaeological object or site, can be very costly, as it involves full documentation of the process to archaeological standards, an in-depth comparative interpretation of the site, and the potential conservation of vast amounts of waterlogged organic material.

5 METHODS AND STANDARDS FOR ARCHAEOLOGICAL SURVEYS

The methods used for an archaeological survey depends on the nature of the area of investigation, the type of archaeological remains expected and the scale of the proposed development. Set out below is a brief outline of the various geophysical, qualitative and visual survey methods employed for archaeological purposes.

5.1 Geophysical Survey Methods

Geophysical survey methods are used to survey large areas of seabed in order to identify protruding or buried archaeological remains such as shipwrecks, but also to identify seascapes and areas that might have been suitable for past settlement sites. Examples of survey methods are side scan sonar, ground penetrating sonar, magnetometer and multi-beam bathymetry. It should be remembered that permission to carry out hydrographical surveys might be required under the Continental Shelf Act and the Protection of Landscape Information Act [26]. In general, all of the above methods require exact positioning systems so that identified anomalies or potential sites can be revisited and inspected visually.

5.1.1 Side Scan Sonar

The use of side scan sonar is a minimum requirement for all large and small-scale archaeological survey operations at sea. In relation to offshore wind farms, surveys should take into account the entire planning area, including corridors for connecting land cables, and be of such a resolution that it is possible to identify disintegrated shipwrecks and other protruding objects of possible archaeological interest. This often requires a higher resolution than is needed for geological surveys.

It is recommended that contact be made with an archaeologist with appropriate maritime expertise prior to commencing a survey operation. This is to ensure that adequate resolution is achieved with regard to bottom surface topography so as to avoid future delays and extra costs. The side scan sonar records shadows of objects protruding from the surrounding seabed (figure 9). These shadows appear differently depending on the angle at which the sonar rays hit them. Therefore, an archaeologist should ideally be present on-board the survey vessel, in order to be able to ask for the survey vessel to revisit an object of interest and look at it from another angle.

All side scan survey data needs to be analysed by the archaeologist. That is, the archaeologist must have access to the raw data in order to be able to assess which anomalies, or shadows, might be of archaeological interest.

Thus, a side scan survey should:

- Take into account the entire planning area, including areas in-between planned rows of windmills, and should also include corridors for connecting cables and land cables.
- Be of a resolution that allows possible archaeological objects to be identifiable, which, depending on seabed topography, might require the presence of archaeological expertise during the actual survey, and, in all cases consultation with such expertise prior to a survey.
- Have appropriate line spacing.
- Produce raw data that is accessible for archaeological analysis.
- Provide for the data to be analysed jointly by specialised archaeologist and specialised geologist.

Figure 9. Examples of high-resolution side scan sonar images, from the top, a cargo carrier somewhere in the Baltic Sea, a wooden shipwreck partly buried in sediments somewhere off the Danish east coast, stone and sand dunes. © MMT AB

5.1.2 Ground Penetrating Sonar Systems

Ground penetrating sonar systems are used for detecting buried archaeological objects and sites. Furthermore, they are considered a minimum standard tool for detecting and reconstructing ancient, now buried, landscapes. When looking to establish offshore wind farms, a ground penetrating sonar survey should be used in areas where the contractor plans to dig, or in any other way might potentially disturb or harm buried UCH.

Ground penetrating sonar systems include Pinger, Boomer, Echo Sounder and Chirp, which uses different frequencies enabling them to penetrate different geological layers beneath the seabed (figure 10). Using more than one frequency for the same survey usually enables better resolution. Frequency and type of sonar system should be decided on in consultation with a specialised maritime archaeologist. In Denmark, submerged settlement sites have been found beneath overlaying sand beds with a thickness of 10 meters or more.

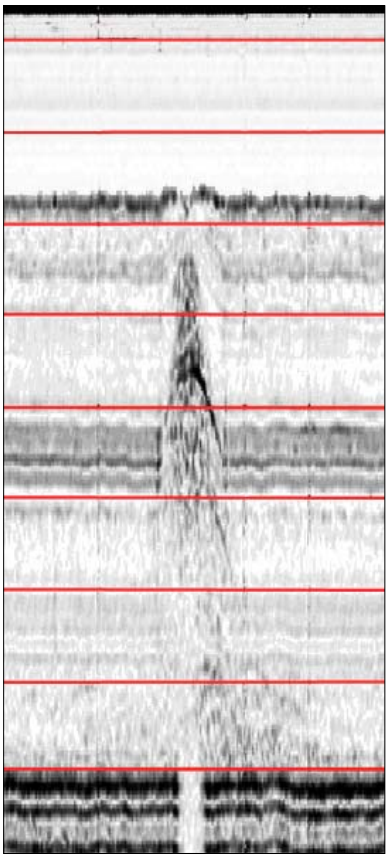

Figure 10. The example of a buried object identified with a ground penetrating sonar system. Horizons between layers of sediments with different density can also be detected. ©MMT AB

A ground penetrating survey should:

- Be used where a contractor might disturb or unintentionally harm buried archaeological sites or monuments - primarily, along planned rows of windmills and corridors for connecting cables and land cables.
- Be of a resolution, which allows the detection of specific time horizons within the geological strata. Resolution and type of sonar system depend on the type of sediment and should be determined in consultation with a specialised archaeologist.
- Have appropriate line spacing for delineating features of interest. A specialised archaeologist should decide this.
- Produce raw data that is accessible for archaeological analysis.
- Provide for the data to be analysed jointly by specialised archaeologist and specialised geologist.

5.1.3 Magnetometer

A magnetometer measures differences in the earth's magnetic field and is used to detect objects of iron lying on the seabed or buried in sediment. It is normally used as a complement to other surveying methods and can be very useful, especially in offshore areas. It should be used with caution near harbours or along popular navigation routes where potentially magnetic material is frequently dumped. In addition, many natural rocks have magnetic properties.

The range of the magnetometer is relatively limited, as it is only being able to record objects directly beneath its path (similar to the ground penetrating sonar systems (see chapter 5.1.2)).

A magnetometric survey should:

- Be used in combination with other survey methods allowing for complementary information on identified objects that might be of archaeological interest.
- Have appropriate line spacing.
- Produce raw data that is accessible for archaeological analysis.

5.1.4 Multibeam Bathymetry

A mulitbeam bathymetric survey is used to map seabed topography and produces a model of the modern time horizon (figure 11). Thus it is not an appropriate tool to identify ancient time horizons in order to assess or study submerged prehistoric land surfaces (see chapters 3.3.2 and 3.6). However, as a complement to other survey methods, it is very useful for detecting and assessing potential archaeological objects on, and partly buried in, the seabed. It has also proven a useful antiquarian tool for monitoring the long time effects of scouring and movement of sediments across archaeological sites and monuments (figure 12) [27].

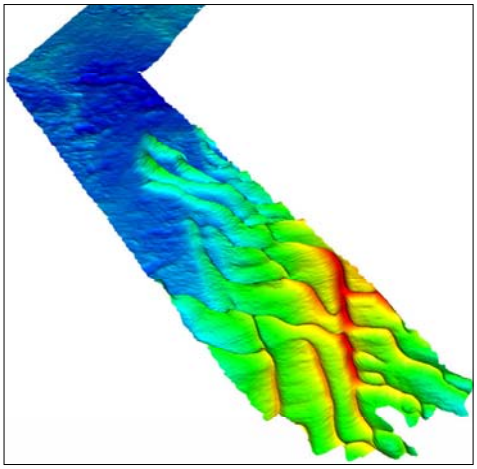

Figure 11. Example of a bathymetric survey showing the modern time horizon of shallow areas of sand dunes in the foreground (red, yellow and green areas in the picture) and deeper and less undulated sediments in the background (blue areas) © MMT AB

A bathymetric survey should:

- Be used in combination with other survey methods allowing for complementary information on anomalies/objects of archaeological interest.
- Produce raw data that is accessible for archaeological analysis.
- Be of adequate resolution for the task.

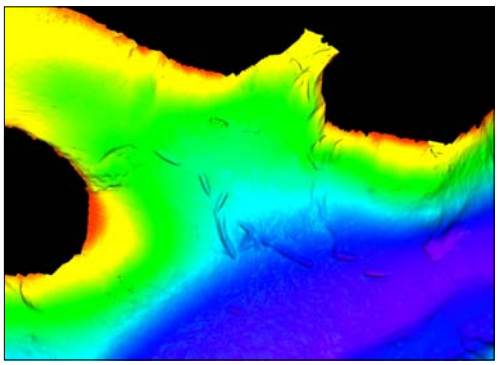

Figure 12. (Left). Bathymetric survey data from the original location of the Vasa in the harbour of Stockholm. Black areas represent land. The boat shaped imprints on the seabed represent hollows made when the Vasa was moved along the bottom during her salvage. © MMT AB

5.1.5 Intrusive Evaluation/Sampling Methods

Intrusive evaluation methods are used for more qualitative archaeological studies within a larger area in order to identify buried archaeological remains. These methods include the use of qualitative test pits, basic grab sampling or simple dredging. Which method is used depends on the particular geological and environmental conditions of the area investigated, the types of expected archaeological remains, and the amount of time available and the targeted level of quality of the survey.

5.1.6 Trenches/Test Pits

Making trenches or test pits using a diving archaeologist with an air lift or water dredge, is the most qualitative sampling method of all the methods available. It is also the preferred method for qualitative archaeological studies as the archaeologist is present and can stop the procedure when encountering potentially fragile archaeological remains.

5.1.7 Grab Sampling

Grab sampling is a primitive way in which to assess the presence of archaeological remains in the upper layers of the seabed. It can be a very useful tool for establishing an absence or presence of near surface or eroding archaeological deposits, but the disadvantage of this method is that it is destructive to fragile archaeological material. It is however, a relatively cost effective way of undertaking empirical evaluation for archaeological assessments and can be easily implemented as a complementary tool to any marine ecological or geological survey.

5.1.8 Dredging

To apply the use of dredges for the purpose of archaeological evaluations is not normally recommended, as it is potentially very destructive to any encountered archaeological material. However, in areas where the archaeological assessment shows a high potential for submerged settlement sites buried under overlaying beds of sediment it is sometimes the only method available.

Where offshore wind farm construction work is concerned, dredges will be used for digging holes for each of the bases of the wind generators. Depending on the circumstances, this process can be made more effective through allowing for some sort of archaeological watching brief, whereby an archaeologist is present on-board the dredger is ready to stop any work, should any archaeological objects be encountered.

5.2 Visual Inspection

Whereas geophysical methods are good for detecting anomalies that might be of archaeological interest, the exact nature of these anomalies must be assessed through visual inspection. Examples of methods used for visual inspection are the deployment of archaeological divers, towed video cameras, and ROVs or 'Remotely Operated Vehicles'. Where the deployment of geophysical survey methods is impossible (for example in shallow water or where other restrictions apply), or too expensive, visual inspection in combination with qualitative test pits is the best way in which to carry out an archaeological survey.

5.2.1 Divers

The deployment of archaeological divers is often the best way in which to inspect anomalies or objects of possible archaeological interest, which have been detected during geophysical surveys. There are also many instances where a swim-line survey is advantage over other types of surveying methods, such as where the seascape is very mountainous, but also in areas where the seabed is covered in vegetation. However, for safety reasons, divers seldom inspect anomalies or carry out swim-line surveys in water depths of 30 or more meters.

5.2.2 Towed video camera

Towed video cameras can be used for visual inspection affording a complement to, for example, a side scan sonar survey, especially on broken ground. The range of vision of the camera depends on the clarity of the seawater, in optimal conditions around 30 meters [28]. In the Sound (the Öresund straight), a visual range of 16 meters or more has been achieved [29]. The method is less useful in areas with thick seabed vegetation (e.g. eelgrass which is frequently found along the Swedish coast), or where changes in the colouring of the seabed occur abruptly, causing strong contrasts.

5.2.3 ROV

Remote controlled vehicles, ROVs, are used for visual inspection in deep waters (below 30 meters) or where the use of divers is deemed unsafe or otherwise deemed too expensive.

6 THE LILLGRUND EXAMPLE

The offshore wind farm at Lillgrund is located about 7 kilometers off the Swedish south coast, just south of Malmö. When taken into production in the autumn of 2007, it was the largest ever offshore wind farm project in Sweden and the third largest in the world. Currently, its 48 turbines supply approximately 60,000 households with electricity. The total cost of the project is calculated to be almost 1,8 billion SEK and the farm is estimated to produce electricity for 20–25 years [30].

The project spanned 10 years from start to finish primarily because it was first of its kind and therefore lacked the advantage of being able to follow a precedent. The process of obtaining the necessary permits began in 1997 with an inquiry of permissibility by the Swedish government. The permit under the Environmental Code was issued in December 2002 and became binding in December 2003. In June 2003, a comprehensive plan of land and water use from the local government area was announced, taking effect in 2004. Finally, a building permit under the Town and County Planning Act was issued in 2005 but has not yet been implemented.

Set out below is a brief outline of the various archaeological assessments and surveys that were undertaken in connection with the Lillgrund project.

6.1 1997 – 2001 - Desk based Assessments

In 1997, a desk-based assessment of the archaeological potential of the entire Lillgrund area (including North, South and East Lillgrund), but excluding any land connecting corridors, was carried out by Fotevikens Museum [31]. The report showed a high potential for encountering shipwrecks and submerged settlements within the investigated area.

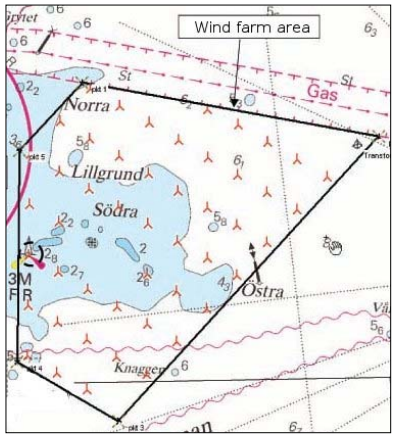

Figure 13. Map showing the Lillgrund wind park area with the 2 and 4.5 metre curve highlighted in blue. The individual wind generators are marked in red (Öijeberg 2006:3, fig. 1).

In October 1998, the County Administration Board approved the suggested location of the wind farm. However, an expert opinion from the National Heritage Board, dated August 1999, stressed the fact that the approval was solely based on a marine archaeological assessment in the offshore area, whereas an archaeological assessment of corridors for connecting land cables (and potential visual impact) was also required. Furthermore, the National Heritage Board emphasized the requirement to conduct an archaeological survey in accordance with the National Heritage Law, so the project plans could proceed [32].

In 2001, Malmö Kulturmiljö conducted another desk-based archaeological assessment [33] in order to update the file and provide the necessary background documentation needed for the EIA. By this stage, the planned working area for the wind farm project was known (figure 13) and data from the geological survey of the area could be included in the assessment. Three shallow areas, in particular, were deemed to have a high potential for containing submerged settlement sites, all of which had sand layers up to 1.2 meters thick [34].

6.2 2002 – Archaeological Survey

The archaeological survey at Lillgrund took place over five days in the late autumn of 2002 [35]. The primary focus lay in detecting previously unknown shipwrecks along the proposed cable lines connecting each of the intended wind generator foundation locations with the sea based transformer station and along the path for the connecting land cable (figure 8 & 13). For the actual survey (phase 1) a video camera, towed behind a vessel, was used to detect and record any anomalies or objects that might be of archaeological interest, along each cable path. The visual range of the camera was on average 16 meters. Thus, only anomalies within a very limited area were detectable (under normal circumstances, the protection area around an archaeological monument would be more than 16 meters). In total, 18 objects were observed, one of which was identified as a wreck site and located about 150 meters south-south-west of one of the planned wind generators in row B, in the path between the interconnecting cables (figure 14) [36].

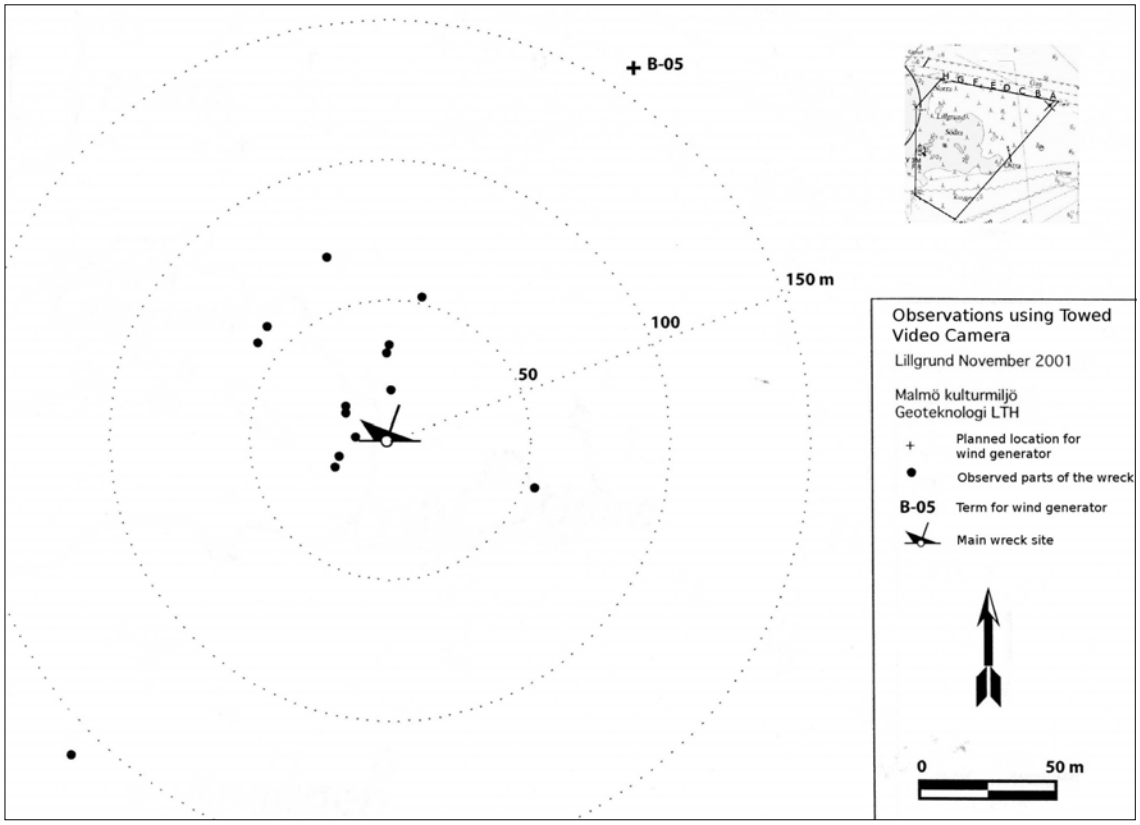

Figure 14. Map showing the wreck site observed during the towed video camera survey. The main site is located about 150 meters south-south-west of the planned location for wind generator B-05, along the path for the inter-connecting cables for row B, with wreck parts spread out within a radius of 150 meters plus. The plan for the entire wind park is inserted in the top right, with individual rows of planned wind generators marked (Öijeberg 2002, appendix 2).

The survey along the path of the connecting land cable was impaired in areas where the seabed was covered in eelgrass, and had to be cut short about 200 meters from land because of the water depth (≤ 2 meters). (It should be added that the survey was cut short because the wrong method was used, not because its lack of archaeological analysis potential, see chapter 3.6). Doing so is far from ideal and would normally be questioned by the authorities.

A diving archaeologist inspected only the wreck site, of the 18 observed objects, (phase 2 in an archaeological survey), and estimated its age to be between 400 – 500 years old (figure 15) [37]. Additional parts of the wreck site were identified within a radius of about 150 meters from the main site.

One day, in total, was used to inspect the site and take samples for dating. No sample provided an exact date, but based on the opinion of the archaeologist, it was designated as an archaeological monument.

It is estimated that about 6% of the entire planning area for the wind farm was documented in the survey. The survey did not take into account areas identified as potential submerged settlement sites, located within the northwestern part of the planning area.

For the future, the report suggested [38]:

- The visual inspection by diving archaeologists of selected objects identified in the towed video survey,
- The investigation of the area for potential submerged settlement sites, and
- Documentation of the wreck site and surrounding wreck site area and the design of a plan for the future protection and preservation of the wreck site.

Based on this survey, planning permission was granted on the condition that the protected wreck site, including the protection area as determined by the County Administration Board, was left untouched. This could easily be solved by running the cable (inter-connecting the two wind generators B-05 and B-06) in a circle around the protection area of the wreck site.

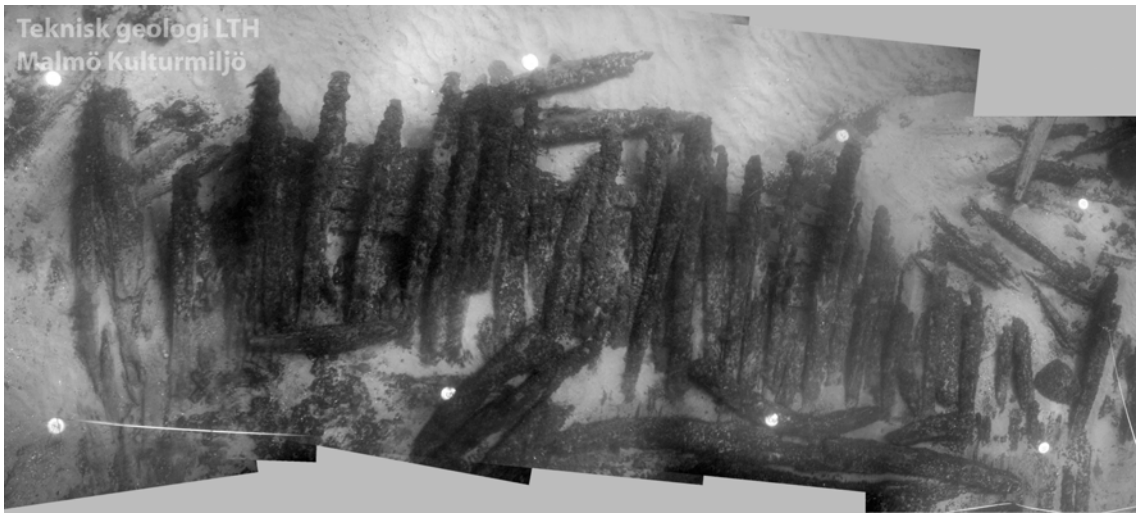

Figure 15. A photo mosaic of the main part of the discovered shipwreck at Lillgrund. The vessel was constructed of oak and pine, and was, at the time of the survey, approximately 25 meters long and 8-9 meters wide. It lays positioned upright on the seabed with features such as the keel and frame timbers largely preserved. Parts of the decking and planking can also be identified, with more parts potentially lying buried in the surrounding sand. In an area in the stern end of the wreck, rounded bricks were found which are assumed to be the galley. This feature is normally seen in ships dated to the 16th or 17th centuries. ©Malmö Kulturmiljö/Teknisk geologi, LTH.

6.3 2006 - 2007 – Additional Archaeological Surveys/Investigations

Leading up to start of the building phase, the met mast, previously located within the planned area for the wind farm, was to be relocated to an area on its outside, which had not been investigated in the 2002 survey. Therefore, the County Administration Board requested a new survey to ensure that no previously unknown archaeological sites were to be damaged within the new proposed working area (figure 16).

The new survey was carried out in one day in April 2006 [39]. Instead of using a towed video camera, geophysical methods were used – combinations of side scan sonar and magnetometer. The investigated area of approximately 3.2 km^2 was divided into 70 meter wide search corridors, allowing for full overlap for the side scan sonar but limited the coverage of the magnetometer. However, not all corridors were searched, only those deemed most interesting.

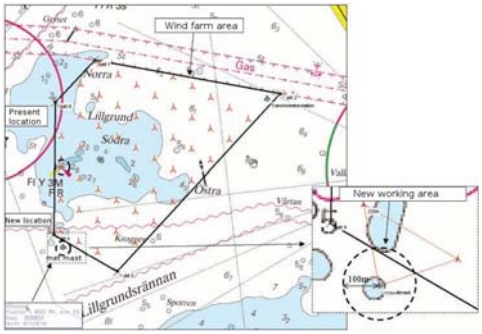

Figure 16. Map showing the planned area for the Lillgrund wind park and the new location of the met mast (Öijeberg 2006:3, fig. 1).

Based on this survey the Board approved the planning application for the new location of the met mast.

During the building phase, it was discovered that the cable, thought to have been sufficiently long to veer around the protected wreck site on its run between wind generators B-05 and B-06, was too short. Because of this, a new path that cut into the wreck protection area was prepared (figure 17). In order to assess whether the altered path would affect the wreck site, the County Administration Board requested an underwater inspection of the area between the new proposed cable path and the main wreck site.

The survey was carried out by a diving archaeologist who measured a minimum of 35 meters between the new cable path and the centre of the wreck[40]. In addition to this, a swim-line survey was carried out in the intervening area, during which a 5-6 meter long piece of worked timber was found, interpreted as belonging to the wreck site. In conclusion, the archaeologist believed that the new cable path would not affect the shipwreck.

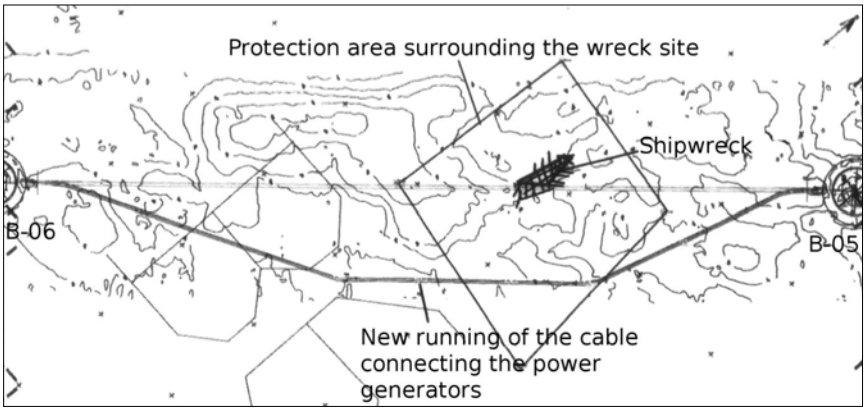

Figure 17. Map showing the proposed path of the cable inter-connecting wind generators B-05 and B-06, while cutting through the protection area surrounding the wreck site (Öijeberg 2007, appendix 1).

7 PROBLEMS AND POSSIBILITIES

As the example of Lillgrund illustrates, the process of adhering to the rules and regulations relating to cultural heritage is not always entirely straightforward. Lillgrund was, however, the first project of its kind in Sweden, and serves as a useful learning experience for the future, in particular its approach to timing, quality, flexibility and cost (all of which will be discussed more in detail below). It can also bring attention to those aspects of the project that, for some reason or another, were not considered, but may be important for the future.

Something that was entirely omitted from any assessment at Lillgrund was the need to consider possible damage to UCH in connection with the drilling phase. For future EIAs such an omission is unlikely to happen unnoticed and already several archaeological surveys for this specific purpose have been requested and carried out at various other projects in Sweden [41].

Another issue that may need to be considered in the future is the potential inclusion of a protection/monitoring plan as a prerequisite for gaining planning permission from the Local County Administration Board. In the past, local County Administration Boards have asked for monitoring plans to be implemented in order to assess the potential damage a proposed project may have on a protected site – prior to allowing such construction work to commence. This is likely to happen more often in areas where current direction may potentially change as a result of the proposed work. However, another possibility is that the Board will ask for a protection/monitoring plan to be prepared as a condition of the planning permit. This provides for archaeological expertise to monitor any newly discovered archaeological sites during the construction phase and through to the maintenance phase. At Lillgrund, such a demand could have been made in connection with the archaeological site located there. It should be added that a protection or monitoring plan need not be costly to implement and is a relatively simple way in which to ensure that a wind farm does not immediately affect a site.

7.1 The Aspect of Time

As a precondition for a permit under the Environmental Code, the County Administration Board asked for an archaeological survey to be carried out with no specified upper limit of cost. The archaeological survey was carried out in the spring in 2002, when the water was beginning to warm up.

The additional survey that needed to be carried out in 2006, due to the relocation of the met mast, is a phase where time could have been saved. This area could have been included in the initial 2001 survey, and another geophysical survey could have been avoided. Time could have also been saved at the time, very early on, that the County Administration Board (see chapter 4.5.2) was deciding if an archaeological survey was required or not. Finally time (and cost) could have been saved through coordinating the timing of the archaeological survey with the timing of any geological and/or biological surveys to be conducted (see chapter 5).

As for the additional archaeological investigation required in 2007, it was simply a matter of the contractor ordering too short a cable, but it illustrates the fact that the County Administration Board will ask for additional surveys and inspections if and when original plans are altered. It also indicates a willingness to be flexible in finding acceptable solutions to sudden problems as they arise.

The best way to save time is to contact an archaeologist with maritime expertise, as well as the local County Administration Board at the earliest possible stage, so that they are included in the entire process and can provide ongoing advice.

7.2 The Aspect of Quality

From an archaeological perspective, the quality of the archaeological assessment and especially the survey is of paramount importance, as the future protection of cultural heritage in the area will depend on it. From the perspective of the developer, a good quality assessment/survey will minimise the risk of delays and later complications in the project.

The archaeological survey that was conducted at Lillgrund in 2002 covered only 6% of the entire planning area of the wind farm. It also failed to include the last 200 meters of the export cable path connecting closest to land. On average, the video cameras employed covered a corridor of 16 meters along each of the rows for the planned windmills or power generators. Thus, any archaeological sites located outside of this span of vision could, in theory, lie only eight meters away from the foundation of a planned wind generator without having been detected. This kind of limited survey coverage will be harder to justify in the future, where it is more reasonable to have a coverage area of up to100 meters. The reasons for this are as follows:

- Historically, working vessels can potentially affect a substantial area during the building phase (see chapter 4.4.2)

- The protection area of an underwater discovery, such as a shipwreck will most definitely exceed eight meters – thus requiring a much wider scan corridor to avoid seriously affecting an unknown archaeological monument (see chapter 4.4.2)

- Should an archaeological monument be detected, a broader survey will make it much easier and quicker to find alternative solutions to a potential complication that might put strains on the time and budget of the project

Under all circumstances, the survey must be carried out to a standard that is satisfactory to the County Administration Board. The methods employed will be decided by the archaeologist involved (see chapter 5).

If, as was the case with the Lillgrund survey, the decision is taken not to include any form of intrusive evaluation methods (see chapter 5.2), this should be carefully considered and assessed in relation to the cost of potential interruptions during the building phase. Obvious consequences of such a decision may be that a wind generator is required to be moved or entirely taken out of the project or that cables have to be rearranged to pass around a particular archaeological site. Furthermore, such a decision might cause the County Administration Board to consider a watching brief as an alternative option (see chapter 5.2.3).

7.3 The Aspect of Flexibility

Good communication and a professional working relationship between contractors and maritime archaeologists are important in order to find good and flexible solutions to a particular problem. The Lillgrund project is an example where such a relationship was established, where the archaeologist was able to come in on a stand-by basis. The developer particularly appreciated this.

However, it is an aspect that will be hugely improved by better understanding of the goals and difficulties involved in planning an offshore wind farm, as well as the importance of cultural heritage and how best to avoid interfering with it.

7.4 The Aspect of Cost

In view of all of the above aspects, it is obvious that time, quality and flexibility all go hand in hand with the aspect of cost.

8 STEP BY STEP GUIDE

8.1 Laws

- Cultural heritage is protected under the Heritage Conservation Act and the Environmental Code (see chapters 3.1, 3.3, 4.2 – 4.3) and must not be disturbed without permission from the County Administration Board. Should an archaeological site or object be encountered at any stage of a working project, all activities in the nearby area must cease and contact must be made with the relevant authorities (chapter 4.1).

- When planning an offshore wind farm project, its potential impact on cultural heritage must be fully considered in the environmental impact analysis (EIA) required to be submitted pursuant to the Environmental Code. This code also applies in the contiguous zone (see chapter 4.3).

- The purpose of the EIA, and indeed any type of archaeological investigations made in association with the EIA, is to avoid causing any damage to cultural heritage and to find acceptable solutions to mitigate the extent of any damage.

- The EIA should include all phases within the lifespan of a wind farm project (figure 18) that might have an effect on cultural heritage (both under water and land based (see chapter 4.4)).

- Whether the wind farm is to be located within Sweden's territorial waters or its contiguous or exclusive zones, the County Administration Board will handle the case directly or on behalf of the Ministry of Industry, Employment and Communication (figure 18, chapters 4.1 and 4.3).

- An archaeological survey, phase 1 and 2, is likely to be required in order to gain a planning permission from the County Administration Board (see chapter 3).

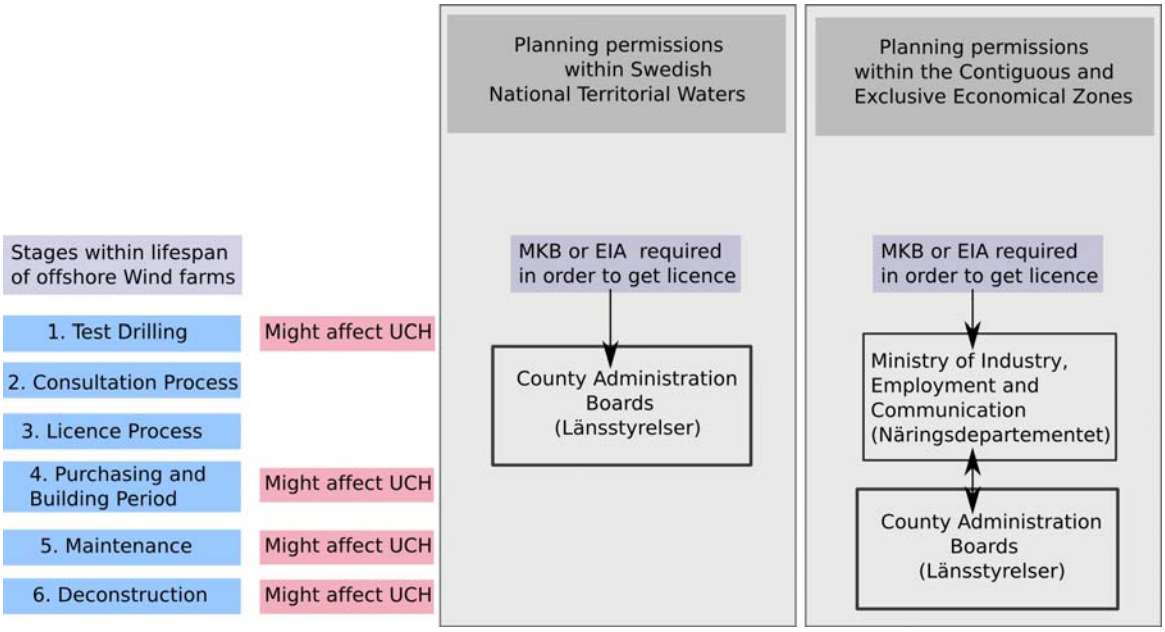

Figure 18. Blue boxes represent phases within the lifespan of an offshore wind farm. Pink boxes indicate phases that might affect the underwater cultural heritage for which an environmental impact analysis is required. The two grey boxes on the right indicate the path of planning applications within and outside Swedish territorial waters.

8.2 Planning and Executing

- To shorten the process of obtaining a planning permission, preparations should start early, preferably in year one (figure 19) by contacting an archaeologist with maritime expertise and/or the local County Administration Board (for a list of organisations with maritime archaeological expertise, see chapter 3).

- An archaeological survey can be commissioned prior to submitting any form of application to the County Administration Board. As handling times vary from Board to Board, such a plan of action saves time. It is, however, worth notifying the Board in advance about your decision (see chapter 4.5.2),

- The archaeological survey should include all areas of seabed potentially affected by the wind farm project; this should include the offshore planning area and corridors for connecting land cables (see chapters 4.4.1 and 4.4.2).

- The archaeologist in agreement with the County Administration Board decides the quality of the archaeological survey.

- Coordinating surveys for geological and/or biological purposes with the archaeological survey can save time and costs. This is of particular use with regard to geophysical surveys using side scan, ground penetrating sonar, multi-beam, or grabs samplings methods (standards for archaeological surveys are described in chapter 5).

- The decision as to whether to include an entire planning area within the survey right from the beginning, or to divide the area into sections to be surveyed at different periods of time, is one that will depend on a number of aspects such as timing, quality, flexibility and costs (see chapters 6 and 7).

- The availability of a stand-by archaeologist with maritime expertise during the course of the project makes it easier to deal with any unforeseen complications that might arise due to any sudden changes of plans.

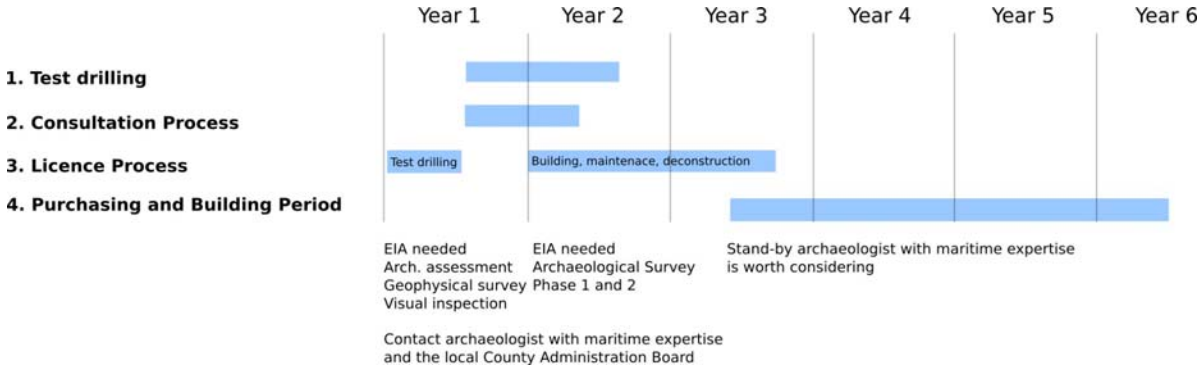

Figure 19. The generic timeline for an offshore wind farm up until the building period.

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13 GLOSSARY

Archaeology – the study of physical remains of past human activity.

Closed find – a term shipwrecks are often referred to as all finds and constructional elements of the ship can be assumed to belong to the same period of time, forming a functional, ideological and symbolic entity.

Continental Shelf Act – see Lag (1966:314) om kontinentalsockel.

In situ – description referring to an archaeological feature which was uncovered in its original position.

Intrusive evaluation – the process of investigation by small-scale, targeted archaeological excavation, often using trenches.

EIA – Environmental Impact Assessment. An assessment of the potential impacts of projects and possible strategies for their mitigation. Also see MKB.

FMIS (Systemet för Fornminnesinformation) – National Sites and Monuments Register. Is available on-line at http://www.raa.se/cms/fornsok/start.html. The register includes all known archaeological sites on land and along inland waterways.

Förordning (1993:1745) om skydd för landskapsinformation – Swedish law that regulates the protection of hydrografical survey information of the seabed. In certain cases such information may not be stored or circulated without permission. The full text is available at http://www.riksdagen.se/webbnav/index.aspx?nid=3911&bet=1993:1742.

Lag (1966:314) om kontinentalsockeln – law that regulates the rights to explore and extract natural resources located on the continental shelf within Swedish territorial waters and its Contiguous and Exclusive Economical Zones as belonging to the Swedish state. Full text is available at http://www.riksdagen.se/webbnav/index.aspx?nid=3911&bet=1966:314.

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Länsstyrelsen – County Administration Board. 21 counties in total, of which nine border the Sea. Responsible for supervising cultural heritage laws and regulations on land and within territorial waters and for issuing planning permissions.

Maritime or marine archaeologist – antiquarian with specialised expertise in relation to archaeological remains situated on the foreshore and under water; generally shipwrecks and remains related to a marine or maritime subsistence.

Miljöbalken – see The Environmental Code.

Miljödomstol – Swedish court specifically dealing with issues relating to environment and water, as regulated in the Environmental Code.

Miljökonsekvensanalys (MKB) – Environmental Impact Assessment (EIA). An assessment of the potential impacts of projects and possible strategies for their mitigation.

Non-intrusive – does not cause any damage or destruction to archaeological or geological features.

Plan- och Bygglagen (1987:10) – Law text containing regulations on the planning of land and water and of construction work on a local governmental basis. Full text is available at http://www.riksdagen.se/webbnav/index.aspx?nid=3911&bet=1987:10.

PBL – See Plan- och bygglagen (1987:10).

Territorial Waters - inland and coastal waters under the jurisdiction of a nation or state. In the case of Sweden, this encompasses seawaters up to 12 nautical miles off the shoreline.

Time capsule – see Closed find.

The Contiguous Zone – refers to the 12-mile zone adjacent to the territorial sea zone of a coastal state. Article 303 of Law of the Sea 1982 allows coastal states to regulate "objects of an archaeological and historical nature found at sea" in the contiguous zone as "an infringement within its territory or territorial sea of the laws and regulations" pertaining to that zone. Several states (e.g., Denmark, France, Tunisia, and China) now have laws controlling underwater archaeological sites in this zone.

The Exclusive Economical Zone (EEZ)/ Continental Shelf – a zone not extended beyond 200 miles from the baselines from which the base of the territorial sea zone is measured. According to article 56 of the Law of the Sea 1982, a coastal state has sovereign rights control the exploration, exploitation, management, and conservation of living and non-living resources.

The Protection of Landscape Information Act – see Förordning (1993:1745) om skydd för landskapsinformation.

The Town and County Planning Act – see Plan och Bygglagen.

Watching Brief – a project to ensure recording or, where appropriate, preservation of previously unknown archaeological features revealed during the construction process on land or underwater. In Swedish, schaktövervakning.

Riksantikvarieämbetet (RAÄ) – Swedish National Heritage Board.

SjöMIS (Sjöhistoriska museets och Sjöfartsverkets maritima informationssystem) – Largely a digital version of the SMA archive. Will soon be available on-line at www.fmis.raa.se/fmis.

SMA (Svenskt Marinarkeologiskt Arkiv) – archives on underwater sites and monuments kept at the Swedish National Maritime Museums (SMM).

The Environmental Code – Miljöbalken, protects the natural and cultural environment. Demands that a special Miljökonsekvensanalys (MKB) is carried out in relation to the planning of large scale construction or exploitation work in water and on land. The comprehensive text is available on-line at http://www.riksdagen.se/webbnav/index.aspx?nid=3911&bet=1998:808.

Underwater archaeology – refers to archaeological remains that are located in water, for which particular survey and investigation methods are required.

UCH, Underwater Cultural Heritage – refers to cultural heritage located in water.