M5/21

BEACH REPLENISHMENT AND DERIVED ARCHAEOLOGICAL MATERIAL:

Mablethorpe to Skegness beach replenishment scheme

County of Lincolnshire

Archaeological assessment

From NGR 551028 385015 (Mablethorpe)
To NGR 557218 363345 (Skegness)

Author Jo Lyon
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1 Introduction

1.1 Location and status of study areas

This project encompasses two separate study areas: a coastal study area and a marine study area. The coastal study area runs along the coastal strip between Mablethorpe and Skegness in Lincolnshire, Ordnance Survey National Grid reference 551028 385015 (Mablethorpe) to 557218 363345 (Skegness). The zone extends north–south by c 24,000m and east–west by c 2,500m. The marine study area is located in the North Sea, c 16,700m off the Lincolnshire coast, and is comprised of two licensed extraction areas. Area 107 covers an area of approximately 49,700m while area 440 covers 53,130m (Fig 1). The Long/Lat coordinates are displayed in Table 1 (Appendix 2).

Neither of the study areas contains SAMs or protected wreck sites. There are a number of Grade II listed buildings and conservation areas within the coastal study area, but none of these are affected by the beach replenishment project.

Throughout this report the study areas are collectively referred to as the Lincshore project.

1.2 Project description

This project takes the form of a desk-based archaeological assessment to examine the relationship between the historic environment and beach replenishment schemes, by exploring the deposition of archaeological materials on replenished beaches and their former offshore contexts. The area of coast between Mablethorpe and Skegness has been used as a case study, as a major beach replenishment scheme has recently taken place here.

The project involves the analysis of data sources (see Section 1.6.1 and Bibliography) and assessment of their usefulness in identifying the potential archaeological impact of beach schemes. This process is carried out with a view to applying the methods outlined in this document to other beach replenishment schemes around the UK.

1.3 Origin of the report

This report has been commissioned from the Museum of London Archaeology Service (MoLAS) by English Heritage and has been carried out in accordance with the standards specified by the Institute of Field Archaeologists (IFA 2001).

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1.4 Aims and objectives

Aims: ALSF and Taking to the Water:

English Heritage is keen to promote projects to further understanding of the archaeology of offshore deposits and their relationship to shoreline management schemes which involve large scale beach replenishment programmes. The Quaternary and Holocene archaeology of offshore areas that are actively exploited for sand and gravel resources is poorly understood. The Beach Replenishment Project is a brief specifically to investigate the relationship between the Mablethorpe to Skegness beach replenishment scheme and extraneous archaeological material derived from offshore aggregate extraction.

The core objective of English Heritage ALSF Projects is to reduce the impact on the historic environment of aggregate extraction, both terrestrial and marine. The Beach Replenishment Project specifically seeks to:

- Develop the capacity to manage aggregate extraction landscapes in the future
- Promote understanding of the conservation issues arising from the impacts of aggregates extraction on the historic environment

In terms of the research priorities laid out in Taking to the Water: English Heritage's Initial Policy for The Management of Maritime Archaeology in England (Roberts and Trow 2002) the Beach Replenishment Project also aims to:

- Enhance and validate the Maritime Record of the NMR through evaluation of the study area
- Help provide understanding and management of the maritime historic environment specifically the stability of offshore environments in extraction areas and the stability of derived material on replenished beaches
- Improve understanding of the drowned coastal landscape and palaeoenvironments of the replenishment and extraction areas

Objectives: Project Specific and Defra Objective 2:

The Beach Replenishment Project objectives are specifically focused on the aim to provide enhanced data sets for future management of beach replenishment schemes and will include:

- Research to enhance understanding of the scale and character of the historic environment in the Beach Replenishment study area in order to provide the baseline information necessary for effective future management
- The archaeology of the Quaternary and Holocene Period: research to characterise the offshore resource in the licensed extraction areas and to develop evaluation frameworks, predictive tools and mitigation strategies
- Identify, where possible, extraneous archaeological material (associated with beach replenishment schemes) likely to have derived from offshore aggregate during the course of beach replenishment and shoreline management schemes. This includes in situ buried landscape material and derived material (wrecks etc)
    - Geographically relate extraneous archaeological material to the aggregate source

- Relate original source material to its Pleistocene (or other) depositional episode
- Relate the material to base line information (cliff erosion etc)

- Provide contextual information (to Local Authority HER Officers and the NMRC)
- Identify future replenishment and other relevant shoreline management schemes
- Provide recommendations for future scheme recording

1.5 Project strategy

The erosion of the Mablethorpe to Skegness coastline, coupled with the importation of recharge materials onto the beach from offshore locations, means that pre-existing archaeological material may potentially be eroding out of the beach and mixing with archaeological material accidentally imported along with aggregates. The situation is complicated even further by natural movement of materials during coastal processes, such as wave action and long shore drift, or more violent episodes like storms.

An archaeological strategy for identifying residual material on replenished beaches is detailed in this document. A number of different factors and processes are taken into account and data collection and research is focused around four main themes:

1. *Proximity of terrestrial/inter-tidal archaeological sites to the replenished beach:* Background geological and archaeological research and assessment of discovery potential has been carried out on the coastal study area between Mablethorpe and Skegness (Sections 3 and 4)
2. *Proximity of submerged archaeological sites to the licensed aggregate extraction areas:* Background geological and archaeological research and assessment of discovery potential has been carried out on the North Sea basin, in the vicinity of licensed extraction areas 107 and 440 (Sections 5 and 6)
3. *The physical state of the beach before replenishment took place:* Development of coastal engineering along the Lincolnshire coast and description of coastal processes within sub-cell 2c (Section 7)
4. *The physical state of the beach after replenishment took place:* Analysis of the effect of replenishment on coastal processes and erosion rates (Section 7)

Analysis centred on these four themes is developed into a discussion of archaeological impacts in Section 8. Possible methods for identifying derived materials on replenished beaches are then outlined in Section 9. This is followed by recommendations, identification of future research potential and future replenishment needs in Section 10.

1.6 Methodology

The assessment has been carried out in accordance with guidance from various bodies including Institute of Field Archaeologists (IFA) Standard and Guidance for Archaeological Desk-based Assessment (IFA 1999), *Marine Aggregate Dredging and*

the Historic Environment produced by the British Marine Aggregate Producers Association (BMAPA) and English Heritage (BMAPA /English Heritage 2003). The latter document aims to ensure the effective and practical consideration of the historic environment, in the licensing of marine aggregate extraction, and elaborates on the guidance provided in the *Code of Practice for Seabed Developers* produced by the JNAPC in 1995.

Secondary sources and archaeological records of known sites were reviewed within the coastal and marine study areas. Models of sea level change in the Southern North Sea were also analysed, to establish when the marine study area was habitable.

These were then compared to patterns of human occupation and activity during the relevant periods, derived from known sites in Britain and other North Sea countries.

Records of known terrestrial and maritime sites, within the study areas, were overlaid on a series of base maps, to demonstrate relationships with underlying geology and proximity to licensed dredging areas, in a Geographical Information System (GIS).

Dredging related impacts upon the known and potential archaeological heritage were identified in the marine study area. Possible archaeological impacts, associated with replenishment and coastal processes, were also identified within the coastal study area. The significance of the effects of such impacts were considered, taking into account previous disturbance and the importance of the known and potential archaeological heritage. Proposals for strategies to mitigate significant adverse effects are also made.

1.6.1 Sources

The principle sources consulted in this assessment are as follows (see Bibliography (Section 12) and Appendix 3 for further information):

- Records held in the maritime section of the National Monuments Record (NMR)
- Records of known archaeological sites and finds in the marine study area from the National Monuments Record (NMR)
- Records of known archaeological sites and finds in the coastal study area from the Lincolnshire County Council SMR (HER)
- Various secondary sources relating to the palaeo-environment, to the Palaeolithic and Mesolithic archaeology of Northern Europe and the North Sea floor (Flemming, N, C, 2002) to the Neolithic, Bronze and Iron Ages of Lincolnshire (May, J, 1976), and to the history of Lincolnshire from the Roman period onwards (Whitwell, J, B, 1992 and Sawyer, P, 1998)
- Environment Agency (Anglian Region) records including Shoreline Management Plans and reviews

1.6.1.1 Terrestrial records

Records of archaeological sites in the coastal study area were obtained from the NMR and HER. All records were tabulated under a unique numerical sequence for use within this document. Arcview 3.2 was used to display the records, superimposed onto OS mapping (Figs 2.1–2.8 and 3.1–3.8). A gazetteer of archaeological sites can be found in Appendix 2.

1.6.1.2 Marine records

In order to assess the maritime archaeological resource within the marine study area, records of wrecks, casualties and seabed features were obtained from the NMR and the BGS. These records were tabulated under a unique numerical sequence for use within this document. This information is displayed on the gazetteer in Appendix 2 and illustrated on Figs 2.1–2.8, 3.1–3.8 and Fig 20.

2 Planning and legislative framework

2.1 Introduction

This study is complicated by the fact it involves the analysis of a terrestrial and a marine study area. The planning framework in both environments will, therefore, be outlined.

England's heritage related planning guidance and legislation is currently going through a period of major review. As a consequence, changes to both legislation and the planning process are likely to be made over the next 3–5 years. What is set out in the sections that follow reflects the current situation.

2.2 Terrestrial guidance

2.2.1 Planning Policy Guidance (PPG 16)

The then Department of the Environment published its *Archaeology and planning: a consultative document*, Planning Policy Guidance Note 16 (PPG 16), in November 1990. This set out the Secretary of State's policy on archaeological remains on land, and provided recommendations many of which have been integrated into local development plans. The key points in PPG16 are the following:

> Archaeological remains should be seen as a finite and non-renewable resource, and in many cases highly fragile and vulnerable to damage and destruction. Appropriate management is therefore essential to ensure that they survive in good condition. In particular, care must be taken to ensure that archaeological remains are not needlessly or thoughtlessly destroyed. They can contain irreplaceable information about our past and the potential for an increase in future knowledge. They are part of our sense of national identity and are valuable both for their own sake and for their role in education, leisure and tourism.
>
> Where nationally important archaeological remains, whether scheduled or not, and their settings, are affected by a proposed development there should be a presumption in favour of their physical preservation.
>
> The key to informed and reasonable planning decisions is for consideration to be given early, before formal planning applications are made, to the question of whether archaeological remains are known to exist on a site where development is planned and the implications for the development proposal.
>
> When important remains are known to exist, or when archaeologists have good reason to believe that important remains exist, developers will be able to help by preparing sympathetic designs using, for example, foundations which avoid disturbing the remains altogether or minimise damage by raising ground levels under a proposed new structure, or by careful siting of landscaped or open areas. There are techniques available for sealing archaeological remains underneath buildings or landscaping, thus securing their preservation for the future even though they remain inaccessible for the time being.
>
> If physical preservation *in situ* is not feasible, an archaeological excavation for the purposes of 'preservation by record' may be an acceptable alternative. From an archaeological point

> of view, this should be regarded as a second-best option. Agreements should also provide for the subsequent publication of the results of any excavation programme.
>
> Decisions by planning authorities on whether to preserve archaeological remains *in situ*, in the face of proposed development, have to be taken on merit, taking account of development plan policies and all other material considerations – including the importance of the remains – and weighing these against the need for development.
>
> Planning authorities, when they propose to allow development which is damaging to archaeological remains, must ensure that the developer has satisfactorily provided for excavation and recording, either through voluntary agreement with the archaeologists or, in the absence of agreement, by imposing an appropriate condition on the planning permission.

PPG16 itself forms part of an emerging European framework which recognises the importance of the archaeological and historic heritage in consideration of development proposals. This has recently been formulated in the *Code of good practice on archaeological heritage in urban development policies* established by the Cultural Heritage Committee of the Council of Europe, and adopted at the 15th plenary session in Strasbourg on 8–10 March 2000 (CC-PAT [99] 18 rev 3). As stated at the beginning of that document however, 'a balance must be struck between the desire to conserve the past and the need to renew for the future'.

2.2.2 Archaeology and planning in Lincolnshire

2.2.2.1 Lincolnshire Structure Plan

The Deposit Draft of the Lincolnshire Structure Plan was approved by the County Council on 20th February 2004, and placed on Deposit from Monday 5th April 2004 to Monday 17th May 2004. Proposed Changes were placed on Deposit from Monday 21st February to Monday 4th April 2005. The plan contains the following excerpts relating to archaeology in Chapter 9: Built Environment and Conservation:

Policy BE4: Archaeological heritage

WHERE DEVELOPMENT PROPOSALS WILL AFFECT SITES OF ARCHAEOLOGICAL SIGNIFICANCE, OR POTENTIAL SIGNIFICANCE, THE RESULTS OF AN ARCHAEOLOGICAL EVALUATION WILL BE REQUIRED TO ACCOMPANY AN APPLICATION FOR PLANNING PERMISSION.

WHERE DEVELOPMENT IS LIKELY TO ADVERSELY AFFECT IMPORTANT ARCHAEOLOGICAL REMAINS, OR THEIR SETTING, THE PHYSICAL PRESERVATION IN SITU OF THOSE REMAINS WILL BE THE PREFERRED OPTION. DEVELOPMENT LIKELY TO ADVERSELY AFFECT ARCHAEOLOGICAL REMAINS OF NATIONAL, OR INTERNATIONAL, IMPORTANCE (WHETHER SCHEDULED OR NOT), OR THEIR SETTING, WILL NOT NORMALLY BE PERMITTED.

WHERE DEVELOPMENT IS PERMITTED AND THE PHYSICAL PRESERVATION IN SITU OF ARCHAEOLOGICAL REMAINS IS NOT WARRANTED OR DESIRABLE, TAKING INTO CONSIDERATION THE IMPORTANCE OF THE REMAINS AND OTHER MATERIAL CONSIDERATIONS, THE EXCAVATION AND RECORDING OF THE

ARCHAEOLOGICAL REMAINS WILL BE REQUIRED ALONG WITH THE APPROPRIATE PUBLICATION OF THE RESULTS.

Explanation:

9.18 PPG16 (Archaeology and Planning) states that archaeological remains 'should be seen as a finite, and non-renewable resource, in many cases highly fragile and vulnerable to damage and destruction' and 'care must be taken to ensure that they are not needlessly or thoughtlessly destroyed'.

9.19 Lincolnshire has a wealth of very important archaeological remains that include the flint tools of the early "Palaeolithic" inhabitants, the prehistoric burial mounds of the Wolds, the waterlogged landscape of the Witham Valley, medieval castles and monasteries and the industrial and agri-industrial buildings of our major towns and World War Two sites and defences. Some of the most important, known sites and buildings are protected in law as Scheduled Ancient Monuments.

9.20 For the majority of human existence archaeological sites form the only record of past activity and environment, but they are also valuable for the contribution they make to our quality of life, education, tourism, regeneration and a sense of local identity. They also help us to understand about the development of the places where we live and work today.

9.21 Not all archaeological sites are equally important. Development adversely affecting an archaeological site of national, or international, importance (where scheduled or not), or its setting, should not normally be permitted. Development affecting a site of lesser importance should be considered with regard to its intrinsic importance and the need for the proposed development. In order to achieve this, applications should not be determined until sufficient information is available to assess the archaeological implications. Where necessary the applicant will be required to submit an evaluation of the archaeological potential of the development site to accompany their application.

9.22 Where development is permitted, satisfactory arrangements will be required for the preservation in situ of archaeological remains or their appropriate excavation and recording along with the publication of the results. Such requirements will be secured through negotiation, planning conditions or legal agreements as appropriate.

9.23 The County Council will continue to offer advice on schemes that have a potential to affect the County's archaeological resource and to interpret, promote and enhance that resource where appropriate. The County Council will also continue to maintain and develop its Environmental Records System with the Sites and Monuments Record at its core.

2.2.2.2 East Lindsey Local Plan

The current East Lindsey Local Plan was adopted in 1995 and formally amended in 1999. Work is currently underway on a replacement East Lindsey Local Plan. The revised Plan was placed on Deposit, for public consultation, on 21st June 2004 for a statutory six-week consultation period. This consultation period ended on 2nd August 2004.

The following excerpts relate to archaeology in east Lindsey and are taken from Chapter 4: Conservation: Policy C10 Archaeology:

A planning application for development on, or affecting, a known or suspected site of archaeological interest must be accompanied by a site evaluation sufficient to allow the Council to determine the site's archaeological significance. The Council will not permit development that would harm the site or setting of :-

- a scheduled ancient monument;
- any unscheduled nationally important archaeological site or monument; or
- any locally important archaeological site deemed worthy of preservation in situ.

On other archaeological sites where preservation in situ is not warranted, development will be permitted provided:-

a) any disturbance is kept to a minimum or avoided altogether;

and

b) the developer makes satisfactory provision for the excavation, recording, archiving and publication of any archaeological remains which will be affected by the development.

Reason:

4.46 Archaeological remains are a finite and non-renewable resource, often highly fragile and vulnerable to damage and destruction. They can contain irreplaceable information about our past and the potential for an increase in future knowledge. They are part of our national identity and are valuable both for their own sake and for their role in education, leisure and tourism.

4.47 In considering applications that affect archaeological sites, the Council will follow the advice offered in *PPG16: Archaeology and Planning.*

4.48 At present there are 104 Scheduled Ancient Monuments (SAMs) in East Lindsey. Works within the scheduled areas requires Scheduled Monument Consent (SMC), for which application is made to the Secretary of State. In addition to SAMs, PPG 16 recognizes 'unscheduled monuments of national importance or of particular local importance', which are worthy of preservation in situ, as well as other sites where 'preservation by record' (ie excavation) may be acceptable

4.49 The archaeological record is documented in the County's Sites and Monument Record (SMR). It is constantly evolving with information on new and existing sites being added to the SMR.

4.50 In all cases, the Council will ensure that the archaeological effects of development proposals are fully assessed before planning applications are determined. To this end the Council will liaise closely with its archaeological advisors (currently Lincolnshire County Council) regarding the form and extent of a site evaluation as part of a planning application. This may, in the first instance, be a desk-based assessment using existing records and/or a field evaluation.

4.51 Developers are strongly encouraged to discuss their proposals with the Council's archaeological advisors prior to submitting their planning application.

4.52 There will be a strong presumption against all development that harms the site or setting of Scheduled Ancient Monuments and Unscheduled Sites of National Importance or particular local importance.

4.53 In the case of other archaeological sites, Policy C10 aims to secure 'preservation by record' and the Council will negotiate with the Developer to achieve this. It may include full excavation or a watching brief during development operations. It will be secured through a planning condition attached to the planning permission or a legal (Section 106) agreement.

2.3 Marine guidance

2.3.1 Planning Policy Guidance (PPG16 and MMG1)

Planning law applies within the territory of local authorities which, as a general rule, extends only to the low water mark. English Heritage and RCHME, however, included the following statement in *England's Coastal Heritage* (see below):

Although it remains government policy not to extend the Town and Country Planning system to the territorial sea, the principles set out in Planning policy guidance note 16: archaeology and planning should be applied to the treatment of sub-tidal archaeological remains in order to secure best practice.

Additionally, Marine Minerals Guidance Note 1 (MMG1); Guidance on the Extraction by Dredging of Sand, Gravel and Other Minerals from the English Seabed (2002) notes that the *JNAPC Code of Practice for Seabed Developers* recommends procedures for consultation and co-operation between seabed developers and archaeologists. This is consistent with the Government's policy on archaeology as stated in PPG16, and should continue to be followed by the dredging industry.

England's Coastal Heritage: a statement on the management of coastal archaeology was published in 1996 by English Heritage and the Royal Commission on the Historical Monuments of England (RCHME). The statement set out a number of principles for managing coastal archaeology:

- The coastal zone of England includes a finite, irreplaceable, and, in many cases, highly fragile archaeological resource which by virtue of its value, variety, and vulnerability justifies a presumption in favour of the physical preservation *in situ* of the most important sites, buildings, and remains.
- Although archaeological remains situated within inter-tidal and sub-tidal areas may be less visible and accessible than remains on dry land, this does not affect their relative importance and they should be managed in accordance with the principles which apply to terrestrial archaeological remains.
- As historic landscapes can extend seamlessly from dry land, through the inter-tidal zone, and into sub-tidal areas, effective management of the coastal archaeological resource cannot be achieved without due consideration of marine as well as terrestrial archaeological remains.

The statement also included a number of detailed recommendations, which include the following:

Development control and environmental assessment:

Coastal archaeological interests should be adequately reflected in structure and local plans, and consistently and comprehensively included in Environmental Assessment procedures for coastal and marine developments (including harbour works, mineral extraction, oil and gas related projects, capital

dredging projects, cable projects, and waste water treatment and disposal) and other activities requiring sectoral consent.

Minerals:

Pending the outcome of the review of marine minerals licensing procedures, adequate consultation procedures for archaeological interests during the granting or renewal of licenses should be promoted and, where appropriate, local authorities should consider the use of their powers under Section 18 of the Coastal Protection Act 1949 to prohibit or license extraction of aggregate from the foreshore and seabed in order to secure the preservation of important archaeological remains.

Identifying and Protecting Palaeolithic Remains; archaeological guidance for planning authorities and developers (English Heritage May 1998) draws attention to the importance of Palaeolithic remains and states that they must be considered in line with PPG 16 when potentially affected by development proposals. Palaeolithic archaeological sites are defined as any land where artefacts or traces of a human presence of Pleistocene date have been found. The document notes that Palaeolithic remains have particular importance if:

- Any human bone is present in relevant deposits
- The remains are in an undisturbed, primary context
- The remains belong to a period or geographic area where evidence of a human presence is particularly rare or was unknown
- Organic artefacts are present
- Well-preserved indicators of the contemporary environment (floral, faunal, sedimentological) can be directly related to the remains
- There is evidence of lifestyle (such as interference with animal remains)
- One deposit containing Palaeolithic remains has a clear stratigraphic relationship with another
- Any artistic representation, no matter how simple, is present
- Any structure, such as a hearth, shelter, floor, securing device etc. survives The site can be related to the exploitation of a resource, such as a raw material
- Artefacts are abundant

The document goes on to note that sites containing any of these features are so rare in Britain that they should be regarded as of national importance and whenever possible should remain undisturbed.

The advice offered to developers and planning officers includes the following:

- It is advisable for prospective developers to research the archaeological potential of their sites (including that for Palaeolithic remains) at an early stage
- It is the responsibility of developers to supply the relevant planning authority on the archaeology of their sites, with proposals for the way in which this will be accommodated within the development scheme, so that an informed planning decision can be reached. Information on the Palaeolithic remains or the potential for such remains within a certain site may be acquired from a desk-based assessment but when this is inadequate it may be necessary to

obtain further information from a limited field evaluation by suitably qualified archaeologists

- Planning authorities may apply a condition to a consent which prohibits the start of development until the applicant has ensured appropriate provision has been made for an adequate record of the site's archaeological remains.

Marine Aggregate Dredging and the Historic Environment produced by the British Marine Aggregate Producers Association (BMAPA) and English Heritage aims to ensure the effective and practical consideration of the historic environment in the licensing of marine aggregate extraction (BMAPA / English Heritage 2003).

It includes practical guidelines on assessing, evaluating, mitigating and monitoring archaeological impacts of marine aggregate dredging. It also elaborates on the Code of Practice for Seabed Developers produced by the Joint Nautical Archaeology Policy Committee.

2.3.2 Protection of Wrecks Act 1973

Under the 1973 Act, wrecks and wreckage of historical, archaeological or artistic importance can be protected by way of designation. It is an offence to carry out certain activities in a defined area surrounding a wreck that has been designated, unless a licence for those activities has been obtained from the Government. Generally, the relevant Secretary of State must consult appropriate advisors prior to designation, though it is also possible to designate a wreck in an emergency without first seeking advice. There are no sites presently designated under this legislation within aggregate extraction areas 107 and 440. If any important wreck or ship borne artefact is discovered during the dredging operations, however, the designation of an area around the find remains a possibility.

2.3.3 Merchant Shipping Act 1995

Within the context of the Merchant Shipping Act 1995, 'wreck' refers to flotsam, jetsam, derelict and lagan found in or on the shores of the sea or any tidal water. It includes a ship, aircraft or hovercraft, parts of these, their cargo or equipment. It may be of antique or archaeological value such as gold coins, or a yacht or dinghy abandoned at sea or items such as drums of chemicals or crates of foodstuffs (Definition from the Receiver of Wreck (ROW)). The ownership of underwater finds that turn out to be 'wreck' is decided according to procedures set out in the Merchant Shipping Act 1995. If any such finds are brought ashore the salvor is required to give notice to the ROW that he has found or taken possession of it and, as directed by the ROW, either hold it to the Receiver's order or deliver it to the Receiver. This applies whether material has been recovered from within or outside UK Territorial Waters, unless the salvor can prove that title to the property has been vested in him (e.g. by assignment to him of rights devolving from the owner of the vessel or its contents at the time of loss). Even if ownership can be proved the salvor is still required to notify the ROW.

The Crown makes no claim on wreck found outside UK Territorial Waters, which remains unclaimed at the end of the statutory one-year, and the property is returned to the salvor. Ownership of unclaimed wreck from within Territorial Waters lies in the Crown or in a person to whom rights of wreck have been granted. The Receiver of Wreck has a duty to ensure that finders who report their finds as equired receive an

appropriate salvage payment. In the case of material considered being of historic or archaeological importance, a suitable museum is asked to buy the material at the current valuation and the finder receives the net proceeds of the sale as a salvage payment. If the right to, or the amount of, salvage cannot be agreed, either between owner and finder or between competing salvors, the Receiver of Wreck will hold the wreck until the matter is settled, either through amicable agreement or by court judgement.

2.3.4 Protection of Military Remains Act 1986

Under the Protection of Military Remains Act 1986, all aircraft that have crashed in military service are protected, and the Ministry of Defence has powers to protect vessels that were in military service when they were wrecked. The Ministry of Defence can designate named vessels as 'protected places' even if the position of the wreck is not known. In addition, the Ministry of Defence can designate 'controlled sites' around wrecks whose position is known. In the case of 'protected places', the vessel must have been lost after 4 August 1914, whereas in the case of a wreck protected as a 'controlled site' no more than 200 years must have elapsed since loss. In neither case is it necessary to demonstrate the presence of human remains. Diving is not prohibited at a 'protected place' but it is an offence to tamper with, damage, move or remove sensitive remains. Diving, salvage and excavation are all prohibited on 'controlled sites', however, though licenses for restricted activities can be sought from the Ministry of Defence. Additionally, it is an offence carry out unauthorised excavations for the purpose of discovering whether any place in UK waters comprises any remains of an aircraft or vessel which has crashed, sunk or been stranded while in military service.

In November 2001, the MoD reported on the Public Consultation on Military Maritime Graves and the Protection of Military Remains Act 1986. The report recommended that a rolling programme of identification and assessment of vessels against the criteria be established to designate all other British vessels in military service when lost, as Protected Places. The records of vessels lost during both World Wars whilst on active service do not always give an exact location.

2.3.5 Protecting our Marine Historic Environment: making the System work better

In March 2004, a consultation document was circulated setting out the key issues and questions in relation to legislation and the management of the marine historic environment. The document includes various suggestions for change including a more unified designation scheme (combining the Protection of Wrecks Act 1973 and the Ancient Monuments and Archaeological Areas Act 1979). The document also includes provision for publishing the criteria that marine cultural heritage sites will need to satisfy in order to be designated. Standardised restrictions are also proposed, so that all sea-users can broadly anticipate what activities are allowed. The consultation process was due for completion at the end of July 2004.

3 Mablethorpe to Skegness coastline: geological, archaeological and historical background

3.1 Introduction

This section will provide an overview of the geological, archaeological and historical background of the coastline between Mablethorpe and Skegness, in order to highlight what remains were known to be present in the terrestrial and inter-tidal areas prior to beach replenishment.

The time-scales used are as follows.

<table>
<tr><td rowspan="3">Mid Pleistocene
450,000–10,000 BP</td><td>Anglian glacial
350,000 to 280,000 BP</td><td rowspan="3">Palaeolithic c 450,000–
10,000 BC</td></tr>
<tr><td>Wolstonian glacial
250,000 to 150,000
years BP</td></tr>
<tr><td>Devensian glacial c
100,000 to 22,000
years BP</td></tr>
<tr><td rowspan="8">Holocene 10,000 BP –
present day</td><td rowspan="8"></td><td>Mesolithic
c 12,000–4000 BC</td></tr>
<tr><td>Neolithic
c 4000–2000 BC</td></tr>
<tr><td>Bronze Age
c 2000–600 BC</td></tr>
<tr><td>Iron Age
c 600 BC–AD 43</td></tr>
<tr><td>Roman
AD 43–410</td></tr>
<tr><td>Saxon
AD 410–*c* 1000</td></tr>
<tr><td>Medieval
c AD 1000–1500</td></tr>
<tr><td>Post-medieval–modern
(including industrial)
c 1500–present</td></tr>
</table>

Sites referred to within this section (eg Site 1, Site 2, etc) are shown on Fig 2.1–2.8 and Fig 3.1–3.8 and appear in the gazetteer of sites, Appendix 2.

3.2 Geology and topography

Lincolnshire is the second largest county in England and is bounded to the north by the River Humber, to the west by the River Trent and to the east by the sea (Boutwood 1999, 23). Most of Lincolnshire lies below 30m except for the two lines of hills: the chalk Wolds and the limestone Heath. In between the hills there is a clay vale, which broadens southwards to the peat and silts of the fens. To the west lies

Trent vale and the Isle of Axholme, while to the east is Lincolnshire Marsh, fringed by the sand dune and salt marsh coastline (Bennett and Bennett 1993, 8).

The solid geology of Lincolnshire is comprised of sedimentary rocks of Mesozoic ages, the oldest of which are the Triassic beds at 220 million years old (Bennett and Bennett 1993, 4). Rocks of Triassic, Jurassic and Cretaceous periods crop out at the surface and dip eastwards, alternating between harder limestone and chalk rocks, and more easily eroded clays, creating a 'scarp and vale' topography (Boutwood 1999, 23) (Fig 4). The drift deposits of till, silt, clay, sand, gravel, peat and blown sands were laid down during the Quaternary period (Boutwood 1999, 23; Bennett and Bennett 1993, 6), mainly in the Pleistocene ice ages and inter-glacials (ibid) (Fig 5). The glacial peaks had different extents on land and sea and the three most recent in the UK are the Devensian (100,000 years BP to 22,000 years BP) the Wolstonian (250,000 years BP to 150,000 years BP) and the Anglian (350,000 years BP to 280,000 BP) (Flemming 2002, 6, 8, 21). In the Mid Pleistocene (Anglian glaciation), Lincolnshire was under a deep ice sheet (Bennett and Bennett 1993, 2), which extended across the North Sea to join the Scandinavian ice sheets (Flemming 2002, 8). The ice sheet eroded the solid geology of the area and deepened clay vales. At the end of the Anglian, the ice sheets melted and left behind large tracts of till, the character of which varies considerably throughout the county (Bennett and Bennett 1993, 2). (Fig 6)

During the most recent, Devensian, glaciation the North Sea floor was dry land and periglacial conditions would have supported vegetation, tundra, large mammals and humans (Flemming 2002, 8). The Devensian ice sheets reached Lincolnshire only briefly before retreating after 13,000 BP (Bennett and Bennett 1993, 2) (Fig 7). North Sea ice from Scotland and north-east England was deflected by Scandinavian Ice into the Humber estuary. Ice from the Lake District came across the Pennines, down the Vale of York and filled the northern part of the Lower Trent Valley (ibid). The advances of the ice would have temporarily blocked river outfalls into the Humber and the Wash, resulting in the formation of lakes (ibid). As the Devensian ice front retreated tundra conditions returned to all areas. Clay and sands slumped down slopes to infill the valley bottoms and sea levels rose rapidly, perhaps by 10m in 1,000 years, in the period around 8,000 BP (the Flandrian transgression). This rise caused the land bridge, which had hitherto existed between Britain and the rest of Europe, to disappear, isolating the British Isles from the rest of Europe for the first time (ibid). The early coniferous forests which had been established were overcome by the advancing sea and their remains can now be found as stumps, roots, branches and twigs, revealed at low tide on beaches along the east coast (ie Huttoft Bank). Sea level continued to rise, flooding the low-lying areas of the Fenlands and the Humber estuary to c 5m OD by c 2000 BP (ibid). Deep and extensive peat deposits also began to accumulate. The complicated sequence of sea level changes, the submergence/re-emergence of the coastline and changing patterns of erosion and accretion has produced a complex series of peat, clay, silt, gravel, shingle and blown sand deposits (Boutwood 1999, 26).

The Lincolnshire coastal plain is today 15km wide and extends from the Fenland Basin in the south to the Humber in the north (Boutwood 1999, 26). The coastal area is split into the Middlemarsh and the Outmarsh (Fig 8). The Middlemarsh largely preserves the Late Glacial topography with a chalk platform at between 10m OD and 25m OD (Van de Noort and Davies 2004, 20) overlain by Quaternary boulder clay, causing an undulating topography (ibid; Bennett and Bennett 1993, 8). The Outmarsh

consists of marine silts with occasional hummocks of boulder clay (Bennett and Bennett 1993, 8), particularly at Mumby, Huttoft and Hogsthorpe (Lane and Morris, 405). Prior to the large scale drainage operations of the post-medieval and modern periods, the hummocky landscape was cut by many small streams and creeks (ibid). The Outmarsh is true coastal plain and is mostly below 10m OD (Van de Noort and Davies 1993, 20). As a result the coast has a long history of embanking to prevent nearby villages and farmland from becoming flooded (Lane and Morris, 405). The topography of the coast also bears evidence of the long tradition of salt making which took place from the prehistoric to post-medieval periods, in the form of the many saltern mounds (Boutwood 1999, 26). Post-medieval land reclamation has increased the area of agricultural land along the coastal strip, but sand dunes, salt marsh and intertidal mudflats still dominate many parts of the coast (ibid).

3.2.1 Prehistoric

Regular sea level change along the Lincolnshire coast, over the millennia, means that many prehistoric archaeological sites are now submerged deep under the North Sea (see Section 5). Those sites that exist along the current coastline have largely become sealed under metres of waterlain sediment (Lane and Morris 2001, 3). Indeed it is not just prehistoric sites that have been affected by coastal change, many more recent sites, right up to the medieval period, are also now buried under the sea and/or in the inter-tidal zone.

There is growing evidence that prehistoric human societies lived in close proximity to the shoreline (Flemming 2002, 6). Evidence of Mesolithic and Neolithic flint scatters, found at various locations along the Lincolnshire coast, probably indicates the existence of hunter-gatherer camps (ibid). The wetlands would have been a useful resource for hunting, fishing and gathering purposes (Van de Noort 2004, 59). Diminished sizes of flint assemblages through the later prehistoric period may suggest that the importance of the wetlands diminished, but this may simply be because later prehistoric assemblages haven't been discovered yet (ibid).

3.2.1.1 Palaeolithic

The earliest occupation of the British Isles by hominids (Homo Heidelbergensis) occurred in the Palaeolithic period (Flemming 2002, 6). In this period there were seven phases of severe cold, of which the last three were fully glacial (May 1976, 13). Each cold period was followed by a long interglacial period, during which the climate became warmer. As mentioned in Section 3.2, the oldest cold phase detected in Lincolnshire is the Anglian glacial. This was followed by the warmer interval known as the Hoxnian interglacial, to which the earliest traces of human life so far discovered in the region belong (ibid).

One site in particular, although not on the coast, is of interest. Kirmington in north Lincolnshire is a depression in the chalk formed in pre-glacial times, which then became filled with 30m of glacial deposits (May 1976, 13–14). In the 1930s, seventy Palaeolithic flints were recovered from the layers (ibid).

After the Wolstonian glacial, Lincolnshire was mostly never again covered by ice. In the Ipswichian interglacial that followed, a new flint working tradition developed, the Mousterian tradition, which continued into the Devensian glacial. This glacial period saw local ice sheets spread from the north-east and cover the coastal marsh (May

1976, 23). At the end of the Devensian, temperatures rose and allowed the growth of fauna like birch, hazel and pine forests and deciduous forests of oak, elm, lime and alder (ibid, 29). The sea level fell and caused parts of the North Sea and the English Channel to become dry land. Cold weather animals began to disappear and red and roe deer, wild ox and pig migrated from the south (ibid, 32). After this period the sea level began to rise again rapidly, with the result that Palaeolithic remains are today found all over the floor of the North Sea (Flemming 2002, 7) (see Section 5).

Most of the recorded Lower Palaeolithic finds from the inland area of Lincolnshire are Acheulian hand axes (May 1976, 16). There are only two recorded findspots of this date in the study area. A Lower Palaeolithic blade was found on the foreshore at Huttoft Bank in 1996 (Site 48, Fig 2.3). This find was made in 1996, during the initial beach replenishment scheme and so could have originated either from an offshore context or been eroded out from in situ deposits (see Section 9). In addition to this find, a Palaeolithic mammoth tooth was found on the beach at Ingoldmells in 1973, twenty years prior to replenishment (Site 98, Fig 2.6).

Further evidence for Palaeolithic human occupation of the coastal area is likely to survive, albeit buried under metres of sediment.

3.2.1.2 Mesolithic

In the Mesolithic period, the British Isles were still connected to Continental Europe by a land bridge (Tann 2004, 12). The ice sheet was retreating at this time, shaping the geology and topography of the Outmarsh area as it went (ibid). The melting ice sheet gradually caused sea levels to rise, which inundated the land bridge (ibid). Most of the Outmarsh area is thought to have been dry land throughout the Mesolithic period (ibid).

Many Mesolithic sites have been recorded in inland Lincolnshire, for instance the settlement at Willoughton, on the Lincoln Edge, which has produced flints and hearths, etc (May 1976, 32, 34). Far fewer coastal sites are known, probably because most lie concealed under metres of marine silt. Storms and tidal currents recently exposed a prehistoric wattle screen or panel, embedded in peat and drowned forest material, on a beach outside the study area, further north at Seaton Carew, Cleveland. The peat has been dated between 4,200 and 5,000 years BP (ibid, 33).

No Mesolithic findspots have been made along the Mablethorpe to Skegness coastline, within the study area. Mesolithic scatters are known in the Middlemarsh area. For instance, one scatter was located at the Bronze Age Butterbump barrow cemetery site (see Section 3.2.1.4), suggesting an earlier phase of occupation (Tann 2004, 12). It is thought that Mesolithic sites do exist all over this area and that more would be located if a comprehensive programme of fieldwalking was undertaken (ibid). There is also potential for Mesolithic sites to be discovered in the intertidal area during any future periods of severe erosion (ibid, 13).

3.2.1.3 Neolithic

The majority of the Mablethorpe to Skegness coastline was dry land at the beginning of the Neolithic period and the area was forested (Tann 2004, 13). The forest was consumed by the advancing sea at the end of the last glacial period, but its remains used to evident in the form of stumps all along the east coast, prior to the beach replenishment scheme (ibid). These remains have been well known since at least

1765, when the first record was made. They were marked on Mitchell's mariners chart, between Sutton on Sea and Anderby, as 'clay huts'. In 1796 stumps were visible between Grimsby and Skegness (ibid). In 1989 the Lindsey Coastal Survey recorded redeposited peat clods at Skegness (Brooks 1990).

Although the replenishment material has buried the remains, they area occasionally revealed whenever the sand is eroded away, for instance stumps were visible at Anderby Creek in September 2004 (ibid). Similar to the Palaeolithic and Mesolithic periods, the Neolithic landscape is likely to be largely buried under marine deposited silts.

The Neolithic period is characterised by the appearance of many new stone tool types and a major change in burial practice (May1976, 41). Few Neolithic settlement sites are known from inland Lincolnshire, however. One early site is located at Tattershall Thorpe, where traces of a square wooden building were revealed (Bennet and Bennet 1993, 10). Other sites have been identified, for instance at Dragonby Hollow, Little Gonerby and Tallington (May 1976 43; Bennet and Bennet 1993, 10). There is also a possible settlement at Great Ponton, south of Grantham (May 1976, 44), and two possible causewayed enclosure sites at Uffington and Barholm (ibid, 45). In contrast to the few known settlements, many Neolithic barrows are known from Lincolnshire. Their distribution appears to show two groups, in the central and southern sectors of the Wolds (ibid). Later in the Neolithic period, henge monuments were built at many of the former burial sites, for instance, at West Ashby near Horncastle (Bennet and Bennet 1993, 10). Another similar site exists at Stainsby on Wolds (ibid).

Numerous Neolithic tools have also been found in Lincolnshire, in particular axe heads, many of which originated from the Langdale axe factory in the Lake District (May 1976, 52). The majority of Neolithic finds recorded in the study area are flint axes, found on the foreshore before replenishment had taken place. For instance, flint axes were found on Mablethorpe beach in 1930 (Site 3, Fig 2.1) and 1934 (Site 7, Fig 2.1), a flint axe was found further inland at Trusthorpe in 1930 (Site 20, Fig 2.1), a worked flint flake (Site 58, Fig 2.5) and flint axe (Site 81, Fig 2.5) were found on the foreshore at Chapel St Leonard's in 1972 and 1976 respectively and a polished stone axe was found on Skegness beach in 1970 (Site 151, Fig 2.8).

There is only one HER entry that post-dates the replenishment scheme. A Langdale VI type axe head was found embedded in clay on the foreshore at Moggs Eye in 1996 (Site 48, Fig 2.3). Given the circumstances of discovery, it is likely that the axe originated from the prehistoric clay levels on the beach. It appears to have been revealed on an occasion when the replenishment material had become very eroded.

The presence of so many axes in Lincolnshire has been interpreted as being associated with the major episodes of forest clearance that are known to have taken place in this period (Bennet and Bennet 1993, 12).

3.2.1.4 Bronze Age

The salt marsh extended further inland during the Bronze Age period and the coastline was still far to the east of the present coast, between Chapel St Leonard's and Gibraltar Point (Tann 2004, 15). It is thought that the tidal range was large in this period, due to early saltern sites being found c 2km inland (ibid).

The Bronze Age saw another major change in burial practice and tool types in Europe. North-west Lincolnshire, in particular, was an important area for Early Bronze Age

settlement in the Beaker period (Bennet and Bennet 1993, 61). A site of particular importance is located at Skendleby (ibid). Most of the evidence so far discovered for the Bronze Age period is related to burial practices and not many occupation sites have been identified (Tann 2004, 15). By the Bronze Age, burial sites were not confined to the higher ground of the Wolds, as they had been in the Neolithic (May 1976, 77). For instance, an important group of barrows lies on what may once have been a low island on the Lincolnshire marsh at Butterbump, Willoughby. The burials consisted of cremations with associated grave goods (ibid, 81). Air photographs taken in the 1970s show further cropmarks to the west, indicating possible ring ditches (Tann 2004, 15). It has been suggested that the cemetery may have had some ritual association with the marshes, as similar burial groups of this date are also associated with wetlands (Van de Noort 2004, 106). For instance, another possible barrow site is situated to the west of this site (Tann 2004, 16). Another burial site, within the study area, was indicated when at least three human bodies were eroded from the beach at Ingoldmells in 1983 (Site 159, Fig 2.7).

Later Bronze Age settlement in Lincolnshire may have been most prevalent in the river valleys, but very few finds have come from the fens and marsh. This is probably mainly because build-up of soils has prevented the chance discovery of artefacts, which may remain buried (Van de Noort 2004, 114). A few isolated Bronze Age artefacts have been discovered in the study area, and all of these were discovered many years prior to the replenishment scheme. A beaker fragment was found on the beach at Sutton on Sea in 1960 (Site 40, Fig 2.2), flint scrapers were found at Chapel Point in 1960 (Site 64, Fig 2.5) and Chapel St Leonard's in 1959 (Site 65, Fig 2.5), flint daggers were also found on the beach at Chapel St Leonard's in 1964 (Sites 66 and 67, Fig 2.5) and a perforated stone hammer was found inland from the beach in Skegness in 1957 (Site 145, Fig 2.8).

Despite the paucity of finds from the Outmarsh area, the coastal area was certainly utilised during this period, as evidenced by the discovery of Bronze Age trackways, further to the north in the Humber Valley (Van de Noort 2004, 59).

It is possible that the salt making industry, which has long characterised the east coast of England, may have had its origins in this period. The oldest known saltern in this area dates to the Late Bronze Age and was found near Tetney Lock, in Lincolnshire Marsh. The site comprised a settling pond and associated briquetage (Van de Noort 2004, 74).

3.2.1.5 Iron Age

The Iron Age was a time of great cultural development and landscape change. Sea level rose considerably during this period and extended inland almost to Burgh le Marsh (Tann 2004, 17). Lincolnshire was inhabited by a tribe known as the Corieltauvi, in the later Iron Age, whose territory stretched from the River Humber to the Nene Valley (Bennet and Bennet 1993, 12). The heartland of Corieltauvian wealth and power lay in Lindsey and it is thought that Sleaford was a key site for coastal and overseas trading (ibid). Rich metal work and art is known from this area, for instance, fine pieces of La Tene metalwork like the Witham shield, found 1826 in the River Whitham (Whitwell 1992, 6). Finds like this suggest growth and prosperity in the region from the 3rd century BC (Whitwell 1992, 143).

Unlike many areas of Iron Age Britain, Lincolnshire had few major fortified sites (Bennet and Bennet 1993, 12). A ploughed out hillfort dating to the early Iron Age was recently found at Tattershall Thorpe, but no others are known in Lindsey (ibid). Aerial photographs show that by the later Iron Age there were field systems present along some parts of the east coast, especially in Yorkshire and Nottingham, indicating increasing use of wetlands for farming (Van de Noort 2004, 59). Marine transgression may have played a significant role in this, with the higher sea level burying all the alder carrs during the 1st millennium BC (ibid).

Archaeological evidence does not support long term settlement in the wetlands and coastal areas prior to the Iron Age (Van de Noort 2004, 77). The Iron Age settlement enclosure at Kelk, with evidence of metallurgical activity, is one of many such sites that were established in a wetland environment during this period (ibid). The raw materials necessary for such activities were readily available in the wetlands, for instance woodlands for charcoal production (essential for production of iron and bronze). Settlements are more prevalent further inland, however, away from the coastal region. For instance, at Dragonby near Scunthorpe (Whitwell 1992, 7), Old Sleaford, Ancaster, South Ferriby, Tallington, Ingoldmells and Colsterworth (Bennet and Bennet 1993, 12).

It is thought that the evidence for Iron Age settlement recorded along the coast is all related to the salt making industry, which developed in this period. The majority of known salt making sites (salterns) along the east coast are Iron Age in date and it is likely that many more salterns are buried under the deep layers of marine silts, which prevents their true distribution from being identified (Van de Noort 2004, 74). Early Iron Age salt making sites have long been known from the east coast, and are evidenced mainly through distinctive briquetage waste (Tann 2004, 17). There is a concentration of sites around Ingoldmells, all discovered before the beach replenishment took place (Sites 89, 91, 94, 97, 100, 103, 104, 115, 116, 117, Fig 2.6, and Sites 125, 126, 127, 158, Fig 2.7). As early as 1848 'hand bricks' of fired clay were noticed on the shore at Ingoldmells, where the tide had eroded away the overlying sediment (Lane and Morris 2001, 407; Bennet and Bennet 1993, 26). In following years further sites were discovered and in 1935 a pair of 'boiling hearths' were excavated (Lane and Morris 2001, 408). Similar sites have also been found at Orby, Addlethorpe and Hogsthorpe, discovered during dyke cutting (Bennet and Bennet 1993, 26). In the drainage scheme at Addlethorpe during the 1960s, 25 new salt making sites were recorded (Site 161, Fig 2.6) (Lane and Morris 2001, 408). Numerous other sites have been identified in the area since then (ibid, 409). The mounds formed by dumping briquetage, etc, during salt production became small artificial islands, which would have been suitable for temporary and seasonal occupation in the intertidal landscape (Van de Noort 2004, 78). It is thought that seasonal salt production on the coast was linked to permanent settlement on the higher land of the Wolds.

There are hardly any occupation sites on the coast, which are recorded on the HER/NMR, that are not directly associated with salt production. Only one of these was captured in the study area when, after a storm, round huts with rush floors were observed on the beach at Mablethorpe (Site 7, Fig 2.1). Iron Age or Roman enclosures were also recorded in the inter-tidal zone close to Ingoldmells in 1990 (Site 88, Fig 2.6). Many of the Ingoldmells saltern sites show continuation into the Roman period (Sites 87, 97 and 117). Some of the inland settlement sites also show continuation, for

example, Tallington Iron Age farm and the town of Ancaster, which is best known as a Roman town but has Iron Age origins (Whitwell 1992, 8).

3.2.2 Roman

By AD 47 a frontier had been established from the Humber to the River Exe in the south, delimited at first by the Fosse Way (Whitwell 1992, 12). The Fosse Way was one of a number of service roads in the region, which led to a series of auxiliary forts that defended the frontier. The Fosse Way meets Ermine Street coming up from the south and it is probable that there was an early fort where they met (ibid). Ermine Street was probably the main military route into the north of the county, but King Street may also have been used. All three routes converged on Lincoln (ibid, 16) (Fig 9).

Due to increasing threat from the Brigantes, Legio II Adiutrix was brought over from the continent in AD 71 by the new governor, Petillius Cerialis and stationed at Lincoln. Once the Brigantian threat had passed, Legio II was moved to Chester to crush Wales (Whitwell 1992, 16). Lincoln was one of the largest and most important Roman towns in the area. The town originated as a fortress and later developed into a colonia, a settlement for veteran soldiers (ibid, 17). Although all evidence lost Whitwell argues that a town of such importance as Lincoln would have had its coastal strip protected (ibid, 136).

Roman villas are known from all over Lincolnshire, except for in the marsh lands bordering the coast (Whitwell 1992, 92). This may be because perishable building materials were used instead of stone, which have not survived. There is evidence that the coastal and marshland areas were settled and utilised during the Roman period, however. Concentrations of pottery finds reveal the presence of Roman sites along the coastal strip, from Killingholme near the Humber to Skegness (ibid). Roman finds on the shore at Sutton on Sea and Chapel St Leonard's are two examples, but these probably weren't major settlements. Isolated farms seem to form the majority of sites in the marsh lands, in the 1st century, but are far less common after AD 120 (Whitwell 1992, 97). Some of these may be thought of as villages but none were big enough to be called towns. There was a Roman settlement at Burgh-le-Marsh but it is not well understood and may not have had many buildings (ibid, 139). Its position on the main road from Lincoln to the coast could have made it important, as it would have been the first site reached after leaving the coast, where the road begins to lift from the coastal marshes onto higher ground (ibid). Another possible centre is the site at Whapole, which has a stone altar and building debris suggesting more permanent buildings than on a normal marshland site. Another possible site is at Maxey on the fen edge.

Aerial photography has revealed clusters of enclosures with lines of double ditches, some of date from the late 1st century and after AD 120 (Whitwell 1992, 93). It is thought that the fields were probably for arable crops and the big open areas to which the ditched roads lead have been interpreted as grazing land for stock (ibid, 95). The period of greatest prosperity in the fens appears to have been from AD 120 to 270. Whitworth argues that the arrangement of estates stems evident in the Roman period may stem from Iron Age times and that this may also have formed the basis of Anglo Saxon settlement that followed (ibid, 98).

Much of the Roman period coincided with a period of marine transgression and the first recorded attempt to control the waters of the Lincolnshire Marsh took place at this time, with the construction of the Fosse Dyke, which connected the rivers Trent and Witham (Bennet and Bennet 1998, 72). The Car Dyke was also constructed around the inner edge of the Fenland (ibid), which connected the region with the river Whitham (Van de Noort 2004, 74). No evidence has been discovered to indicate that the Romans attempted to prevent the sea inundating the Outmarsh (Tann 2004, 18). The sea level was 20ft lower then than it is today and the coastline between Mablethorpe and Skegness was half a mile further to the east than it is now (Bennet and Bennet 1998, 72). The offshore banks and shoals that had previously protected the coast began to erode (ibid; Van de Noort and Davies 1993) and sea level started to rise in the 2nd century AD. The peatlands and Isle of Axholme also began to form at this time (Bennet and Bennet 1998, 72).

Settlement of the marsh area must have been associated to some extent with the salt making industry, which continued into the Roman period, although there is evidence that the industry may have been on the wane by the end of the early Roman period (Whitwell 1992, 49). It is difficult to tell the difference between Iron Age and Roman briquetage and only a few definite Roman salt making sites have been recorded on the HER/NMR (Sites 96 and 109, Fig 2.6, Site 158, Fig 2.7). The existence of a number of Roman settlements, in what had previously been saltmarsh, has been interpreted as evidence that the nature of salt production in the marsh had changed (Van de Noort 2004, 76). Van de Noort argues that salt making in the Roman period was a long term interest, in contrast to the Iron Age, as marine transgression focused salt production around the deepest tidal creeks and any adjacent settlement would have been less prone to flooding than Iron Age predecessors. It would, therefore, be possible to have a year round salt trade (Van de Noort 2004, 77).

Much of the area was permeated by creeks in the early part of the Roman period as many salterns, which are now far inland, were arranged along their banks (Whitwell 1992, 96). For instance, a large number of saltern sites are known or suspected in the region of Hogsthorpe and Addlethorpe. Research into the Roman saltern at Holbeck, St James suggests the flow of sea water through channels was regulated by a simple sluice (Van de Noort 2004, 74). The process for producing salt in the Roman period was as follows: at spring tides sea water was directed into pans from salt water creeks. The water was then allowed to evaporate and the salt crust and underlying clay was then scraped off and thrown on an open fire (Whitwell 1992, 118). This separated the salt and clay, which was then mixed with fresh brine to make a concentrated solution. The solution was then boiled in clay vessels on a hearth; the resulting salt was then formed into blocks (Whitwell 1992, 118).

The occupation sites recorded along the coast may have been the living quarters of those who operated this industry, and also the fishers and fowlers (Whitwell 1992, 92). Most of the sites recorded close the coastline are chance finds, pottery scatters and possible occupation sites. For instance, an occupation site dating to the 4th century was recorded at Mablethorpe beach, consisting of huts, pottery and a coin hoard (Site 7, Fig 2.1). A further two possible occupation sites were seen at Ingoldmells on the beach (Sites 107 and 118, Fig 2.6) and a number of pottery scatters and coin finds were recorded in the same area (Sites 124, 157, Fig 2.7, Sites 92 and 109, Fig 2.6). Further pottery finds indicative of settlement activity were found at Huttoft (Sites 45–47, Fig 2.3), Anderby (Sites 51, 52 and 54, Fig 2.4) and Chapel St Leonard's (Sites 61, 63, 68, 74 and 79, Fig 2.5, Sites 83, 84 and 86, Fig 2.6).

Lots of Roman sites in Lincolnshire demonstrate trade with other parts of Britain, but there are also industries intended for the local population. One of the earliest pottery kilns known in the county was found in Dragonby and dates to the 1st century. There are two distinct types of local pottery, Dales and Parisian Ware, both produced at Market Rasen. A type of Dales ware is recorded from a number of sites along the coast of north Lincolnshire and so a kiln source in that area is likely (Whitwell 1992, 107).

In medieval times long stretches around the Wash were embanked to keep the sea out and this may also have happened in the Roman period, but the Roman coastline is now under the sea and so all the evidence has been lost (Whitwell 1992, 96). Other banks which still exist have since been shown to be of Saxon or medieval construction (ibid).

3.2.3 Saxon

The Romans abandoned Lincolnshire in the 5th century and by the later 6th century the Anglo Saxons occupied Britain (Bennett and Bennett 1993, 22). Their communities are evident in Lincolnshire through observing the widespread cemeteries that have been found (ibid), which also appear to suggest that the invaders came in small groups (Sawyer 1998, 39). The location of Anglo Saxon settlements, however, is poorly understood and they may have been focused on the uplands (Bennett and Bennett 1993, 22). Finds of Ipswich ware along the coast may indicate some sort of trade by this period (ibid). There may have been a number of Anglo Saxon settlements in the Middlemarsh, as indicated by place name evidence (Van de Noort and Davies 1993, 23). This may suggest that the Outmarsh was not suitable for settlement at this time (ibid). Indeed, there are only two entries in the study area that date to the Saxon period. A wattle hurdle was exposed on the tidal flats at Sutton on Sea in 1995, after the beach was replenished (Site 26, Fig 3.2) and some pottery was found further inland at Sutton on Sea in 1992 (Site 31, Fig 3.2).

Despite the lack of archaeological evidence, it is thought that many of the nucleated villages of Lincolnshire came into existence in the early Anglo Saxon period (Van de Noort and Davies 1993, 23). By the time of the Domesday survey, a dyke had been constructed between North Cotes and Saltfleet, and much of the salt marsh had been reclaimed (ibid).

There is very little documentary evidence for Lincolnshire prior to the Norman Conquest. Sources that do exist indicate that between the 7th and 11th centuries, Lincolnshire was divided between two dioceses, Lindsey and Leicester (Sawyer 1998, 2). The first historical reference to Lincolnshire occurs in Bede's Ecclesiastical History, which indicates that by the 620s the northern part of Lindsey was subservient to Northumbria and Mercia (Bennett and Bennett 1993, 22). The 7th century was dominated by conflict between the Mercian and Northumbrian kings as they struggled to gain supremacy (Sawyer 1998, 56). By the end of the century the king of Mercia was overlord and Lindsey remained under Mercian control for 200 years (ibid).

By the 9th century, the political structure of Anglo Saxon Lincolnshire was beginning to disintegrate, in the wake of the Viking raids (Sawyer 1998, 96). Scandinavians probably began to settle permanently in Lincolnshire in 877 when, according to the Anglo Saxon Chronicle, some sections of the 'great army' shared out part of Mercia (ibid, 97). From the late 9th century onwards, there is evidence for extensive

Scandinavian influence in the county, shown through place names, the names of individuals and moneyers on coins (Bennett and Bennett 1993, 22). At this time, Lincoln and Stamford became Danish boroughs and had the territories of Lindsey, Kesteven and Holland assigned to them (ibid, 38). It was not until the English reconquest with the campaigns of Edward the Elder, King of Wessex, and Aethelflaeda, lady of the Mercians, between 910 and 921, that Kesteven and Holland were assimilated into a united England (ibid). Lincoln and Lindsey remained part of the still independent Danish Northumberland until 927.

With the submission of York in 954, an integrated system of local government was introduced. The whole of Lincolnshire was divided into wapentakes. New royal courts were set up in each and charged with the collection of taxes through a network of twelve carucate hundreds, a system of frankpledge where villages were responsible for the behaviour of their members (ibid). The nineteen wapentakes in Lindsey were assigned to Lincoln and the fourteen in Kesteven and Holland to Stamford (ibid). Neither borough was autonomous; both were joined to Leicester, Nottingham and Derby to form a confederacy of the Five Boroughs under the control of an ealdorman. This was designed to divorce the Danes of the East Midlands from their kinsmen in a still unstable north, by fostering a sense of separate interest and identity. It was, however, foiled when Swein invaded in 1013 as the East Midlands sided with the invaders and the north. The shire of Lincoln emerged when the territories of Lincoln and Stamford combined under a single Earl, directly accountable to the king. This structure formed the framework of local government throughout the medieval period (ibid).

The Danish invasions of the 9th and 10th centuries stimulated urban growth in the region for the first time since the Romans left (Bennett and Bennett 1993, 42). Lincoln became one of England's major towns and developed an international trade in wool, cloth, and regional markets in manufacture of goods like pottery, metalwork and leather (ibid). It is not known whether the earlier salt industries of the Iron Age and Roman periods continued into the Saxon period, but Domesday shows that the industry was equally well established in 1086. It is not known what happened in the interim period (ibid, 28).

The landscape along the coast changed considerably during the Saxon period, for instance, The Wash was much larger in the 11th century than it is now (Sawyer 1998, 12). It has been suggested that the Saxons invaded during a period of high sea level and that coastal regression began after this, during the 7th century (ibid). By the 9th century, the coastline was approximately 2km east of its present day location and the rising sea levels began to produce beaches from the glacial sands on the offshore banks (Posford Duvivier 1992, 6). It has been suggested that one or two stations in the system of Saxon shore forts were lost off the Lincolnshire coast as a result of post-Roman erosion (Whitwell 1992, 136).

3.2.4 Medieval

By the medieval period, Lincolnshire was composed of three parts, Lindsey, Kesteven and Holland. Lindsey, the most ancient of the three with its Anglo Saxon origins, was divided into north, south and west ridings (Bennett and Bennett 1993, 28) (Fig 10). The Norman conquest of 1066 brought with it the construction of many castles in Lincolnshire. Almost all were established in the first 100 years of the conquest, the earliest of which were in Lincoln and Stamford, built for the king in 1068 as regional

strongholds (Bennett and Bennett 1993, 40). Some of the earlier Anglo Saxon sea-banks were linked after the conquest to form the earliest sea banks.

Trade and industry blossomed in Lincolnshire in the medieval period. For instance, because of its proximity to the River Witham, Boston grew within a century from rural fair into one of the greatest medieval towns in England (Bennett and Bennett 1993, 42). By the 13th century, there were few places in Lincolnshire that were further than 5 miles away from a market. There were twenty settlements on the Lincolnshire Marsh that received market charters in the medieval period, but only Barton, Grimsby, Louth and Alford developed into towns (Van de Noort 2004, 146). Lots of moated manor houses were also built, mostly between 1250 and 1350 (Sites 15, Fig 3.1 and Site 131, Fig 3.7) (Van de Noort 2004, 146). By the 14th century, Lincolnshire had become a county of market towns (Bennett and Bennett 1993, 42).

A large number of monasteries were also founded during the 12th and 13th centuries (Van de Noort 2004, 140). At the time of the Dissolution over 40 ecclesiastical establishments were recorded in the wetlands, which reflects the Norman practice of establishing abbeys, monasteries and priories in remote areas. The most prominent Abbeys in Lincolnshire were Selby Abbey, Thornton Abbey in the Lincolnshire Marsh and Meaux Abbey in the lower Hull valley (ibid). Thornton Abbey was founded in 1139 by William LeGross, the Count of Aumale, and raised to the status of abbey in 1148 (ibid, 141). Thornton went on to become one of the richest Augustinian houses in the country (ibid). The wealth of such houses came directly from wetland exploitation.

In the 13th and 14th centuries the Lincolnshire coastline was dotted with many small ports and havens, many of which are now many miles from the sea (Bennett and Bennett 1993, 56). The shape of the coast has changed beyond recognition since the medieval period, as has the navigability of the rivers (ibid). The main port of Lincolnshire in the medieval period was at Boston, through which all shipments of wool were supposed to pass on their way to Calais. Until the end of the 13th century, Boston exported more wool than any other port in England. Many Lincolnshire ports also had their own seasonal fishing fleets. For instance, by the 14th century Saltfleet was sending the largest Lincolnshire fleet to the herring fares of Scarborough and Yarmouth (Bennett and Bennett 1993, 56). In 1343, thirteen Saltfleet fishing boats went to Yarmouth laden with local salt for sale and returned with a cargo of salted herrings (ibid) (Fig 11).

Of the 2,300 place names found in the Lincolnshire Domesday, only 790 can be linked with a settlement that exists today. This demonstrates that many settlements in which previously existed in the Wolds and coastal marsh have since disappeared (Bennett and Bennett 1993, 34). Documentary sources indicate that over twenty settlements were deserted and turned to pasture, indeed many DMVs are recorded on the HER, some of which are captured within the study area (for instance at Sites 31 and 39 Fig 3.2, Site 75 Fig 3.5 and Site 174 Fig 3.1). It is thought the villages were abandoned due to the black death, soil exhaustion and the enclosure movement (ibid, 52).

Before the 13th century the Lincolnshire coast was protected from the open sea by offshore islands and gravel shoals (Bennett and Bennett 1993, 8). Once these had been eroded and consumed by the sea the coastline began to retreat rapidly (ibid). The 12th to 14th centuries were characterised by a number of severe storms (Van de Noort 1993, 24), during this time sandy storm beaches built up and the havens were

gradually abandoned. Coastal erosion was severe and many churches and villages were lost to the advancing tides (ibid). For instance, the earliest recorded flood was in 1253, which affected settlements at Hannah cum Hagnaby and Alvingham (Tann 2004, 22). Another flood in 1287 affected coastal settlements including Mablethorpe and destroying its church (ibid). Mablethorpe along with Maltby in the Marsh were hit by another flood in 1288, again destroying the church (ibid). Other flood events in following years caused the destruction of the church at Sutton and the flooding of land in Ingoldmells (ibid). One of the many effects of the regular flooding appears to have been that inland grazing was reduced to summer grazing (Bennett and Bennett 1993, 72) and the peatlands became 'foule and flabby quagmires'.

A combination of air photography, documentary sources and archaeological fieldwork has indicated the presence of many small plots associated with former villages, which appear to run up to the former limits of drained land (Tann 2004, 23). Arable cultivation has left its mark on the landscape in the form of fields of ridge and furrow, for instance at Sites 22 (Fig 3.1), 37 (Fig 3.2), 184 and 197 (Fig 3.7) (also see medieval field systems on Figs 3.1 to 3.8). Steady accretion occurred in the later medieval period, along the coast from Boston towards Wainfleet and the Marshchapel Somercotes area (Bennett and Bennett 1993, 28). The process of land reclamation can be traced by studying the successive sea banks (ibid). As the sea level rose and land became less suitable for crops, use of land as pasture for grazing would have become more prevalent (for instance, at Sites 179 Fig 3.5, Sites 193 and 195 Fig 3.6) (Lindsey arc 24).

The salt making industries, known from the earlier periods, were re-established and flourished along the Lincolnshire coast (Bennett and Bennett 1993, 28). A number of salterns were recorded all over the county in Domesday (ibid). Some of these apparently belonged to villages situated well away from the sea, such as Maidenwell and Fotherby. It is thought that these places possessed holdings in the marsh area to the east. As the marshes accumulated, the saltmakers moved to remain close to the salt water. Eventually, many estuaries along the coast, such as at Saltfleet, Wainfleet, Wrangle and Fleet silted up and were closed off. Biker Haven dwindled to one channel and the medieval salt making sites in the area are now up to 15km from the sea. Salt making sites recorded on the HER/NMR include a possible salt making site on the foreshore at Chapel St Leonard's (Site 62, Fig 3.5), salt pans and pottery found just below high water mark nearby (Site 85, Fig 3.5), probable saltworks were seen as earthworks (Site 178, Fig 3.5) and numerous salt making sites at Ingoldmells (Sites 89, 90, 102, 110, Fig 3.6). Medieval activity is also evidenced on the coast by a number of isolated finds, including pottery at Mablethorpe and Trusthorpe (Sites 7 and 12, Fig 3.1), pottery at Huttoft and Anderby (Site 44, Fig 3.3 and Site 50, Fig 3.4), pottery at Chapel St Leonard's (Site 73, Fig 3.5) and Skegness (Site 142, Fig 3.8).

Massive mounds of waste soil formed along the coast, as a result of salt production, which changed the shape of the surrounding landscape and influenced the nature of future landuse (Sawyer 1998, 15; Bennett and Bennett 1993, 28). For instance, many of the earliest mounds, along the former medieval shoreline, went on the have churches built on them, such as Tydd St Mary, Gedney in South Holland, Marshchapel, Grainthorpe, Conisholme and north Coates in Lindsey Marsh (Sawyer 1998, 15). Other old salt hills are less easy to identify, but could be present in fields which display irregular hummocks. There are many examples where such fields adjoin a church which is itself on slightly raised ground, like at Skidbrook, Saltfleetby St Peter, Theddlethorpe All Saints, Croft, Thorpe St Peter and Friskney (Sawyer 1998,

15). Such mounds are often located close to an early sea bank (Bennett and Bennett 1993, 28).

The process of salt making in the medieval period differed from that in the Iron Age and Roman periods. Salt laden sand was filtered and the resulting brine was boiled (Van de Noort 2004, 151). Documentary sources record three main phases of production: collection, filtration and evaporation (Bennett and Bennett 1993, 28). Salt producers rented their salt making areas and a grant of peat digging rights often accommodated the lease (ibid). The process was carried out during the summer months and a payment of salt was made to landlords at Midsummer and Michaelmas time (ibid). The salt makers also owned smallholdings and had other sources of income and kept animals like geese and sheep. In Lindsey the saltboiling industry died out in the early 1600s, but in other parts of Britain it carried on until the 18th century. One the reasons for the decline was the importation of better quality salt from the Bay of Biscay (ibid).

As well as salt production, the inter-tidal areas continued to be used for seasonal grazing, fishing and fowling in the medieval and post-medieval periods (Van de Noort 2004, 151).

3.2.5 Post-medieval–modern

In the 16th century the manorially dominated village was superseded by the parish, although the medieval wapentake remained (Bennett and Bennett 1993, 38). This structure was to survive into the 19th century.

The floods of the medieval period continued throughout the post-medieval period, causing widespread damage (Tann 2004, 26). For instance, serious flooding occurred in Skegness in 1517 and 1526 (ibid). Mablethorpe church and its parish was largely lost in 1540s, along with a chapel at Saltfleet (ibid). Further coastal churches were lost in 1570 at Sutton, Chapel St Leonard's and Trusthorpe (ibid). Parts of the Outmarsh were still being reclaimed, a process which had continued from the medieval period. Between Mablethorpe and Ingoldmells, however, the sea regularly encroached valuable settled land (ibid). Serious measures began to be taken to prevent the destruction of further settlements, such as the construction of more sea banks. For instance, the Skegness and Winthorpe sea bank, known as Roman Bank, was completed 1574 (Site 113, Fig 3.6) (Tann 2004, 27).

Another important activity to take place the post-medieval period, which went a long way towards keeping floods at bay, was the draining of the marshes. The first attempt at drainage took place in 1626 when Sir Cornelius Vermuyden planned to drain the marsh land along the coast (Bennett and Bennett 1993, 72). This venture wasn't successful at first and eventually others took over the process. By 1660 17,374 acres from Gedney and Moulton had been embanked and Biker Haven had been cut off from the sea (ibid). John Rennie was the engineer who made the most impact in the early 19th century, with the drainage of c 40,000 acres (ibid). Other attempts at reclamation took place, for instance in 1630 at Donna Nook and in 1770 when the Louth Navigation Canal was opened, linking Louth with the North Sea (Van de Noort 1993, 24) (Fig 12).

By the 19th century, the gradual improvement and reconstruction of the defences began to stabilise the advance of the sea, between Mablethorpe and Skegness (Posford Duvivier 1996, 6). There were still floods in the 19th century, however, due to failure

of the sea banks (ibid, 17). For instance, in 1837 flood water rose by 8' 9'' above ground level around Winthorpe Church and in 1833 sea defence works were required at Sutton and Trusthorpe (ibid). These episodes of flooding continued into the 20th century, culminating in the massive storm surge of 1953, during which water flowed inland for 10km (ibid). The defences were rebuilt and strengthened as a result of this disaster and were able to withstand further storms in 1976 and 1978 (ibid, 18). Today coastal erosion is controlled by defence strategies such as the massive sea wall from Mablethorpe to Skegness (Bennett and Bennett 1993, 8). There has been a general advance in the high water mark between 1880 and 1970, but between Saltfleet and Donna Nook the low water mark has been retreating (Posford Duvivier 1996, 13). The coastal map regression on Figs 12 to 19 shows the changing coastline over the post-medieval period.

Most of the post-medieval entries recorded on the HER/NMR relate to standing buildings and World War II coastal defence structures such as pillboxes. There are also wrecked Second World War aircraft (in Sites 172, Fig 3.1 and 189, Fig 3.5). Other features include extraction pits, for replenishing the coastal banks (Sites 24 Fig 3.2 and 69, Fig 3.5). Numerous ship hulls are also recorded, some of which floundered but others of which were deliberately beached for local dismantling industries (Lindsey arc, 29) (Sites 5, 6, 8, 172 and 173 Fig 3.1, Sites 23, 27 and 175 Fig 3.2, Site 177 Fig 3.5, Sites 180, 203 and 204 Fig 3.6 and Site 186, Fig 3.8). Most of the wreck sites were buried when the beach was replenished.

4 Archaeological potential along the Lincolnshire coast

Previous archaeological and geological analysis along this stretch of coastline has indicated that there is a high potential for the discovery of remains dating from all periods. Work undertaken by the Humber Wetlands Survey (van de Noort and Davies 1993) and the Lindsey Archaeological Services (Brooks 1990 and Tann 2004) has shown that Prehistoric landscapes and fragments of Roman and medieval landscapes are still preserved under a thick layer of marine silts along the coast. Prior to the beach replenishment, deposits and artefacts relating to these landscapes were continually eroded out of the clay, which underlies the beach deposits. Even since the beach replenishment, archaeological material is still eroded from the underlying geological strata of the beach, during episodes of severe erosion like storm events.

4.1 Prehistoric

4.1.1 Palaeolithic

There are only two recorded findspots of this date in the study area: a Lower Palaeolithic blade found on the foreshore at Huttoft Bank in 1996 (Site 48, Fig 2.3) and a Palaeolithic mammoth tooth, found on the beach at Ingoldmells in 1973 (Site 98, Fig 2.6).

Despite the low volume of recorded artefacts, there is a high potential for the survival of Palaeolithic archaeological deposits and artefacts, beneath the replenishment material, along the coast between Mablethorpe and Skegness.

4.1.2 Mesolithic

There are no findspots dating to this period known from the study area.

Despite this, there is a high potential for the survival of Mesolithic archaeological deposits and artefacts, beneath the replenishment material, along the coast between Mablethorpe and Skegness.

4.1.3 Neolithic

The remains of the Neolithic forest, most often exposed at Huttoft, are present along considerable stretches of the coastline.

Seven Neolithic artefacts have been discovered at various locations along the coast, mostly stone axe heads.

There is a high potential for the survival of Neolithic archaeological deposits and artefacts, beneath the replenishment material, along the coast between Mablethorpe and Skegness.

4.1.4 Bronze Age

It is thought that the Outmarsh area was used as a burial ground during the Bronze Age, evidenced by the group of Bronze Age burials at Butterbump. Another burial

site, within the study area, was indicated when at human remains were eroded from the beach at Ingoldmells in 1983 (Site 159, Fig 2.7).

Another six isolated findspots were made in the study area, including pottery, flint scrapers and daggers.

There is a high potential for the survival of Bronze Age archaeological deposits and artefacts, beneath the replenishment material, along the coast between Mablethorpe and Skegness.

4.1.5 Iron Age

The Lincolnshire coast was an important centre for salt production during the Iron Age, and most of the nineteen HER entries in the study area relate to this industry.

There is a high potential for the survival of Iron Age archaeological deposits and artefacts, beneath the replenishment material, along the coast between Mablethorpe and Skegness.

4.2 Roman

There were Roman settlements situated along the coast in the Roman period and it is thought that some of these may have been associated with the salt making industry, which continued from the Iron Age into the Roman period.

There are 30 HER entries, which date to the Roman period, most of which were discovered on the foreshore.

There is a high potential for the survival of Roman archaeological deposits and artefacts, beneath the replenishment material, along the coast between Mablethorpe and Skegness.

4.3 Saxon

The location of Saxon settlements is not well understood but place name evidence indicates that some may have been located in the Middlemarsh. This has been interpreted as evidence that the Outmarsh may have been unsuitable for settlement at this time (Van de Noort and Davies 1993, 23).

The Anglo Saxon coastline was 2km further east than today, and so some sites may be buried in the inter-tidal area. This is evidenced by the fact that a wattle hurdle was exposed on the tidal flats at Sutton on Sea in 1995 (Site 26, Fig 3.2).

There is a medium potential for the survival of Saxon archaeological deposits and artefacts, beneath the replenishment material, along the coast between Mablethorpe and Skegness.

4.4 Medieval

The marsh lands were settled in the medieval period and the coastline was dotted with many small ports and havens. The shape of the coast has changed beyond recognition since the medieval period, however, with many of the former ports now many miles

from the sea (Bennett and Bennett 1993, 56). Other areas of the medieval coast are now below sea level, as regular flooding affected the coast between Mablethorpe and Skegness (Van de Noort 1993, 24).

The salt making industry was re-established during this period. Out of the 37 sites recorded on the HER within the study area, seven are saltern sites. The other entries, from the beach area, are all pottery scatters.

There is a medium potential for the survival of medieval archaeological deposits and artefacts, beneath the replenishment material, along the coast between Mablethorpe and Skegness.

4.5 Post-medieval–modern

Most of the post-medieval entries on the HER, which are situated on the beach or inter-tidal areas, are World War II coastal defence structures and wreck sites.

There is a high potential for the survival of post-medieval ship wrecks, beneath the replenishment material, along the coast between Mablethorpe and Skegness.

5 Licensed dredging areas 107 and 440: geological and archaeological background

5.1 Introduction

This section will provide an overview of the archaeology of the North Sea, in the wider area around licensed extraction areas 107 and 440, which were used as a source of replenishment material for the Mablethorpe to Skegness coastline.

Parts of the North Sea floor were dry land during the prehistoric period and most of the geological and archaeological background outlined in Section 3 is also directly relevant to this section. The submerged landscape of the North Sea basin has, however, been subject to different environmental processes than that of the Lincolnshire coast. Its geology and archaeology will, therefore, be studied in relation to taphonomic processes. The exact location and composition of geological and archaeological deposits under the North Sea is not well understood. As a result it has been necessary to consider a wide geographic area in order to fully assess the potential of what is a comparatively small area.

5.2 Geology and topography

The North Sea is a relatively shallow part of the UK continental shelf, with water depths almost everywhere less than 50m (Humphreys et al 1996, 83). North of Flamborough Head, the sea floor slopes steeply from the coast and the 50m isobath is between 10km and 30km offshore (ibid). South of Flamborough Head, the shelf is entirely shallower than 50m except for several elongated valleys or pits (ibid). The largest of these is the Silver Pit, which is orientated north–south and lies approximately 35km off the Humber Estuary (ibid). There are also many sand banks off the east coast, some of which are over 20km long, between 2m and 3m wide and 15–20m higher than the surrounding sea bed.

The North Sea floor was shaped mainly during the last (Devensian) glaciation (Flemming 2004, 85). The solid geology of the sea floor off the Lincolnshire coast, stretching out as far as licensed extraction area 440, consists of chalk and flint (BGS Spurn sheet 53°N–00°). The solid geology is overlaid by Quaternary deposits, known as the Boulders Bank formation (ibid). This Pleistocene till lies very close to the sea bed surface, under a thin veneer of sediments, and stretches for very wide areas, well beyond the extents of areas 107 and 440 (Flemming 2004, 85). The till offshore from Lincolnshire is less than 5m thick, but thickens towards the coast to up to 20m in places. The layer is generally even or gently undulating. There are also topographic features in this area including incised palaeovalleys, submerged cliff lines, enclosed deeps and sediment cover, such as sand ridges and sandbanks (Humphreys et al 1996, 83).

The sand bank systems off the Lincolnshire coast were all formed during the last ice age. For instance, the Theddlethorpe Overfalls form part of the terminal morraine, that

once stood at the edge of the retreating Devensian ice sheet (Environment Agency 2004, F27). The retreating ice sheet also deposited silts to form the Docking Shoal bank (Posford Duvivier 1996, 6). The immediate offshore area is relatively flat with the most prominent feature being the Inner Dowsing bank (Environment Agency 2004, F.27). Areas 107 and 440 lie on the eastern edge of the ancient river valley known as the Silver Pit (Fig 20). Area 107 in particular is in very close proximity to the river valley. Immediately to the south-east is Docking Shoal bank while Race Bank lies to the east. The sea bed sediments within Area 107 are a mixture of sandy gravel, gravely sand and slightly gravely sand (Fig 20). Within Area 440 sediments consist entirely of sandy gravel (Fig 20).

Not much is known about the composition of all the areas of the North Sea floor as few samples have analysed in terms of their archaeological potential (Flemming 2002, 15). Those that do exist show that not all of the offshore banks are ancient, as some are hydrodynamic bedforms created by modern tidal currents (ibid). The banks that have been sampled and found to contain ancient deposits do not lie in the immediate study area. For instance, the Dogger Bank, situated much further to the north off the coast of Northumberland, is comprised of Pleistocene and Holocene deposits (ibid, 17). Brown Bank, which lies much further south below East Anglia, and close to Holland in Southern Bight, also has eroded Pleistocene deposits (ibid) (Fig 21). Tens of thousands of Pleistocene mammal fossils have been recovered from these particular areas of the North Sea floor (van Kolfschoten and van Essen 2004, 72; Glimmerveen et al 2004, 43) (Fig 22).

Drees' map (Fig 23) reveals that all the locations where concentrations of mammal fossil remains have been found are well to the south of the study area, mainly between Brown Bank and Deep Water Channel (van Kolfschoten and van Essen 2004, 72). Many of the remains around the Brown Bank are perfectly preserved and complete or partial skeletons have been recovered, indicating a lack of secondary transport (Glimmerveen et al 2004, 45). Trawler operators state that the bones are dredged up in gullies around the Brown Bank, in a 25km zone west and south-west (Flemming 2002, 35). Many thousands of fossils have also been found in the Dogger Bank area and reports suggest that the finds have been trawled from the upper surface of the bank. Flemming questions the accuracy of this observation, however, and argues that a more likely location would be the far richer environment around the vast lagoon that existed to the south of Dogger from c 8,000 to 7,000 years BP (ibid, 33). At around 7,500 BP there was a shallow sea basin c 5m deep and 90 nautical miles in diameter in this area. The basin was connected to the North Sea, to the north-west, by a narrow channel, now the Outer Silver Pit (ibid, 33) (Fig 24).

At around 7,000 BP shorelines were more or less at the same position that they are now. This means that terrestrial mammals could only live in the North Sea basin area during the early Holocene, in other words prior to 8,000 BP and, therefore, before the introduction of domestic animals into the area. This explains why the number of Holocene remains and variety of species found in the North Sea is restricted. Early hominids entered central and north-west Europe during the early mid Pleistocene. The North Sea faunal remains, therefore, date from a period when hominids were present in Europe (van Kolfschoten and van Essen 2004, 79). Indeed, some of the bones from the North Sea had been modified by humans into artefacts (ibid).

5.2.1 Prehistoric

The North Sea floor was dry land throughout the Devensian glaciation (22,000 years BP) until the Mesolithic period (around 8,000 BP). From this time onwards sea levels gradually rose and eventually cut the British Isles off from the rest of mainland Europe. The North Sea floor, therefore, has the potential to contain a substantial part of the evidence for the human occupation of north-western Europe (Flemming 2004, 18). It was only during the Palaeolithic and Mesolithic periods, however, that the North Sea basin would have been a habitable environment for early human societies. This means that the archaeology of the North Sea floor dates mainly to the early prehistoric periods, apart from a few chance finds and shipwrecks from later periods.

Only the Palaeolithic and Mesolithic periods are considered in this section, along with evidence from the post-medieval period (shipwrecks).

5.2.1.1 Palaeolithic

Evidence for the Palaeolithic occupation of Europe discovered so far is very disparate, but nonetheless gives enough clues to piece together the likely movements of early human societies in Northern Europe. The earliest proto-human and human migrations are all intimately related to the different extents of the ice fronts in glacial periods. For instance, some of the earliest hominid occupation sites in the UK are Boxgrove at 700,000 BP and Pontnewyyd cave near the North Wales coast at 225,000 BP (Flemming 2005, 20). Sites like these indicate that the British Isles were occupied during the milder periods between the ice ages (ibid). Populations would have been forced out of the area during glacial peaks, although there is much debate as to how close to the ice caps people could survive (ibid, 2). Evidence from the Arctic North of Russia indicates human occupation in close proximity to the ice cap. The excavation of Paviland cave in South Wales shows people were living close to the ice edge during the glacial maximum. Submerged Palaeolithic sites such as that at Fermanville off Cherbourg show that people were living 20m below current sea level at around 45,000 BP (ibid, 2).

When the ice melted, between 20,000 and 10,000 BP, the people who had been living on the continental shelf, northern France and Western Europe moved northwards. By 12,000 BP Denmark, Norway and Britain were occupied by Late Palaeolithic societies (ibid, 22). Most of the early evidence for human development is, therefore, buried under the North Sea.

No actual occupation sites or findspots have been identified in either of the licensed extraction areas, or even in close proximity to them. The lack of physical evidence may simply be due to the fact that deposits lie buried under metres of sediment. It is likely that the occupation sites of Palaeolithic people were concentrated in the previous river valleys of the North Sea basin (ibid, 2).

5.2.1.2 Mesolithic

The Late Palaeolithic societies of Northern Europe expanded rapidly during the Mesolithic period (Flemming 2005, 3). Most of the evidence for Mesolithic Europe comes from submerged sites in the Danish archipelago, where it has been demonstrated that the settlers combined a coastal existence, of seafaring and hunting, with excursions in land (ibid). The survival and discovery of these sites has been due to the particular topographic and coastal conditions of this area. The ocean floor is

protected from the open sea by the surrounding topography and sites are regularly discovered and accessible to divers because they not buried under metres of marine silt. This is because sediment load transport by rivers is very limited, leaving archaeological material close to the surface (Flemming 2002, 31). Sites have yielded finds like worked flints, fish traps, fish weirs, wattle fencing, dugout canoes, ornaments of carved antler and trade goods from central Europe. Fireplaces were also found complete with charcoal (ibid, 29). The evidence demonstrates intensive occupation of the Danish coastline between 8,000 and 4,000 years BP (ibid).

Analysis has indicated that many families were living together at these coastal sites, while the inland sites were more likely outposts for foraging in the hinterland. It has also been shown that land was densely forested at this time with lime, oak, elm, ash and hazel (ibid). It has been suggested that the Danish archipelago could serve as a good model for what the Mesolithic coastline of the UK might have been like (Flemming 2002, 33).

No Mesolithic sites or buried landscapes/occupation sites have been discovered in close proximity to licensed extraction areas 107 and 440, but this may simply be because they are still buried under metres of sediment. Mesolithic finds are known from other areas of the North Sea basin. For instance, a submerged Mesolithic peat landscape, dated c 8,500 years BP, was identified between the Leman and Ower Banks, much further to the east. A barbed weapon was trawled up here in 1931 (ibid, 34).

5.2.2 Post-medieval

The evidence from this period relates entirely to wrecks of ships and aircraft. The NMR records many shipwrecks off the Lincolnshire coast, some of which are located in close proximity to extraction areas 107 and 440 (Fig 20). Most of these are English vessels lost during the 1800s and 1900s, but there area also vessels from other parts of Europe like Italy (Site 201), Norway (Sites 202 and 203), Poland (Site 202), Germany (Site 203) and Russia (Site 164). The wrecks of Second World War aircraft are also recorded from this area; for instance, four bombers (Site 203) and a Spitfire (Site 201).

6 Archaeological potential in dredging areas 107 and 440

6.1 Factors determining archaeological potential

Submerged archaeological deposits are subject to complicated taphonomic processes, which may change slowly or quickly through time depending on prevailing environmental conditions. Sites may be covered by metres of sediment, which may protect them, or they may be eroded by ice, rivers, surf action, bottom action of storm waves in shallow water, tidal currents, chemically altered or distributed by trawling and dredging (Flemming 2002, 12). Conditions in the North Sea are particularly harsh, with stormy conditions, strong winds and big waves from the Atlantic (Flemming 2004, 11). There is a very active sand transport pattern with fields of sand waves moving slowly like sand dunes in the desert (ibid).

Tidal and wave induced currents have been responsible for extensively reworking seabed sediments on the North Sea floor over millenia. Many different actions have caused different sediment types to be deposited/redeposited. For example, in some areas strong tidal regimes have caused the growth of sand banks, whereas in lower energy environments, such as sheltered bays and offshore deeps, thick deposits of fine sediment has tended to accumulate (Flemming 2004, 84).

It is possible to identify areas of the North Sea that may have the potential for archaeological survival (Flemming 2004, 11), but there is no guarantee that deposits concealed in these areas will ever become exposed. The areas of greatest potential are fossilised estuaries and river valleys, peat layers, depressions or basins with wetland or marsh deposits, archipelago topographies (Flemming 2002, 13). Flemming also argues that sand banks with a core earlier than Holocene in date could have formed headlands, promontories, or sheltering islands on the coast. He suggests that closely spaced banks might have had narrow channels between them, perhaps providing shelter and good fishing. The tops of the various banks and ridges would probably not have been inhabited in arctic conditions, as Late Palaeolithic and Mesolithic people would more likely have founded their settlements in the shelter of the ridges and headlands (ibid, 18).

Virtually all of the sites in the North Sea where prehistoric artefacts have been recorded are in low ground or a depression, where scour has removed has removed the usual presence of mobile marine sands (ibid). Some sites of prospective interest are the depressions to the west of Viking and Bergen Banks (to the north of the study area), the extensive depression to the south of Dogger Bank and through Outer Silver Pit (to the north-east of the study area), the depression to the south and west of Brown Ridge (to the south-east of the study area), the depressions and gulleys between the banks of Leman, Ower and Swarte Banks (to the east of the study area). In particular, two large areas of the central North Sea, to the west and south of Dogger and the south-west of Brown Bank are of high potential. Smaller zones in the lee of banks and islands on palaeo-shorelines are potential hot spots (ibid, 20).

Evidence from known submerged prehistoric sites in other seas shows materials are preserved in context most effectively where topographic conditions ensure a local low energy environment and moderate sediment transport or permanent sediment cover

(Flemming 2004, 11). Low energy environments do exist in the North Sea, for instance the estuaries and bays of East Anglia, The Wash and The Humber. In these environments, however, there are also tens of metres thickness of Holocene sedimentation burying the archaeology (ibid, 12). Archaeological deposits are known from other low energy environments, for instance, the submerged Mesolithic site near Bouldnor Cliff, off the Isle of Wight (ibid, 17).

6.2 Prehistoric

The archaeological potential of the coastal study area in the prehistoric period is related to the known extents of the ice caps at any one time, sea levels, sediment type and offshore processes. Flemming notes that studies carried out in Denmark have suggested that there were no human settlements within 100km of the ice front, and that as the ice retreated north, settlers may have followed in its wake (Flemming 2002, 17). During the last three glacial peaks (Anglian, Wolstonian and Devensian) this area of the North Sea floor was under ice, so people would not have been able to occupy the area permanently until after the ice had melted (20,000 to 10,000 years ago) (Fig 25, Fig 26, Fig 27 and Fig 28).

The other important factor to note about this area is that after the ice sheets had melted, a deep river valley known as Silver Pit ran from the area that is now The Wash, northwards towards the area known as 'Doggerland'. This deep river valley may have been an attractive area for settlement during the Upper Palaeolithic. Any archaeological deposits and artefacts related to this activity are, however, likely to be buried under metres of sediment, perhaps concealed deep within the valley, which makes their discovery in extraction areas 107 and 440 unlikely (Flemming, N, C, 2002).

In both of the extraction areas, marine sands and gravels overlie earlier Quaternary deposits. The majority of the sand banks and sediments in this area were laid down during the Devensian ice age, but the upper sea-bed sediments are likely to have been deposited more recently. Based on the current state of knowledge the probability of artefacts and deposits being discovered in these upper deposits may be low, although the discovery of isolated artefacts cannot be ruled out (Flemming, N, C, 2002).

It follows that there is a low risk that artefacts were dredged up and redeposited on the beach during replenishment.

6.3 Post-medieval–modern

The NMR indicates a number of shipwrecks in close proximity to areas 107 and 440. None of these are likely to be disturbed by dredging activities at present, as the remains lie outside the active areas of each of the zones (Fig 20).

There is a low risk of disturbing post-medieval remains in the dredging areas and consequently there is a low risk that remains were redeposited onto the beach between Mablethorpe and Skegness during initial beach replenishment or beach topping up episodes.

7 Coastal engineering along the Lincolnshire coast: history and development

7.1 Introduction

The erosion of the east coast of England has been studied for many centuries, since major storm events were first recorded in the medieval period. Over the past 100 years patterns of erosion along the coast have been scientifically analysed and measured and an understanding of the processes, which lead to certain types of erosion, has been developed.

This section will provide an analysis of coastal processes along the Mablethorpe to Skegness coastline, which ultimately culminated in the beach replenishment project of 1994. The composition of the beach both before and after replenishment took place will be the focus here, along with the processes that were acting upon it over these periods.

7.2 Coastal defence prior to 1994

Before 1953 the coastal defences consisted of natural dunes, clay banks and areas of hard standing (Posford Duvivier 1996, 17). The storm surge of 1953 caused multiple breaches between Mablethorpe and Ingoldmells and flood water and sand was driven in land for up to 15km (ibid, 6) (Fig 29). Following the storm, the breaches in the dunes were repaired with clay and a concrete sea wall was constructed along 19km of the coastline, fronted by timber groynes (Environment Agency 2004, 10). The seawall extends from Mablethorpe promenade to Anderby and is reinforced in places with concrete or rock armour at the toe, particularly at Sandilands and Huttoft Bank (ibid, F31). Between Anderby and Chapel St Leonard's the coastal defences comprise revetments covered by the natural dune system. The sea wall commences again at Chapel St Leonard's from which point it extends southwards to Seathorne (ibid). The strengthened defences were able to withstand further storm surges in 1976 and 1978. During these surges the defences were overtopped but no breaches occurred (Posford Duvivier 1996, 18).

7.2.1 Shoreline Management

Since the storm surge of the early 1950s, the east coast of England has been the subject of a number of different studies aimed at developing an understanding of the complicated processes at work, which lead to erosion and catastrophic storm events. Systematic measurement of the rate and nature of morphological change on Lincolnshire's beaches was first started in 1959, by recording sections of the beach at set intervals each month (Environment Agency 2004, A32). This long term study formed the basis for many subsequent beach modelling projects and reviews, which culminated in the development of the first comprehensive Shoreline Management Plan (SMP) for this area in 1996 (Posford Duvivier).

Shoreline Management Plans (SMPs) were drawn up for the entire coast of England and Wales during the 1980s and 1990s, at the behest of Defra (Posford Duvivier 1996, 1). An SMP is designed to provide a framework for development of sustainable coastal defence policies and set objectives for future shoreline management (Environment Agency 2004, 12). The SMPs separate the English coast into eleven different sediment cells. A cell is defined as a length of coast that is self contained, as far as movement of sand or shingle is concerned, and where interruption to such movement does not have a significant effect on adjacent cells (Posford Duvivier 1996, 1–2). Some of these sediment cells are very large and so have been separated out into sub cells in order that a workable SMP may be produced (ibid). The entire east coast of England falls into cell 2, which has been split into sub-cells. The Lincolnshire coast falls into sub-cell 2c, which extends from Donna Nook, north of Mablethorpe, to Gibraltar Point just, south of Skegness (Fig 30). Sub-cell 2c has been further subdivided into a series of management units (shown on Fig 31).

The boundaries of sub-cell 2c are set at Donna Nook and Gibraltar Point because coastal processes change to the north of Donna Nook (into sub-cell 2b) where there is a drift divide, a point where direction of the coast changes and material moves way in both directions. Coastal processes also change to the south of Gibraltar Point (into sub-cell 2d) where there is a sediment sink, a point at which sediment transport paths meet (Posford Duvivier 1996, 4). Erosion is often the result where there is a drift divide and accretion normally occurs at a sediment sink. Accretion is occurring in both areas, however, as the beaches to the north of Donna Nook are being fed by offshore sand banks (ibid). By contrast, the area between Mablethorpe and Skegness is subject to erosion. The beaches prior to 1994 were narrow and relatively steep with little sand cover for the underlying clay (ibid, 8).

There are also hinterland and offshore boundaries for the SMP. The hinterland boundary includes all land below +5m OD and is largely based on the extent of the 1953 storm surge (ibid, 4). The offshore boundary is located at –10m CD to include nearshore sand bank systems, which have a number of effects on the coastline, including modification of waves approaching the coast and feeding adjacent beaches with sand (ibid, 5) (Fig 30).

In 1993 the National Rivers Authority estimated a sea level allowance, for the Anglian region, of 6mm/year up to the year 2030 (ibid, 11). Between 2030 an 2100, the estimated rise is 8.5mm/year. Coastal defence strategies in this area are based on these long term estimates.

7.2.2 Coastal processes

It has long been observed that the grading of the material on the beaches between Mablethorpe and Skegness varies seasonally. The underlying clay was often exposed and during winter rough seas were responsible for depositing coarse sand and gravel on the upper beach, as finer material was transported offshore. In summer months the beach would recover and finer sand would migrate onto the upper beach (Posford Duvivier 1996, 8).

The erosion of the Lincolnshire coast is caused by high water levels and extreme waves, along with a combination of other factors (ibid, 11; Environment Agency 2004, F27). The convex shape of the coastline exposes it to a number of wave directions. Lack of shelter and long wave fetch lengths extending across the North Sea

means that large waves approach the coast from most directions within the range (ibid, F28). The most dominant waves are from the north-east, however, and these waves are responsible for mobilising sediment and moving it southwards by longshore transport processes (ibid, F29; Posford Duvivier 1996, 8). As a result, the beaches of Lincolnshire have a ridge and runnel formation, orientated in a south-easterly direction and with a tendency to migrate southwards (ibid, 8).

The existence of relatively steep beaches on both the accreting and retreating parts of the Lincolnshire coast also shows that tidal currents play a dominant role in sediment transport. Waves are clearly significant for the local movement of materials over short time scales (Environment Agency 2004, F29). During periods when the waves breaking on shore are of the plunging type, the beach will tend to build up against the beach head. When the waves are of the spilling type, the sand fraction will tend to be pulled offshore. The latter wave type is more prevalent during the winter. The native sand on the Lincolnshire coast (prior to 1994) was generally fine (between 0.1 and 0.3mm) and so more material was pulled offshore by storm events and carried away by offshore currents than could be replaced by longshore drift, ultimately causing erosion (ibid, F30). This trend has caused the beaches to steepen and fall as shoreline retreat is prevented by the presence of the hard defences (Posford Duvivier 1996, 13; Environment Agency 2004, F27).

Wave analysis has shown that the waves generated in the North Sea are modified by the seabed bathymetry as they approach the coastline. For instance, the interaction between sand banks and tidal currents has resulted in turbulent areas such as the Theddlethorpe, Trusthorpe and Protecter Overfalls, situated off the Mablethorpe coast (Fig 30). The tidal regime along the coast is semi-diurnal (water level rises and falls twice a day) (Posford Duvivier 1996, 10). Rising currents flow north to south while ebb currents flow south to north (ibid, 11). The currents are moderate with peak flows of 2 knots on a spring tide (ibid).

Cross shore transport is also evident along the frontage and is related to the daily, monthly and seasonal changes in the tidal regime (Environment Agency 2004, F29). Sediment modelling has indicated a net southerly transport path across Docking Shoal and Burnham Flats, with the potential for some sand exchange between the offshore banks (ibid, F31). Research has shown that a major source of sediment input into the Lincolnshire coast is material derived from the erosion of cliffs along the Flamborogh to Spurn Head coastline, to the north of the Humber Estuary in sub cell 2b (ibid, F28). The majority of that material, along with that eroded from the Lincshore frontage, is transferred to the accretionary spit at Gibraltar Point, just south of the study area (ibid).

Another cause of beach loss has been the erosion of the underlying clay. The North Sea is susceptible to storm surges, during which the thin layer of sand is largely removed from the upper beach and transported offshore (ibid). The clay is then eroded, transported away from the beach and permanently lost. The sand gradually returns but at a lower level due to the clay loss (Posford Duvivier 1996, 13). The levels of the beaches in this area are falling at a general rate of 2cm per year (ibid).

As can be seen the sedimentary regime of this stretch of coast is complex. It has been established that a large anticlockwise circulatory cell operates across the nearshore and offshore region of Lincolnshire, within which smaller scale circulatory cells operate (Environment Agency 2004, F28). Potential sediment inputs to the Lincshore coastal system include longshore drift, foreshore erosion and onshore transport of

sediment. Losses include longshore transport from littoral zone, dune accretion via windblown sand and offshore transportation of material (ibid).

7.3 Coastal defence after 1994

The construction of the concrete sea wall, which currently stretches along the most of the coastline between Mablethorpe and Skegness, was not finally completed until the 1990s (Environment Agency 2004, F28). By this time, however, the erosion of the beaches in front of the wall had become a cause for series concern. New defence options were researched and a beach replenishment scheme was designed, in order to compliment and strengthen the existing defences.

Up until the early 90s regular monitoring had taken place along the shoreline including twice yearly profile surveys at 1km intervals, bathymetric surveys at 4 yearly intervals, annual aerial surveys taken during low water, shoreline inspections of the beach and structures (Posford Duviver 1996, 33). The SMP stimulated that this level of monitoring should continue.

7.3.1 Defence options

In 1991 Posford Duvivier carried out research to identify the most suitable defence option for this line of coast. Several different approaches were considered and 'hold the line' was recommended as the most suitable technical, environmental and economic solution to erosion (Environment Agency 2004, B2). It was concluded that the performance of the existing hard defences could be considerably improved by topping up the eroding beaches in front of it. This approach is known as soft shoreline defence. Soft defences aim to protect coastlines against erosion by dissipating wave energy. The beach replenishment scheme that was designed for the Lincolnshire coastline was the product of years of monitoring and analysis of processes affecting sediment movement along the Lincolnshire coast (ibid).

The standard of defence against overtopping and breaching was 1 in 50 years prior to the replenishment of 1994, with 3% of the total defence length vulnerable to such events. A 1 in 50 year event would result in the inundation of approximately 1,200 hectares of urban and agricultural areas (Environment Agency 2004, 1–2). Although not an emergency situation, this standard was below those recommended in government guidelines (ibid). It was noted that if no action were taken the beaches would be completely eroded after ten years (see Fig 32, Fig 33 and Fig 34). Areas of the defences that are most at risk are shown on Fig 35 and areas that would be affected by flooding if no action taken are shown in relation to various defence standards on Fig 36.

The original sea defence strategy study was based on a 50 year strategy lifetime (Environment Agency 2004, 13). In the strategy review this lifetime was questioned in light of more recent Defra guidance, which stated that the strategy lifetime should be determined by the longest-lived asset of the coastal defences. In this case it is the sea wall, which has a 100 year lifespan. This project is complicated by the fact that beach renourishment is effective at some points along the Lincolnshire coast for as little as a few months, before it has to be topped up. The updated Shoreline Management Plan stated that the two defence approaches (soft and hard) should not be considered separately as erosion causes significant lowering of the beaches,

making the hard defences more vulnerable to failure. Beach replenishment is, therefore, not an independent solution, but one that effectively increases the efficiency and lifespan of the hard defences. With this in mind, Defra have agreed in principle to the 50 year strategy lifespan (ibid).

A review of possible sources for beach nourishment materials was carried out by Posford Duvivier in 1997 and concluded that marine aggregates would be most suitable (Environment Agency 2004, 16). There are six main aggregate dredging regions around the coast: the north-east coast, the east coast, the Thames Estuary, the south coast, the south-west coast and the north-west coast (Humphreys et al 1996, 58). The first four areas are important sources of gravel with sand while the last two are mainly sand only areas (ibid). Research showed that the most suitable sediment types and amounts for the Lincshore project could be found in the Humber region, off the east coast. Licensed extraction areas 107 and 440, in close proximity to the Mablethorpe to Skegness coastline, were selected as extraction sites for the project (Environment Agency 2004, 17).

7.3.2 Replenishment method

The initial replenishment scheme was carried out between 1994 and 1998, during which time 6.21 million m3 of sand was dumped on the 24km of coastline between Mablethorpe and Skegness (Environment Agency 2004, 10). Since the completion of the initial renourishment, the beach has required periodic topping up to replace sand lost through natural processes. The location and quantity of renourishment campaigns are determined annually, based on beach and bathymetry surveys carried out along the entire coastal frontage. A further 1.37 million m3 was placed on the beach annually between 1999 and 2004, giving a total volume of 7.58 million m3 over the past 10 years. The annual renourishment campaigns have been centred on four hotspots, where erosion rates have been the most significant, at Trusthorpe, Boygrift, Chapel Six Marshes and Trunch Lane/Ingoldmells (ibid). The rate of renourishment did not keep up with the annual erosion losses between 1999 and 2004 (due to funding difficulties) and as a result, beach levels have dropped since the completion of the initial nourishment programme in 1998.

The sand used to replenish the beach, up to and including 1999, was dredged from licensed extraction area 107, situated approximately 20km offshore (Environment Agency 2004, F9). From 2000 onwards, extraction area 440 was used. The sand was removed from the sea bed in each of the areas with a trailer hopper dredger. The drag head was lowered onto the sea bed and the material was pumped up through the dredger arm into the hopper. In order to ensure only sand of the most suitable size was retrieved, all other material like shingle and gravel was screened out and returned to the sea bed. The dredger was anchored approximately 500m offshore and the dredged sand placed on the beaches by pumping it ashore, through a submerged pipeline, as a sand/water mix.

The initial replenishment programme began at Whitehouse Corner, 1km south of Ingoldmells Point, and progressed northwards to Mablethorpe (Posford Duvivier 1996, 20). Stretches of 100m, to the north to south of the pipeline, were renourished at a time and once one section had been completed the pipe was towed to the next location and the process began again. Once on the shore the sand was formed into the correct beach profile using excavators and bulldozers. The preferred profile (originally outlined in the 1991 strategy study) was a berm on the upper beach, at c

4.5m OD, with nourishment material sloping down to the existing beach at a gradient of 1:25 (ibid) (see Fig 37 to Fig 42).

7.3.3 Review of beach design

Despite great advances in the development of design and evaluation techniques, it is still very difficult to predict the morphological and sedimentological behaviour of artificially nourished beaches because of the complex relationships between coastal processes, beach and nearshore morphology and sediment properties (Blott and Pye 2004, 214). No beach recharge is permanent and schemes will always need topping up or completely redoing (ibid).

The Environment Agency (Anglian Region) has carried out beach and bathymetric surveys at regular intervals along the Lincolnshire coast to assess the performance of the nourishment scheme (Environment Agency 2004, B3). The beach profile surveys give information on beach levels at specific locations to allow historical comparisons between profiles to be made (ibid, B5). Between 1994 and 1999 profiles were taken quarterly, but since 1999 they have been taken bi-annually (due to the review recommendations) (ibid). Bathymetric surveys were previously carried out every year but are now carried out every two years, usually in winter to provide information ready for spring recharge. As well as these surveys, wind, wave and water level monitoring, sediment sampling, aerial photography and walkover surveys are also carried out (ibid, 8–9).

This level of monitoring gives a good indication of how recharge is affecting the beach, coastal processes and surrounding environment. For instance, the original beach design created a berm on the upper beach at c 4.5m OD, sloping down to the existing beach at a gradient of 1:25. Nine months later, however, the lower beach at Sandilands still had a shallow gradient but a steep slope had developed on the mid and upper beach. The same pattern occurred at Ingoldmells, but this beach is more exposed to dominant north-easterly waves and so erosion was more severe (Blott and Pye 2004, 222). Two years after nourishment the beach had returned to pre-nourishment levels on the upper and middle beach. The berm had been completely removed and accretion of sediment occurred in the sub-tidal zone. An area to the south of Chapel Point is the only part of the beach to have shown accretion since nourishment. This is due to the area being less exposed to wave activity and, therefore, acts as a sediment sink for sediments transported further from the north (ibid).

A review of coastal processes concluded that, after renourishment, wave action causes rapid redistribution of material over the subsequent weeks (Environment Agency 2004, F30). It is thought that the steeper slope was created because the material used to replenish the beach was coarser than the native beach material. The steeper slope and coarse material ultimately reduces dissipation of wave energy and increases wave reflectance on the lower beach, causes accelerated erosion. Review and modelling has assessed which grain sizes could be used to minimise losses from erosion (ibid). Availability of material, however, ultimately determines the size of sediment used in most cases. As a result of these observations, the beach gradient was increased from 1:25 to a steeper gradient of 1:15. The beach berm width was also remodelled. The steeper design has resulted in a significant reduction in loss of renourishment materials (Environment Agency 2004, C7). Use of unsuitable sediment is, however, contributing to the pattern of accretion at Gibraltar Point and Skegness Banks.

The dredger loads used to replenish the beach were also surveyed and it was found that the nourishment material consisted mainly of gravely sand. The material was poorly sorted and significantly coarser than the natural beach sediment (Blott and Pye 2004, 223). The nourishment material was not consistent, however, and depended on the source of each dredger load. There was also considerable variation within each dredger load (ibid, 225). In general, material placed on the beaches to the south of Anderby Creek was finer and better sorted than that placed on beaches to the north (ibid).

In January 1999 over 90% of renourishment material placed in the nearshore zone had been retained. The upper berm was also retained. Losses occurred to the upper and middle beach and in some areas, like Wolla Bank, the beach eroded back down to clay once again (ibid, 230). Other areas, such as the beaches north of Trusthorpe and south of Ingoldmells, are stable at present and showing signs of accretion (Environment Agency 2004, B4) (see Fig 43 and Fig 44).

The replenishment of the beach has been successful in temporarily raising and widening Lincolnshire's beaches, which dissipates wave energy. In many places, however, the beaches are now coarser than they originally were. Research indicates that stability can be improved by nourishment with sediment slightly coarser than the native sediment (Blott and Pye 2004, 226), but if too coarse the profile will be too static and unresponsive to wave conditions. If too fine it will be washed away, blown inland or washed down into pores therefore reducing drainage (ibid, 227).

Despite these drawbacks, beach renourishment is considered to be the best defence option for this line of coast (Environment Agency 2004, 16). Improvements could be made to the losses of renourishment materials that occur by using finer, better sorted sediment and avoiding gravel, which does not occur naturally in large quantities on these beaches. The material could be better processed on the dredger to filer out the coarser material (Blott and Pye 2004, 230).

Addition of sediment can only be seen as a short term coastal defence strategy as beaches will continue to erode indefinitely and is likely to increase in the future. Managed retreat of the sea defences may provide the only true solution to the advancing sea (ibid, 231).

8 Archaeological impacts

In the coastal and offshore study areas outlined in this project, archaeological deposits are not only at risk from human activities, such as dredging, pipelines and trawling, they are also at risk from coastal and submarine taphonomic processes (see Section 7). The situation is further complicated by the fact that human activity in coastal and submarine environments, which does not directly affect archaeological deposits, may significantly alter coastal and submarine processes, thereby causing indirect damage to archaeological deposits.

Direct archaeological impact, caused by preconceived human activity, is by its nature predictable and measurable. This is in contrast to impact caused by taphonomic processes, which can be extremely difficult to predict or monitor. In addition, either form of impact can have short and/or long term effects.

In an attempt to identify possible long and short term effects of the Mablethorpe to Skegness beach replenishment scheme, the onshore and offshore impacts of the scheme will be considered in this section. This will ultimately allow the exploration of conditions under which archaeological material, derived from offshore contexts, may be redeposited during beach replenishment schemes.

8.1 Offshore impact: dredging areas 107 and 440

The probability of in situ archaeological deposits being present in the upper sea bed sediments within areas 107 and 440 is considered to be low (see Section 6). The presence of isolated prehistoric artefacts cannot be ruled out, however. This means that the likelihood of archaeological materials being removed from their original contexts and redeposited on the Lincshore beaches is low.

Only the northern part of extraction area 107 is actively dredged at present, obtaining a mixture of sandy gravel and gravely sand, while only the central part of extraction area 440 is actively dredged, targeted to obtain sandy gravel deposits (Fig 20). The sand is removed from the sea floor with a trailer hopper dredger (see Section 7.3.2). The drag head is lowered onto the sea bed and the material pumped up through the dredger arm into the hopper. This process creates plough like furrows in the surface of the sediment, which extend to a depth of c 1m.

The likelihood of this process extending deeper, into the underlying quaternary deposits, is considered to be low as sands and gravels in this area are known to be at least 1m thick. In addition, the sands and gravels are the specific target of the dredger and so it is in the best interests of the operators to collect deposits of this nature alone. It cannot be confirmed for certain, but to the authors knowledge no archaeological deposits have so far been reported from this extraction area.

8.2 Onshore impact: Mablethorpe to Skegness beach

There is a high probability of survival of archaeological deposits from all periods on the beach and inter-tidal zone between Mablethorpe and Skegness. In order to assess

the impact of the replenishment scheme and check for derived archaeological material, it is necessary to interpret patterns of erosion on the beach in relation to the archaeological record, before and after the scheme took place.

8.2.1 Pre-replenishment scheme

The discussion of pre-replenishment coastal processes in section 7.2 shows that the beach has been regularly eroded down to clay levels, at least since the construction of the sea wall and particularly during the winter months. It is thought that the addition of the sea wall may have contributed to erosion of the beaches. It is worth noting, however, that historic maps dating back to the 19th century show that the clay was regularly exposed along this stretch of beach long prior to the construction of the sea wall (Fig 14, Fig 15, Fig 16, Fig 17, Fig 18 and Fig 19).

Analysis of coastal processes indicates that the most dominant waves approach the shore from the north-east, causing south–east orientated runnels to form on the beach. In the winter rough seas move coarse sand and gravel onto the upper beach and pull the finer material offshore. As the native sand is fine, lots of material is regularly lost, causing the beach to steepen. Longshore drift then moves this material southwards and deposits it on the accretionary beaches south of Gibraltar Point. While some of this sand moves back onto the beaches between Mablethorpe and Skegness during periods of recovery (in the summer months), material from the eroded underlying clay does not return, causing beach levels to fall (Fig 44).

Although the processes at work along the Lincolnshire coast are now fairly well understood, it is very difficult to predict when any of the conditions described above will occur and to what extent, because of seasonal changes. It is only possible to make general statements such as:

- More material is lost from the beach than is returned
- Fine deposits are more likely to be moved southwards away from the beach by longshore drift
- Coarser deposits tend to be moved further up the beach
- The beach has erosion hot spots

Every time the clay substrata has been exposed and eroded in the past, there is a high risk that archaeological deposits were damaged and redistributed along the beach. Indeed, study of HER/NMR records suggest that most of the artefacts within the inter-tidal area originated from the underlying clay levels. According to the coastal cell model, deposits on the beach have a tendency to migrate southwards. In addition, coarse materials tend to be pushed towards the back of the beach. The archaeological implications of this could be that the majority of artefacts, which have eroded out of the clay substrata, are washed up towards the back of the beach. HER records, entered prior to the 1990s when erosion was at its height, do in fact show that most findspots were located on the upper beach (see Table 2, Appendix 2, and Fig 2, Appendix 3). A number of prehistoric and Roman occupation sites were also recorded lower down the beach, in the process of eroding out of the underlying clay. Some of the scattered artefacts along the beach may have originated from these areas.

As Table 2 shows, all of the artefacts and sites recorded on the beach prior to replenishment date to the Prehistoric and Roman periods. The vast majority of these sites are concentrated around Chapel St Leonard's and Ingoldmells, where erosion has

historically been at its greatest. The most obvious pattern, with regard to coastal processes, is that long term erosion appears to have caused most of these finds to be pushed up onto the upper beach area.

8.2.2 Post-replenishment scheme

The eroded natural beaches of Lincolnshire were buried under metres of sand during the replenished scheme of 1994 to 1998. The scheme was intended to protect underlying natural beach sediments from further erosion and make the existing hard defences more efficient. Since the initial replenishment scheme was completed, the beach has required regular topping up in particular areas.

The long term effects of replenishment are still not fully understood due to the volatile nature of the coast. The scheme appears not to have radically altered the general nature of sub-cell activities in this area, although it has amplified many of the processes at work. For instance:

- Regular topping up has caused even more material to be lost to the sea than is returned, increasing longshore drift
- The use of too coarse a grade of material has increased cross shore processes causing larger volumes of material to migrate to the upper beach
- Replenishment has not prevented clay substrate from becoming exposed and becoming prone to erosion in certain high risk areas

The possible effects of this, on the archaeological resource, are many-fold. In areas where the beach is exposed to lower energy and less erosion, the replenishment scheme has the potential to act as an aid to archaeological preservation in situ. In erosion hot spots, however, it may be causing, or at least exacerbating, archaeological impact. The potential for the scheme to cause impact lies entirely with the method by which it is implemented. For instance, it has been shown that not using the optimum grade of material accelerates the rate at which renourishment has to be carried out. This in turn could be seen as increasing the potential for archaeological impact to occur, both in the short term and the long term, as follows:

- *Short term impact*: caused as a result of the physical method by which the beach design is created. During the initial replenishment scheme machines were used to move the sand into position on the beach, which could have disturbed underlying archaeological deposits. Accelerated erosion caused by the beach design means that machines also have to be used to move sand into position during each episode of renourishment.
- *Long term impact*: is related to how the beach design performs in the months and years after replenishment. Some parts of the replenished beach have been very quickly eroded back to pre-replenishment levels, leaving underlying deposits once again open to erosion. It is clear that this accelerated erosion has had an archaeological impact on at least two occasions to date. For instance, the HER records a Neolithic axe, which had eroded out of the underlying clay during the initial replenishment period in 1996, on the lower beach at Moggs Eye. A Saxon wattle structure was also eroded out of the clay at Sutton on Sea in 1995 (Table 3, Appendix 2 and Fig 2, Appendix 3).

There have been too few finds recorded on the HER since replenishment took place to allow any real patterns to be observed or to really test the hypotheses outlined here.

Judging by the recorded effects of replenishment on coastal processes, however, it is possible to surmise that derived archaeological material would be affected in the same way as the material recorded prior to replenishment. That is to say it would have the tendency to be pushed towards the back of the beach.

9 Methods for identifying derived archaeological material

Beach replenishment schemes carry with them the risk that Prehistoric archaeological artefacts and deposits may get redeposited onto beaches, along with sand and gravel from offshore contexts, and become mixed with 'native' archaeological material. This could potentially cause the SMR record to become contaminated and create an inaccurate picture of archaeological survival in any one area.

9.1 The Lincolnshire case study

It has been shown that the potential for discovery of Prehistoric artefacts and deposits in the surface deposits of the replenishment sources for the Mablethorpe to Skeness beaches (extraction areas 107 and 440) is low, which means the possibility that finds were redeposited from these areas onto the beach is also low. These findings appear to be corroborated by the fact that there are only three entries on the Lincolnshire HER, which post date the replenishment scheme, and two of these are clearly in situ deposits that were eroded out from the underlying clay substrata (see Table 3). The wattle structure discovered in the inter-tidal zone is of Saxon date and could not therefore have been derived from an offshore context. The Neolithic axe at Moggs Eye is also too late in date to have come from this area of the North Sea.

There is a strong possibility that the third artefact, a Lower Palaeolithic blade, could have been dredged up from areas 107 or 440. The blade was found at Anderby, which is not an erosion hotspot and hasn't required topping up since initial replenishment (Fig 45). In addition it was found on the upper beach area, where post-replenishment coastal processes have been shown to deposit the coarsest of the imported beach material. It also dates to the Lower Palaeolithic period, at which time the southern North Sea floor would have been dry land and able to support human life.

Although the evidence for derived material on the Lincshore beaches is low, this study area can still be used to demonstrate methods by which derived material could be identified.

The first important thing to note is only finds of Palaeolithic and Mesolithic date have the potential to be derived from offshore contexts. Secondly, the probability of being able to differentiate between derived and in situ artefacts on the beach alters depending on what part of the beach is being studied. This is because there are erosion hot spots along the Lincolnshire shoreline, where replenishment material is completely washed away, leaving underlying archaeological deposits subject to periodic erosion. In these areas there is a high risk that any archaeological material, which has eroded out from the beach, could mix with derived material from offshore contexts, should both sets of finds exist. The probability of being able to differentiate between both sets of finds under these conditions is low.

Conversely, areas that are less prone to erosion have a higher potential for differentiation. This is because where replenishment material has been left largely intact it acts as a barrier, sealing underlying archaeological deposits. Any early prehistoric artefacts found towards the back of the beach, therefore, have a higher

probability of having been derived from an offshore context, as demonstrated by the Anderby flint blade example (Section 8.2.2, Table 3).

The Mablethorpe to Skegness study area can be split into areas where there is a low probability of being able to differentiate between derived and native archaeological deposits, and areas where there is a much higher probability of being able to differentiate. The areas of low probability are focused at the locations where erosion is at its greatest, which are also the areas requiring annual renourishment, illustrated on Fig 45. The areas are: Trusthorpe between profiles 15 and 19, Boygrift between profiles 33 and 37, Chapel Six Marshes between profiles 53 and 58, Trunch Lane between profiles 67 and 73 and Ingoldmells between profiles 75 and 78. The areas of higher probability are simply all the areas in between those stipulated above.

There are, of course many mitigating factors that have to be considered when making this judgement. Cross comparison with factors such as archaeological background, pre-replenishment finds made in the area, composition of beach before and after replenishment, are essential. An example of this might be if large numbers of finds of Iron Age date had been made for many years prior to the replenishment scheme in the Ingoldmells area. If, for the sake of argument, following replenishment a number of Palaeolithic and Mesolithic artefacts were discovered in the same area, where none had been discovered before, there might be an argument for suggesting these had originated from an offshore context. This possibility should then be tested against an assessment of coastal processes, before and after replenishment, as it might be revealed that replenishment caused a different erosion pattern to develop, which might in turn have caused erosion of previously undisturbed early prehistoric deposits.

9.2 Wider application of methodology

Due to the fact that replenishment can change coastal processes in unpredictable ways, any method for identifying derived archaeological remains can only work on probability factors. This process is similar to the traditional methods of interrogation used in terrestrial archaeological impact assessments. The main difference, in this case, is that the procedure is more like a process of elimination.

Once all the stages of background analysis have been carried out, including: research into archaeological background and potential of coastal and offshore study areas, analysis of impact of coastal processes and assessment of impact of replenishment scheme, the final steps are:

- Using the Shoreline Management Plan, divide the beach into its different coastal cell units. This will allow identification of accreting, eroding and stable areas.
- Divide the HER and NMR information for the coastal study area into finds made on the beach before and finds made after replenishment took place.
- Isolate any Palaeolithic and Mesolithic finds, out of the 'finds made on the beach after replenishment' category.

The Palaeolithic and Mesolithic finds are the only group that could have potentially originated from an offshore context. This group of finds should then be studied in relation to coastal processes and known archaeological sites in the immediate area of their discovery.

This process may allow suspected derived finds to be separated from those which are certain to have originated from the terrestrial study area.

10 Recommendations and research aims

The effects of beach replenishment schemes on offshore and onshore coastal processes, in terms of archaeological impacts, is at an early stage of study and this report is seen as a first step in addressing this issue. Because of the many variables in the dynamic coastal environment accurate and long term modelling is reliant on continuous data gathering and recording. These comprehensive studies, collecting data and observing the effects of different actions are carried out by both the Environment Agency, the Aggregates Industry, and their appointed agents. This data has been analysed on the Lincshore project to allow a detailed Shoreline Management Plan for the beach replenishment to be drawn up.. This current SMP, which is subject to regular reviews, provides an outline archaeological background for this stretch of coast. The work proposed here can be seen as assessing a specific impact; that of derived archaeological material.

In order to gain an understanding of the effects of beach replenishment on archaeological material, derived or otherwise, it is recommended that SMPs add another level of monitoring to investigate the ways in which areas of known archaeological potential are affected by coastal processes, both before and after replenishment has taken place.

10.1 Future replenishment needs

Replenishment is set to carry on as a solution to coastal erosion along the Lincolnshire front for at least the next 50 years (Environment Agency 2004). This means that alternative aggregate sources will have to be found in the future, as the active areas of 107 and 440 will not provide an unlimited supply of material. Each new area that becomes licensed for aggregate extraction will bring with it the renewed possibility of causing derived archaeological material to become redeposited onto the beach. It is estimated that the average annual recharge amount need for the Lincshore project will be 317,000 m3 (Environment Agency 2004, B5). Areas 107 and 440 can cope with this demand as at the moment, as only a small part of the licensed area is actively dredged.

The Mablethorpe to Skegness replenishment scheme is not the only one in the UK, however. Major replenishment schemes have also been carried out between Happisburgh and Winterton, and on the south coast at Hythe, Eastbourne, Hurst Spit and Weymouth (BMAPA 2001, 1), and it is likely that these will continue into the foreseeable future. The estimated maximum recharge demand for beach replenishment schemes on the east coast alone, over the next 20 years, is 51.5 million m3, including maintenance demand (Humphreys et al 1996, 154). Research suggests that aggregates will last a further 50 years at present levels of extraction.

Future extraction areas are already being researched (BMAPA, Environment Agency 2004). In the study area, large sand banks like Docking Shoal and Race Bank have been identified as possible areas suitable for future exploitation (ibid, F48). The most suitable materials for beach replenishment are often to be found close to fossilised river valleys and ancient buried beaches. Unfortunately, these kinds of locations are

also the ones that have the highest potential for discovery of Prehistoric archaeological deposits, creating a clash of interests.

The risk of archaeological material from offshore contexts being transported onto replenished beaches can be reduced by carrying out suitable archaeological impact assessments on the extraction areas.

10.2 Research Potential

This study has identified areas where there is the potential for further research to take place.

10.2.1 Offshore context

Particular areas of the southern North Sea have a high potential for discovery of Prehistoric sites and artefacts, such as Dogger bank and Brown Bank (see Section 6). None of these are situated in close proximity to the study area. This does not mean that areas 107 and 440 do not have the potential to contain archaeological deposits, however. There is more that could be done to assess the archaeological potential of these areas.

The archaeological potential of proposed extraction areas is currently assessed by using methods like acoustics, swath bathymetry, side scan sonar and shallow sub-bottom profiling. These techniques can reveal the presence of river valleys or ancient beachheads: ancient landscapes which have high potential to contain archaeological deposits. These methods are often not totally conclusive, however, as they do not penetrate very deep into the seabed sediments. They need to be backed up by physical archaeological sampling. This is often a practical impossibility in the harsh and stormy conditions of the North Sea (Flemming 2004, 11). The BGS have numerous cores that have never been looked at from an archaeological point of view, however. This could provide a massive body of data that could be used to corroborate other sampling techniques (Contact: zoe.hazell@english-heritage.org.uk). The following possible research aim is suggested:

1. *Can BGS data be used to back up other forms of survey, which may have been carried out in the vicinity of extraction areas 107 and 440, to gain a more detailed knowledge of potential for archaeological survival in these areas?*

10.2.2 Onshore context

This study has suggested that the current distribution of archaeological sites along the coast may reflect erosion patterns rather than patterns of human occupation. The archaeological potential of the Lincolnshire coast is well documented but very few archaeological surveys have taken place. The Lindsey coastal survey was carried out in the 1990s (Brooks 1990), but this has recently been superceded by a more up to date survey: Lincolnshire Coastal Grazing Marsh Archaeological and Historical Data Collection (Tann 2004). The focus of these surveys was more the coastal marsh than the inter-tidal zone. A number of related fieldwalking and sampling surveys were undertaken as part of the Wetlands Survey Project, in 1993. The information collected during this project, even though its focus was the Humber Wetlands, has often formed the basis for subsequent studies in Lincolnshire. In order to gain a more accurate picture of archaeological survival in the inter-tidal zone, between Mablethorpe and

Skegness, a comprehensive archaeological sampling and fieldwalking programme focused on this specific area is needed. The results of such a survey could be compared with erosion patterns identified in the SMP, to check for correlations and answer the following research aim:

2. *What is the extent of the relationship between the coastal erosion pattern and distribution of archaeological sites, between Mablethorpe and Skegness?*

Further research into these specific points would help to identify derived archaeological material on replenished beaches with greater accuracy. If this issue was tackled at both SMP and Environmental Impact Assessment level, the problem of derived archaeological material could be eradicated altogether in the future. This will be considered as part of the Lincolnshire RCZA (Rapid Coastal Zone Assessment) – English Heritage, forthcoming.

11 Conclusions

Having reviewed all the variables in the study areas it is now possible to visualise a method by which derived archaeological material on replenished beaches could be identified.

It has been demonstrated that it is only possible to recognise derived archaeological material by firstly conducting research from a number of different perspectives, which should be developed in the following ways:

- Detailed study of archaeological background of study areas
- Assessment of the archaeological potential and significance of study areas
- Detailed study of coastal processes within the study areas
- Assessment of archaeological impact of coastal processes and replenishment scheme

It has been demonstrated that the potential for archaeological survival in the coastal study area between Mablethorpe and Skegness is high, from the Prehistoric to the post-medieval periods. In particular there is a high potential for remains from the Bronze and Iron Ages, in the form of salterns, burials and related occupation sites. Sites and findspots dating to these periods are particularly common around Chapel St Leonard's and Ingoldmells. Medieval remains are also very prevalent in this area and many field systems, now very close to the coast, have survived. Many medieval saltern sites are also known.

The Prehistoric, Roman and medieval remains between Mablethorpe and Skegness are of high regional significance.

The potential for survival of Prehistoric archaeological deposits in the offshore study areas, extraction areas 107 and 440, cannot be fully quantified at present but it is thought that area 107 may have a much higher potential than 440. This is because area 107 is situated very close to the submerged palaeo-river valley known as the Silver Pit, which is considered to have been a Palaeolithic occupation hot spot (Flemming 2002). The probability of such remains being disturbed by dredging activities is, however, thought to be low.

Any prehistoric remains in the North Sea are considered to be of international significance.

This study has demonstrated that prior to the replenishment scheme beach erosion regularly caused archaeological sites and artefacts of all periods to become exposed, damaged and moved around the beach. In addition, marine transgression, cross-shore transport processes and longshore drift have caused the loss of many artefacts and sites over the centuries.

Analysis of sub-cell activity in relation to distribution of archaeological sites along the Lincolnshire coast has indicated that most loose artefacts were discovered, prior to the replenishment scheme, on the upper portion of the beach. Findspots were also concentrated in particular locations, which have since been identified in the Shoreline Management Plan as erosion hotspots. This indicates that distribution pattern of

known sites may not be meaningful, in an archaeological sense, and may reveal nothing more than a bias created by erosion.

Following replenishment, 1994–1998, very few artefacts have been discovered on the beach, according to the HER records. This could be due to one or other, or a combination, of the following two possibilities:

- On the whole, the replenishment material has provided a sufficient enough cover to prevent underlying archaeological deposits from being eroded out of the beach and recorded on the HER
- There is a low potential for early Prehistoric archaeological remains to be disturbed within extraction areas 107 and 440, making the probability that such remains have been, or will be, redeposited onto the Lincshore beaches low.

A study of post-replenishment coastal processes indicates that, should archaeological material derived from an offshore context be present on the beach, it is likely to be found on the upper beach, where the coarse material from areas 107 and 440 tends to be redistributed to. Also, the study of the archaeological background of the North Sea basin indicates that finds from offshore contexts will only be of Palaeolithic or Mesolithic date. If such finds are made in an area where post-replenishment erosion is known to be low, then the probability that it has originated from an offshore context increases. Should such finds be made in an erosion hotspot, however, where the beach sometimes erodes back down to the clay substrate level, the probability decreases. This is because it would be virtually impossible to differentiate between pre-existing and derived early Prehistoric archaeological remains under such circumstances. The only exception would be if the find could be proven to have originated from the underlying clay substrate.

Using the methods developed as part of this study, it has been demonstrated that there is a low potential for derived archaeological material on the beaches between Mablethorpe and Skegness at present.

12 Bibliography

ACAO, 1993 Association of County Archaeological Officers, *Model briefs and specifications for archaeological assessments and field evaluations*, Bedford

Bailey, G, 2004 The wider significance of submerged archaeological sites and their relevance to world prehistory, in N C Flemming (ed) *Submarine prehistoric archaeology of the North Sea*, 3–10, CBA Research Report 141

Bennett, S, and Bennett, N, 1993 *An Historical Atlas of Lincolnshire*, The University of Hull Press

Blott, S, J, and Pye, K, 2004 Morphological and Sedimentological Changes on an Artificially Nourished Beach, Lincolnshire, UK, *Journal of Coastal Research*, 20, 1, Winter 2004, 214–233

BMAPA, 2002 Aggregates from the sea, http://www.bmapa.org/pdf/brochure.pdf

BMAPA, 2002 Seabed Dredging: The Area Involved, http://www.bmapa.org/pdf/brochure.pdf

Boutwood, Y, 1999 The physical landscape of Lincolnshire, in R H Bewley (ed) *Lincolnshire's archaeology from the air*, Occasional papers in Lincolnshire history and archaeology 11, 23–28

Brampton, A, H, and Evans, C, D, R, 1998 *Regional seabed sediment studies and assessment of marine aggregate dredging*, CIRIA, London

Brooks, #, 1990 Lindsey coastal survey, unpublished Lindsey Archaeological Services report

Defra, 2002 Futurecoast: Prediction of Future Coastal Evolution for SMP Review, Defra report, http://www.defra.gov.uk/environ/fcd/futurecoast.htm

DoE, 1990 Department of the Environment, *Archaeology and planning: a consultative document*, Planning Policy Guidance Note 16, London

DoE, 1993 Department of the Environment [and] Department of National Heritage, *Planning policy guidance: historic buildings and conservation areas*, Planning Policy Guidance Note 15, London

East Lindsey District Council, 2004 East Lindsey Local Plan, first deposit, June 2004, http://www.e-lindsey.gov.uk/environment/planning/policy-local-plan/

English Heritage, 1991 *Exploring our past: strategies for the archaeology of England*, London

English Heritage, 1991 *Management of archaeological projects [MAP2]*, London

English Heritage, 1997 *Sustaining the historic environment: new perspectives on the future*, London

English Heritage, 2000 *Power of place, the future of the historic environment*, London

English Heritage, 2002 *Taking to the Water: English Heritage's Initial Policy for The Management of Maritime Archaeology in England*, English Heritage

English Heritage, 2003 *Coastal Defence and the Historic Environment*, English Heritage Guidance, English Heritage

English Heritage, 2003 *Marine Aggregate Dredging and the Historic Environment*, BMAPA/English Heritage/Wessex Archaeology

Environment Agency, 2003 Strategic Environmental Assessment – Environmental Report, Lincshore PAR and Strategy Review, unpublished Environment Agency Report

Environment Agency, 2004 Lincshore PAR 2005 to 2010, unpublished Environment Agency Report, Anglian Region

Environment Agency, 2004 Shoreline Monitoring Data Catalogue, public version, Enironment Agency report, Anglian Region

Flemming, N, C, 2002 The scope of Strategic Environmental Assessment of North Sea areas SEA3 and SEA2 in regard to prehistoric archaeological remains, Department of Trade and Industry

Flemming, N, C, 2004 The prehistory of the North Sea floor in the context of Continental Shelf archaeology from the Mediterranean to Nova Zemla, in N C Flemming (ed) *Submarine prehistoric archaeology of the North Sea*, 11–36, CBA Research Report 141

Flemming, N, C, 2005 Submerged Archaeological Landscapes: Evidence of human migrations, *Conservation Bulletin*, Issue 48, Spring 2005, 20–22

Glimmerveen, J, Mol, D, Post, K, Reumer, J, W, F, van der Plicht, H, de Vos, J, van Geel, B, van Reenen, G, and Pals, J, P, 2004 The North Sea project: the first palaeontological, palynological, and archaeological results, in N C Flemming (ed) *Submarine prehistoric archaeology of the North Sea*, 36–52, CBA Research Report 141

Humphreys, B, Coates, T, Watkiss, M and Harrison, D, 1996 *Beach recharge materials – demand and resources*, Report 154, CIRIA

IFA, 2001 Institute of Field Archaeologists, *By-laws, standards and policy statements of the Institute of Field Archaeologists, standard and guidance: desk-based assessment*, rev, Reading

Kenyon, N, H, Belderson, R, H, Stride, A, H, and Johnson, M, A, 1981 *Offshore tidal sandbanks as indicators of net sand transport and as potential deposits*, Spec. Publs. inst. Ass. Sediment. Vol 5, 257–268

Lambeck, K, 1995 Late Devensian and Holocene shorelines of the British Isles and North Sea from models of glacio-hydro-isostatic rebound, *Journal of the Geological Society of London*, 152, 437–448.

Lane, T and Morris, E, L, (eds), 2001 *A millennium of saltmaking: prehistoric and Romano-British salt production in the Fenland*, Sleaford: Heritage Trust of Lincolnshire

Lincolnshire County Council, 2004 Deposit Draft Structure Plan, April 2004, http://www.lincolnshire.gov.uk/section.asp?catId=3698

Lincolnshire County Council, 2004 Ingoldmells Draft Archaeological Management Plan, http://www.sogaer.ex.ac.uk/wetlandresearch/hmew/ingoldmells.pdf

Louwe Kooijmans, L P, 1970–71 Mesolithic bone and antler implements from the North Sea and from the Netherlands, *Ber. Rijksdienst oudheidk. bodemonderz,* 20/21, 27–73

Masters, P, M, and Flemming, N, C, 1983 *Quaternary Coastlines and Marine Archaeology*, Academic Press, London and New York

May, J, 1976 *Prehistoric Lincolnshire,* Lincoln: History of Lincolnshire Committee

Murray, L, 1994, Sand and gravel extraction for beach recharge – is conflict with fisheries inevitable? MAFF report, http://www.bmapa.org/pdf/sandand.pdf

Oxley, I, and O'Regan, D, 2005 The Marine Archaeological Resource, IFA paper no 4,http://www.archaeologists.net/modules/icontent/inPages/docs/pubs/maritime_resource.pdf

Posford Duvivier, 1991 Lincshore Sea Defence Strategy, National Rivers Authority report

Posford Duvivier, 1992 Lincshore Environmental Statement, National Rivers Authority report

Posford Duvivier, 1996 Lincolnshire Shoreline Management Plan. Volumes I, II & III, Environmental Agency report, Anglian Region

Posford Duvivier, 1998 Review of Lincshore Renourishment Strategy Study, Environmental Agency report, Anglian Region

Sawyer, P, 1998 *Anglo Saxon Lincolnshire*, Lincoln: History of Lincolnshire Committee

Shennan, I, Lambeck, K, Flather, R, Horton, B, McArthur, J, Innes, J, Lloyd, J, Rutherford, M, and Wingfield, R 2000 Modelling western North Sea palaeographies and tidal changes during the Holocene, in I Shennan and J E Andrews (eds), *Holocene Land–Ocean Interaction and Environmental Change around the North Sea*, Geological Society Special Publication No166, 299–319

Shennan, I, Lambeck, K, Horton, B, Innes, J, Lloyd, J, McArthur, J, and Rutherford, M., 2000 Holocene isostasy and relative sea-level changes on the east coast of England, in I Shennan and J E Andrews (eds), *Holocene Land–Ocean Interaction and Environmental Change around the North Sea*, Geological Society Special Publication, 166, 275–298

Tann, G 2004 Lincolnshire Coastal Grazing Marsh Archaeological and Historical Data Collection, Report for Lincolnshire Wildlife Trust, on behalf of English Heritage and Lincolnshire County Council Conservation Section, Lindsey Archaeological Services, Report No. 770, September 2004.

The Crown Estate, 2003 The Area Involved – 6th Annual Report http://www.thecrownestate.co.uk/40_aggregate_dredging_6th_arpt_-_inserts.pdf, http://www.thecrownestate.co.uk/40_aggregate_dredging_6th_arpt.pdf

van de Noort, R, 2004 *The Humber Wetlands: the archaeology of a dynamic landscape*, Bollington, Windgather

van de Noort, R, and Davies, P, 1993 *Wetland Heritage: an archaeological assessment of the Humber wetlands*, Hull : Humber Wetlands Project, School of Geography and Earth Resources, University of Hull

van Kolfschoten, T, and van Essen, H, 2004 Palaeozoological heritage from the bottom of the North Sea, in N C Flemming (ed) *Submarine prehistoric archaeology of the North Sea*, 70–80, CBA Research Report 141

Whitwell, J, B, 1992 *Roman Lincolnshire*, revised edition, History of Lincolnshire Committee for the Society for Lincolnshire History and Archaeology

Woodcock, N, H, 2000 The Quaternary history of an ice age, 392–411, in N H Woodcock and R Strachan (eds) *Geological History of Britain and Ireland*, Blackwell Science Ltd, Oxford

13 Appendix 1: Figures

Fig 1 Location of study areas

Fig 2.1–2.8 Prehistoric and Roman HER/NMR findspots, monuments and archaeological sites between Mablethorpe and Skegness

Fig 3.1–3.8 Medieval and post-medieval HER/NMR findspots, monuments, archaeological sites and conservation areas between Mablethorpe and Skegness

Fig 4 Solid geology of Lincolnshire (after Bennet and Bennet 1993)

Fig 5 Drift geology of Lincolnshire (after Bennet and Bennet 1993)

Fig 6 Extent of Anglian and Wolstonian ice sheets (based on Gibbard 1998, after Woodcock, in Woodcock and Strachan 2000)

Fig 7 Extent of Devensian ice sheets (after Woodcock and Strachan 2000)

Fig 8 Topographic map of Lincolnshire (after Bennet and Bennet 1993)

Fig 9 Roman road network in Lincolnshire (after Bennet and Bennet 1993)

Fig 10 Medieval districts of Lincolnshire (after Bennet and Bennet 1993)

Fig 11 Medieval trade and fishing (after Bennet and Bennet 1993)

Fig 12 Post-medieval drainage and land reclamation (after Bennet and Bennet 1993)

Fig 13 Map of Lincolnshire coastline, 1778, Mablethorpe to Ingoldmells

Fig 14 Bryants map of Lincolnshire, 18th century, Ingoldmells to Skegness

Fig 15 Map of Lincolnshire coastline, 1831, Ingoldmells to Skegness

Fig 16.1–16.8 OS map of Lincolnshire 6", 1st Ed 1888, showing coastline. Sheets 1–8

Fig 17.1–17.12 OS map of Lincolnshire 25", 2nd Ed 1906, showing coastline. Sheets 1–12

Fig 18.1–18.9 OS map of Lincolnshire 6", 2nd Ed 1907, showing coastline. Sheets 1–9

Fig 19.1–19.25 Map of coastal strip, 1937, Mablethorpe to Skegness. Sheets 1–25

Fig 20 Sea bed bathymetry, geology, sediments and NMR findspots/monuments in vicinity of licensed extraction areas 107 and 440

Fig 21 Map showing offshore sand banks, notably Dogger Bank, in south-western part of North Sea (after Kenyon et al 1981)

Fig 22 Fossils from bottom of North Sea, collected from Dogger Bank area (Kolfschoten and van Essen 2004)

Fig 23 Map showing locations of mammal fossil concentrations in area of Brown Bank (van Kolfschoten and van Essen 2004, after Drees 1986 and based on unpublished data by J Mulder)

Fig 24 Map showing extent of dry land and river courses in North Sea basin at end of Devensian period (after Flemming 2002)

Fig 25 Isobase maps of predicted shorelines, shoreline locations and ice sheet limits for selected epochs. (a) 22,000 years BP corresponding to the adopted time of maximum glaciation over the British Isles, (b) 18,000 years BP corresponding to the time of the onset of deglaciation of the large ice sheets, (c) 16,000 years BP, (d)14,000 years BP, (e) 12,000 years BP, (f) 10,000 years BP, (g) 8,000 years BP, (h) 7,000 years BP. The maximum ice heights for these epochs are: 1,500m at the time of the glacial maximum at 22,000 years BP, 1,400m at 18,000 years BP, 1,300m at 16,000 years BP, 1,000m at 14,000 years BP and 400m at 10,000 years BP. Palaeowater depths are also indicated with contours at 50, 100, 150 and 200m. Isobase contour intervals are 50m for (a) to (d), 25m for (e) and (f) and 10m for (g) and (h) (after Lambeck 1995).

Fig 26 Palaeogeographic reconstructions of north-western Europe, showing coastal extents during the Mesolithic period: (a) 10,000 years BP, (b) 9,000 years BP, (c) 8,000 years BP, (d) 7.5,000 years BP, (e) 7,000 years BP, (f) 6,000 years BP, (g) 5,000 years BP and (h) 4,000 years BP (after Shennan 2000)

Fig 27 Map showing known areas of potential, in southern North Sea, for survival of submarine prehistoric archaeological deposits (after Louwe Kooijmans 1970–71)

Fig 28 Map of North Sea basin showing areas of shallow water, which are the areas of highest potential for prehistoric human habitation (after Long et al 2004)

Fig 29 Mablethorpe beach after the storm surge of 1953 (Environment Agency 2004)

Fig 30 Shoreline Management Plan boundaries, sub-cell 2c (Posford Duvivier 1996)

Fig 31 Plan of existing coastal defences showing profile locations, coastal cells and existing seawall structures (Environment Agency 2004)

Fig 32 Cross section of Lincolnshire beach, showing how replenishment improves the beach (Environment Agency 2004)

Fig 33 Cross section showing the damage that coastal erosion will do to the beach if beaches not replenished after 10 years (Environment Agency 2004)

Fig 34 Cross section showing damage that coastal erosion will do if beach not replenished after 50 years (Environment Agency 2004)

Fig 35 Location of defences at risk under a 1:50, 1:100 and 1:200 storm event (Environment Agency 2004)

Fig 36 Extent of future flood risk zones, if no action taken (Environment Agency 2004)

Fig 37 Trusthorpe beach prior to renourishment in 1994 (Environment Agency 2004)

Fig 38 Trusthorpe beach after renourishment (Environment Agency 2004)

Fig 39 Recolonisation of Chapel Six Marshes following renourishment (Environment Agency 2004)

Fig 40 Image of renourished beach at low water, looking north from Vickers point (Environment Agency 2004)

Fig 41 Image of renourished beach at Anderby Creek (Environment Agency 2004)

Fig 42 Image of renourished beach at Gibraltar Point (Environment Agency 2004)

Fig 43 Potential shoreline change predicted for Lincolnshire coast (Environment Agency 2004)

Fig 44 Conceptual model showing coastal processes at work on Lincolnshire coast (Environment Agency 2004)

Fig 45 Locations and volumes of beach recharge between 1999 and 2003 (Environment Agency 2004)

14 Appendix 2: Tables

Table 1: Coordinates for extraction areas 107 and 440 (reproduced from Crown Estate 2005)

Licensed Dredging Areas: Humber region Coordinates displayed in Degrees and Decimal Minutes (DDM) Long/Lat (West if–ve, otherwise East), datum WGS84		
	Long	**Lat**
Area 107	00 35.9967	53 15.0180
	00 41.5961	53 15.0181
	00 41.8962	53 12.8183
	00 37.1968	53 08.6186
Area 440	00 48.8951	53 24.0173
	00 49.8949	53 24.6673
	00 52.8946	53 25.5173
	00 54.3945	53 24.5174
	01 01.9771	53 24.5175
	01 06.5934	53 23.4177
	01 06.5934	53.22 9510
	00 50.8116	53 23.0341

Table 2: HER sites and findspots recorded on the beach prior to 1994 replenishment

Site no	**Fig no**	**Period**	**NMR/HER ref**	**Class**	**Description**	**Date discovered**	**Location**
3	2.1	Neolithic	HER LI41427	Findspot	Flint axe from Mablethorpe, found in shingle on the beach	1930	Upper beach
7	2.1	Neolithic	NMR 356005	Monument	Neolithic axe found at low water mark	1934	Lower beach
7	2.1	Iron Age	NMR 356005 HER LI41436	Monument Findspot	Iron Age occupation site with huts. Site exposed after storm and then covered over again. Iron Age pygmy urn found	1963	Lower beach
7	2.1	Roman	NMR 356005 HER LI41437	Monument	Roman occupation site with huts. Roman pottery and a hoard containing coins found, dating from Augustus to the mid-4th century AD.	1934	Lower beach
9	2.1	Roman	HER LI41439	Monument	Roman Flavian bowl and coin hoard found at Mablethorpe	1943 1948	Upper beach
18	2.1	Roman	HER LI41452	Findspot	Romano British pottery found in Trusthorpe on the beach	1969	Upper beach

21	2.1	Roman	NMR 356014 HER LI41444	Monument	Romano British pottery found Sutton On Sea	1953	Upper beach
40	2.2	Bronze Age	NMR 356020 HER LI41443	Findspot	Beaker fragment found on beach at Sutton on Sea	1960	Upper beach
51	2.4	Roman	NMR 355928 HER LI41607	Findspot	Roman potsherd (4th c.) found in clay at mid tide level, Anderby	1954	Lower beach
54	2.4	Roman	NMR 355931 HER LI41602	Findspot	Romano British pottery found at high water mark, Anderby	1974	Upper beach
58	2.5	Neolithic	HER LI41613	Findspot	Worked flint flake from Chapel St Leonard's	1972	Upper beach
61	2.5	Roman	HER LI41623	Findspot	Greyware rim found on the shore at Chapel St Leonard's	1965	Upper beach
63	2.5	Roman	NMR 355971	Monument	Roman pottery found on the shore, north of Chapel Point	1965	Upper beach
64	2.5	Bronze Age	NMR 355965	Monument	Bronze Age scraper found at Chapel Point, to the rear of the old gun position	1960	Upper beach
65	2.5	Bronze Age	HER LI41614	Findspot	Flint scraper found, Chapel St Leonard's	1959	Upper beach
66	2.5	Bronze Age	HER LI41622	Findspot	Bronze Age dagger found on the beach at Chapel St Leonard's	1964	Upper beach
67	2.5	Bronze Age	NMR 355959	Monument	Early Bronze Age flint dagger found on beach	1964	Upper beach
68	2.5	Roman	NMR 355953 HER LI41625	Findspot	Romano British gritted jar (3rd c.) found on sandy foreshore	1960	Upper beach
79	2.5	Roman	HER LI41612	Findspot	Romano British greyware and base of human skull found Chapel St Leonard's	1967	Upper beach
80	2.5	Roman or Prehistoric	NMR 355974	Monument	Antler pick	1969	Upper beach
81	2.5	Neolithic	HER LI41616	Findspot	Neolithic flint axe found on beach, Chapel St Leonard's	1976	Upper beach
86	2.6	Roman	HER LI41615	Findspot	Romano British sherd found at low tide mark, Chapel St Leonard's	1967	Lower beach
87	2.6	Iron Age to Roman	HER LI43342	Monument	Trunch Lane briquetage site	1990	Upper beach
87	2.6	Iron Age to Roman	HER LI43347	Monument	Trunch Lane briquetage site	1990	Upper beach
88	2.6	Iron Age to Roman	HER LI43348	Monument	Enclosures in intertidal zone	1990	Upper beach
89	2.6	Iron Age	HER LI41667	Monument	Iron Age saltern site, Ingoldmells exposed in 1954 and again in 1979	1954	Upper beach
91	2.6	Iron Age	HER LI87088	Monument	Iron Age or Roman salt working site, North of Ingoldmells Point	1979	Upper beach

92	2.6	Roman	HER LI87090	Findspot	Silver Denarius, Vickers Point, Ingoldmells	1953	Upper beach
97	2.6	Iron Age Roman	HER LI43341	Monument	Iron Age to Roman saltworks, Vickers Point (south), Ingoldmells	1990	Upper beach
98	2.6	Palaeolithic	HER LI41635	Findspot	Mammoth tooth found on foreshore at Ingoldmells	1973	Upper beach
100	2.6	Iron Age	HER LI41660	Monument	Early Iron Age saltern, Ingoldmells	1964	Upper beach
103	2.6	Iron Age	HER LI41661	Monument	Early Iron Age saltworkings, Ingoldmells	1964	Upper beach
104	2.6	Iron Age	HER LI41658	Monument	Early Iron Age saltworking site, Ingoldmells	1964	Upper beach
106	2.6	Undated	NMR 355868 HER LI41634 HER LI41645	Monument Findspot Monument	Hut circle group. (Wooden piles, clayfloors & briquetage). Ingoldmells Undated cooking pot	1907	Upper beach
107	2.6	Roman	NMR 355841 HER LI41639	Monument	A possible Roman occupation site dated by pottery to the 2nd to 4th centuries with finds of animal bones. Ingoldmells	1952	Upper beach
108	2.6	Undated	HER LI41649	Monument	Undated saltern site, exposed during beach erosion at Ingoldmells	1980	Lower beach
109	2.6	Roman	HER LI87091	Findspot	Roman coin Ingoldmells Point, Ingoldmells	1983	Upper beach
109	2.6	Roman	HER LI87092	Findspot	Roman hand bricks, Ingoldmells Point, Ingoldmells	1983	Upper beach
118	2.6	Roman	NMR 355847 HER LI41641	Monument	Supposed Roman site, now covered by sea defences. Ingoldmells	1964	Upper beach
125	2.7	Iron Age	NMR 355850 EX 633091	Excavation	Iron Age salt-workings, briquetage, pottery including Belgic. Ingoldmells Point 1932	1932	Upper beach
126	2.7	Iron Age	HER LI41663	Monument	Iron Age saltworking site, Ingoldmells	1954	Upper beach
127	2.7	Iron Age	HER LI41662	Monument	Iron Age saltworking site, exposed in mud on the beach at Ingoldmells	1954	Upper beach
151	2.8	Neolithic	HER LI41691	Findspot	Polished stone axe found on Skegness beach	1970	Upper beach
154	2.8	Roman	HER LI41687	Findspot	Romano British greyware sherd, found on the beach in Skegness	1970	Upper beach
156	2.6	Roman	HER LI41637	Monument	Roman ditch, Ingoldmells	1964	Upper beach
157	2.6	Roman	HER LI41633	Monument	Possible Romano-British pottery scatter, Ingoldmells	1976	Upper beach
158	2.7	Roman	HER LI41650	Monument	Hand bricks and base of gritty jar, Ingoldmells	1981	Upper beach
158	2.7	Iron Age	HER LI41664	Monument	Iron Age to Roman saltworking, Ingoldmells	1953	Upper beach
159	2.7	Bronze Age	HER LI41670	Monument	Human remains, Ingoldmells	1983	Upper beach

Table 3: HER sites and findspots recorded on the beach after commencement of 1994 replenishment

Site no	Fig no	Period	NMR/HER ref	Class	Description	Date discovered	Location
26	3.2	Saxon	HER LI43148	Findspot	Wattle hurdle or structure exposed on the tidal flats at Sutton on Sea	1995	Lower beach
48	2.3	Neolithic	HER LI43463	Findspot	Butt end of a Langdale VI type axe found on the foreshore in clay at Moggs Eye,	1996	Lower beach
49	2.4	Palaeolithic	HER LI43430	Findspot	Lower Palaeolithic blade	1996	Upper beach

15 Appendix 3: Archaeological findspots, sites and monuments in the study areas, recorded on the NMR and Lincolnshire HER

Site no	Fig no	Period	NMR/HER ref	Class	Description	Date discovered
1	3.1	Post-medieval	HER 289.007	Grade 2 listed building	Tennysons Cottage, Quebec Road	N/A
2	3.1	Post-medieval	HER 289.008	Grade 2 listed building	Pump at Tennysons Cottage, Quebec Road	N/A
3	2.1	Neolithic	HER LI41427	Findspot	Flint axe from Mablethorpe, found in shingle on the beach	1930
4	3.1	Post-medieval	HER LI43506	Monument	Mablethorpe and Sutton railway station	N/A
5	3.1	Post-medieval	HER LI43426	Monument	Wreck of a boat on the foreshore	1992
6	3.1	Post-medieval	HER LI43425	Monument	Wreck of a boat on the foreshore	1992
7	2.1	Neolithic	NMR 356005	Monument	Neolithic axe found at low water mark	1934
7	2.1	Iron Age	NMR 356005 HER LI41436	Monument Findspot	Iron Age occupation site with huts. Site exposed after storm and then covered over again. Iron Age pygmy urn found	1963
7	2.1	Roman	NMR 356005 HER LI41437	Monument	Roman occupation site with huts. Roman pottery and a hoard containing coins found, dating from Augustus to the mid-4th century AD.	1934
7	3.1	Medieval	NMR 356005 HER LI41438	Monument	Medieval finds including pottery.	1963
8	3.1	Post-medieval	HER LI43424	Monument	Wreck of a boat on the foreshore	1992
9	2.1	Roman	HER LI41439	Monument	Roman Flavian bowl and coin hoard found at Mablethorpe	1943 1948
10	3.1	Post-medieval	NMR 1075133	Monument	Convalescent home of 1871 by James Fowler. A bath house was added in 1875 supplied with both salt and fresh water. Now demolished.	N/A
11	3.1	Post-medieval	NMR 1429625	Monument	Rectangular pillbox, with 3 bays.	N/A
12	3.1	Medieval	HER LI41450	Monument	Pottery found Trusthorpe	No date
13	3.1	Post-medieval	NMR 498305	Monument	A tower mill built in 1881 for cereal milling. It ceased working in 1935 only the base remains and is now used as a store.	N/A
14	3.1	Medieval	HER LI43684	Monument	Medieval remains, Seaholme Road	1992
14	2.1	Roman	HER LI43685	Monument	Romano British material	1997
15	3.1	Medieval	HER LI41448	Monument	Moated site, Trusthorpe	1952

16	3.1	Post-medieval	NMR 498304	Monument	Windmill of uncertain date, Trusthorpe	N/A
17	3.1	Post-medieval	HER 289.001	Grade 2 listed building	Church of St Peter	N/A
18	2.1	Roman	HER LI41452	Findspot	Romano British pottery found in Trusthorpe on the beach	1969
19	3.1	Post-medieval	HER 289.006	Grade 2 listed building	Bourne Farm Cottage, Main Street	N/A
20	2.1	Neolithic	HER LI41449	Findspot	Flint axe found Trusthorpe	1930
21	2.1	Roman	NMR 356014 HER LI41444	Monument	Romano British pottery found Sutton On Sea	1953
22	3.1	Medieval	HER LI43658	Monument	Part of a medieval ridge and furrow system	N/A
23	3.2	Post-medieval	HER LI43423	Monument	Wreck of a boat on the foreshore	1992
24	3.2	Post-medieval	NMR 356008 HER LI41446	Monument	Post-medieval clay extraction pits for using clay to build and repair sea defences, found in the inter-tidal zone following severe storms, when the sand was washed of the beach, most notably in 1953. Previously thought to be a salt making. The HER records this as the medieval village that was washed into the sea at Sutton On Sea	1953
25	3.2	Post-medieval	HER LI41440	Findspot	Pewter spoon found in clay on the foreshore at Sutton On Sea	1981
26	3.2	Saxon	HER LI43148	Findspot	Wattle hurdle or structure exposed on the tidal flats at Sutton on Sea	1995
27	3.2	Post-medieval	HER LI43422	Monument	Wreck of a boat on the foreshore	1992
28	3.2	Post-medieval	NMR 1380897	Monument	Wesleyan methodist chapel built in 1910 by John Wills and Sons.	N/A
29	3.2	Post-medieval	HER LI43675	Monument	Sutton On Sea to Alford tramway	N/A
30	3.2	Medieval	HER LI41456	Monument	Manor Farm. Placename evidence	N/A
31	2.2	Roman	HER LI43089	Monument	Romano British pottery	1992
31	3.2	Medieval	HER LI43090	Monument	Medieval settlement remains	1992
31	3.2	Saxon	HER LI43659	Monument	Late Saxon pottery	1992
32	3.2	Post-medieval	HER LI43411	Monument	Railway signal box	N/A
33	3.2	Post-medieval	HER 289.012	Grade 2 listed building	Wavelands, Furlongs Road	N/A
34	3.2	Post-medieval	HER 289.010	Grade 2 listed building	Marsoville, Furlongs Road	N/A
35	3.2	Post-medieval	HER 289.011	Grade 2 listed building	Lindum, Furlongs Road	N/A
36	3.2	Post-medieval	HER LI43412	Monument	Railway station, Sutton On Sea	N/A

36	3.2	Post-medieval	NMR 507089	Monument	Sutton on Sea station	N/A
37	3.2	Medieval	HER LI43160	Monument	Medieval ridge and furrow, Cade's Field	1992
38	3.2	Post-medieval	HER 289.004	Grade 2 listed building	Church of St Clement, Huttorft Road	N/A
39	3.2	Medieval	NMR 1314425	Desk Based Assessment	Sutton On Sea to Mablethorpe rising main. Potential for medeival settlement and earthworks on proposed route of the water pipe 1992	N/A
39	3.2	Medieval	NMR 983968	Watching Brief	Sutton On Sea to Mablethorpe rising main. Two phases of evaluation with fieldwalking and trial trenching revealed medieval rectangular enclosure and related features 1992-1993	1992
40	2.2	Bronze Age	NMR 356020 HER LI41443	Findspot	Beaker fragment found on beach at Sutton on Sea	1960
41	3.2	Post-medieval	NMR 839123	Monument	An eighteen-hole seaside links golf course founded in 1901.	N/A
42	2.3	Undated	NMR 893345	Monument	Salt works of unknown date, destroyed by the construction of a golf course.	1901
43	3.3	Medieval	NMR 1059703	Monument	Probable medieval or post medieval enclosure seen as earthworks.	1992
44	3.3	Medieval	HER LI41492	Monument	Medieval pottery found at Huttoft	1962
45	2.3	Roman	NMR 355932 HER LI41495	Findspot	A late 3rd century Roman urn found Huttoft	1951
46	2.3	Roman	NMR 355938	Monument	Romano British beaker found at Huttoft	1952
47	2.3	Roman	HER LI41493	Findspot	Romano British beaker found at Huttoft	1952
48	2.3	Neolithic	HER LI43463	Findspot	Butt end of a Langdale VI type axe found on the foreshore in clay at Moggs Eye,	1996
49	2.4	Palaeolithic	HER LI43430	Findspot	Lower Palaeolithic blade	1996
50	3.4	Medieval	HER LI41601	Monument	Medieval pottery found at the high water mark, Anderby	1974
51	2.4	Roman	NMR 355928 HER LI41607	Findspot	Roman potsherd (4th c.) found in clay at mid tide level, Anderby	1954
52	2.4	Roman	HER LI41608	Findspot	Romano British potsherd	No date
53	3.4	Medieval Post-medieval	NMR 1059662	Monument	Possible Medieval or Post Medieval drains and/or enclosures seen as earthworks.	1992
54	2.4	Roman	NMR 355931 HER LI41602	Findspot	Romano British pottery found at high water mark, Anderby	1974
55	3.4	Post-medieval	HER LI43273	Monument	Pillbox of coastal crust at Hogsthorpe	N/A
56	3.5	Post-medieval	NMR 1418952	Monument	Type 22 pillbox.	N/A
57	3.5	Post-medieval	NMR 1059863	Monument	Possible Medieval, Post Medieval or potentially Modern enclosure seen as cropmarks.	1992
58	2.5	Neolithic	HER LI41613	Findspot	Worked flint flake from Chapel St Leonard's	1972
59	3.5	Post-medieval	NMR 1412035	Monument	Orlit post	N/A

60	3.5	Post-medieval	NMR 1412034	Monument	Royal observer corps monitoring post	N/A
61	2.5	Roman	HER LI41623	Findspot	Greyware rim found on the shore at Chapel St Leonard's	1965
62	3.5	Medieval	NMR 355944 HER LI41624	Monument	Possible medieval salt works recorded from documentary sources, located on foreshore at Chapel St Leonard's	1954
63	2.5	Roman	NMR 355971	Monument	Roman pottery found on the shore, north of Chapel Point	1965
64	2.5	Bronze Age	NMR 355965	Monument	Bronze Age scraper found at Chapel Point, to the rear of the old gun position	1960
65	3.5	Post-medieval	NMR 1419834 HER LI43279	Monument	Base of hexagonal pillbox.	N/A
65	2.5	Bronze Age	HER LI41614	Findspot	Flint scraper found, Chapel St Leonard's	1959
66	2.5	Bronze Age	HER LI41622	Findspot	Bronze Age dagger found on the beach at Chapel St Leonard's	1964
67	2.5	Bronze Age	NMR 355959	Monument	Early Bronze Age flint dagger found on beach	1964
68	2.5	Roman	NMR 355953 HER LI41625	Findspot	Romano British gritted jar (3rd c.) found on sandy foreshore	1960
69	3.5	post-medieval	NMR 1059861	Monument	Probable pit of unknown date seen as cropmarks.	1992
70	3.5	Post-medieval	NMR 1326303	Desk Based Assessment	Land off Skegness Road. Earthwork survey in 1999 recorded no archaeology	N/A
71	3.5	Post-medieval	NMR 1375555	Monument	Primitive Methodist chapel built in 1836	N/A
72	3.5	Post-medieval	NMR 1352768	Watching Brief	Land off St Leonard's Drive. No archaeology discovered 1999	N/A
73	3.5	Medieval	HER LI41610	Monument	Medieval pottery found Chapel St Leonard's	1960
74	2.5	Roman	NMR 1086392 W/B 1065621 HER LI43304	Watching Brief	Unspecified Roman remains at Sea Road.	1995
74	3.5	Medieval	NMR 1086392 W/B 1065621	Watching Brief	Medieval remains, Sea Road	1995
75	3.5	Medieval	HER LI41619	Monument	Shrunken medieval village, Mumby Chapel	1959
76	3.5	Medieval	HER LI84267	Findspot	Sherd of medieval pottery, Chapel Farm Drive, Chapel St Leonard's	2002
77	3.5	Post-medieval	NMR 355962 HER LI41621 HER 095.001	Grade 2 listed building	St Leonard's Church (18th c.) (? on site of 16th c. church).	N/A
77	3.5	Post-medieval	HER LI41620	Monument	Mumby Chapel	N/A
78	3.5	Medieval	HER LI41618	Monument	Earthworks, Chapel St Leonard's	1959
79	2.5	Roman	HER LI41612	Findspot	Romano British greyware and base of human skull found Chapel St Leonard's	1967
80	2.5	Roman or Prehistoric	NMR 355974	Monument	Antler pick	1969

81	2.5	Neolithic	HER LI41616	Findspot	Neolithic flint axe found on beach, Chapel St Leonard's	1976
82	3.5	Post-medieval	NMR 1059869	Monument	Probable World War II searchlight battery seen as earthworks, now levelled and visible as cropmarks.	1992
83	2.6	Roman	HER LI41611	Findspot	Romano British greyware, Chapel St Leonard's	1966
84	2.6	Roman	NMR 355968	Monument	Roman pot found in blue clay at a depth of 10 ft, during an excavation to install a petrol tank, at Chapel St Leonard's	1965
85	3.5	Medieval	HER LI41626	Monument	Medieval salt pans and pottery found just below high water mark	1951
86	2.6	Roman	HER LI41615	Findspot	Romano British sherd found at low tide mark, Chapel St Leonard's	1967
87	2.6	Iron Age to Roman	HER LI43342	Monument	Trunch Lane briquetage site	1990
87	2.6	Iron Age to Roman	HER LI43347	Monument	Trunch Lane briquetage site	1990
88	2.6	Iron Age to Roman	HER LI43348	Monument	Enclosures in intertidal zone	1990
89	2.6	Iron Age	HER LI41667	Monument	Iron Age saltern site, Ingoldmells exposed in 1954 and again in 1979	1954
89	3.6	Medieval	HER LI41668	Monument	Medieval salt working site, Ingoldmells exposed in 1954	1954
90	3.6	Medieval	HER LI41669	Monument	Medieval salt working site, Ingoldmells	1964
91	2.6	Iron Age	HER LI87088	Monument	Iron Age or Roman salt working site, North of Ingoldmells Point	1979
92	2.6	Roman	HER LI87090	Findspot	Silver Denarius, Vickers Point, Ingoldmells	1953
93	3.6	Medieval	HER LI41636	Findspot	Medieval pilgrim ampulla, Anchor Lane, Ingoldmells	1979
94	2.6	Iron Age	HER LI41651	Monument	Saltern sites, Ingoldmells	1976
95	3.6	Post-medieval	NMR 1060749	Monument	Potential enclosure of unknown date seen as cropmarks.	1992
96	2.6	Roman	HER LI41652	Monument	Roman Saltern site, Ingoldmells	1976
97	2.6	Iron Age Roman	HER LI43341	Monument	Iron Age to Roman saltworks, Vickers Point (south), Ingoldmells	1990
98	2.6	Palaeolithic	HER LI41635	Findspot	Mammoth tooth found on foreshore at Ingoldmells	1973
99	3.6	Post-medieval	NMR 1060752 HER LI87077	Monument	Potential enclosure of unknown date seen as earthworks. Ingoldmells	1992
100	2.6	Iron Age	HER LI41660	Monument	Early Iron Age saltern, Ingoldmells	1964
101	3.6	Post-medieval	NMR 1347968	Watching Brief	Land north-east of the parish church. No archaeology found, 2000	N/A
101	3.6	Modern	NMR 1377001	Evaluation	Land at Ingoldmells. Modern cropmark discovered 2000	N/A
102	3.6	Medieval	HER LI41653	Monument	Medieval saltern site, Ingoldmells	1976
103	2.6	Iron Age	HER LI41661	Monument	Early Iron Age saltworkings, Ingoldmells	1964
203	3.6	Post-medieval	NMR 1350993	Monument	Ann. English brigantine, 1873	N/A

104	2.6	Iron Age	HER LI41658	Monument	Early Iron Age saltworking site, Ingoldmells	1964
105	3.6	Post-medieval	NMR 1347967	Watching Brief	Land at Sun City, Ingoldmells Point. No archaeology discovered, 2000	N/A
106	2.6	Undated	NMR 355868 HER LI41634 HER LI41645	Monument Findspot Monument	Hut circle group. (Wooden piles, clayfloors & briquetage). Ingoldmells Undated cooking pot	1907
107	2.6	Roman	NMR 355841 HER LI41639	Monument	A possible Roman occupation site dated by pottery to the 2nd to 4th centuries with finds of animal bones. Ingoldmells	1952
108	2.6	Undated	HER LI41649	Monument	Undated saltern site, exposed during beach erosion at Ingoldmells	1980
109	2.6	Roman	HER LI87091	Findspot	Roman coin Ingoldmells Point, Ingoldmells	1983
109	2.6	Roman	HER LI87092	Findspot	Roman hand bricks, Ingoldmells Point, Ingoldmells	1983
110	3.6	Medieval	NMR 355844 HER LI41648	Monument	Possible Medieval salt-working site.	1964
111	3.6	Post-medieval	NMR 1419835 HER LI43280	Monument	Type 22 pillbox in river embankment. Ingoldmells Point.	N/A
112	3.6	Post-medieval	HER LI41630	Findspot	Pewter plates. Ingoldmells	No date
113	3.6	Medieval	HER LI80708	Monument	Roman Bank, Ingoldmells	2000
114	3.6	Post-medieval	NMR 1347969	Watching Brief	Land at Roman Bank, Fantasy Island Theme Park. No archaeology discovered, 2000	N/A
115	2.6	Iron Age	HER LI41654	Monument	Iron Age saltern site, Ingoldmells	1971
116	2.6	Iron Age	HER LI41655	Monument	Iron Age saltern site, Ingoldmells	1971
117	2.6	Iron Age Roman	NMR 1343747	Excavation	Ingoldmells beach. Humber Wetlands Project in 2000 located an Iron Age saltern and waterchannel, and also a Roman saltern	2000
118	2.6	Roman	NMR 355847 HER LI41641	Monument	Supposed Roman site, now covered by sea defences. Ingoldmells	1964
119	3.6	Post-medieval	NMR 1060743	Monument	Potential enclosure of unknown date seen as earthworks.	1992
120	3.6	Medieval	HER LI41632	Findspot	Bronze horseshoe shaped artefact, Ingoldmells	1970
121	2.7	Undated	HER LI41647	Monument	Salt workings, Ingoldmells	1964
122	3.6	Post-medieval	NMR 1060740	Monument	Possible Medieval or Post Medieval enclosures and boundaries seen as earthworks, but now built over.	1992
123	3.6	Post-medieval	NMR 1419838 HER LI43283	Monument	Type 22 pillbox with large machine gun embrasure. South of Ingoldmells, Butlins Holiday Camp	N/A
124	2.7	Roman	NMR 355853 HER LI41640	Monument	Romano-British pottery scatter, Ingoldmells	1964
125	2.7	Iron Age	NMR 355850 EX 633091	Excavation	Iron Age salt-workings, briquetage, pottery including Belgic. Ingoldmells Point 1932	1932
126	2.7	Iron Age	HER LI41663	Monument	Iron Age saltworking site, Ingoldmells	1954
127	2.7	Iron Age	HER LI41662	Monument	Iron Age saltworking site, exposed in mud on the beach at Ingoldmells	1954

128	3.7	Post-medieval	HER 240.003	Grade 2 listed building	Gardeners Cottage, by Addlethorpe Avenue	N/A
129	2.7	Undated	HER LI41646	Monument	Clay cylinders and bricks found Ingoldmells	1964
130	2.7	Undated	NMR 355856	Monument	Clay cylinders, bricks, etc.	1930
131	3.7	Medieval	HER LI41675	Monument	Moated site, Skegness	1930
131	3.7	Medieval	NMR 355871	Monument	Medieval moat seen as earthworks. Probable site of a, now demolished, Medieval manor house	N/A
132	3.7	Post-medieval	NMR 1060738	Monument	Possible Medieval or Post Medieval enclosure and boundary seen as earthworks, but now built over.	1992
133	3.7	Post-medieval	NMR 1060737	Monument	Potential World War II anti-aircraft battery seen as earthworks but now built over.	1992
134	3.7	Post-medieval	NMR 1419837 HER LI43281	Monument	Coastal battery includes platform with two holdfasts for 6in gun and engine room.	N/A
135	3.7	Medieval	HER LI41680	Monument	Grange Farm, place name evidence	N/A
136	3.7	Post-medieval	NMR 762367	Monument	Derbyshire Miners Convalescent Home 1927	N/A
137	3.7	Post-medieval	NMR 837725	Monument	An eighteen-hole links and parkland golf course founded in 1910 and designed by James Braid	N/A
138	3.7	Post-medieval	HER 397.013 HER 397.016 HER 397.017 HER 397.018 HER 397.019	Grade 2 listed buildings	Nos 1 to 5 St Andrew's Drive	N/A
139	3.7	Post-medieval	NMR 1419839 HER LI43284	Monument	Square concrete pillbox or observation post, entered by tunnel.	N/A
140	3.7	Post-medieval	HER 397.003	Grade 2 listed building	Gateposts to Ivy House	N/A
141	3.8	Post-medieval	HER 397.002	Grade 2 listed building	Ivy House Farm, Houseburgh Road.	N/A
142	3.8	Medieval	HER LI41688	Monument	Medieval pottery found Skegness	1964
142	3.8	Post-medieval	HER LI41689	Monument	Post-medieval pottery,Skegness	1964
143	2.8	Undated	NMR 355901	Findspot	Perforated stone hammer.	1957
144	3.8	Post-medieval	HER 397.001	Grade 2 listed building	Ship Hotel, Castleton Boulevard	N/A
145	2.8	Bronze Age	HER LI41698	Findspot	Perforated stone hammer found at Skegness	1957
146	3.8	Post-medieval	NMR 1075131	Monument	Skegness Town Hall	N/A
147	3.8	Post-medieval	NMR 1074020	Monument	Skegness and district hospital	N/A
148	3.8	Post-medieval	HER 397.014	Church	Church of St Matthew, Scarborough Avenue	N/A
149	3.8	Post-medieval	NMR 1380319	Monument	Wesleyan Methodist chapel built in 1881-2 by Charles Bell	N/A

150	3.8	Post-medieval	NMR 355908	Monument	Skegness Pier, built 1880	N/A
151	2.8	Neolithic	HER LI41691	Findspot	Polished stone axe found on Skegness beach	1970
152	3.8	Post-medieval	NMR 1380312	Monument	Baptist chapel built in 1911 by John Wills and Sons	N/A
153	3.8	Post-medieval	HER 397.011	Grade 2 listed building	Jubilee Clock Tower, Lumley Road	N/A
154	2.8	Roman	HER LI41687	findspot	Romano British greyware sherd, found on the beach in Skegness	1970
154	2.8	Roman	HER LI41709	findspot	Brothel token found on Skegness beach	No date
155	3.5	Post-medieval	HER LI41617	Findspot	Latten spoon found Chapel St Leonard's	1996
156	2.6	Roman	HER LI41637	Monument	Roman ditch, Ingoldmells	1964
157	2.6	Roman	HER LI41633	Monument	Possible Romano-British pottery scatter, Ingoldmells	1976
158	2.7	Roman	HER LI41650	Monument	Hand bricks and base of gritty jar, Ingoldmells	1981
158	2.7	Iron Age	HER LI41664	Monument	Iron Age to Roman saltworking, Ingoldmells	1953
159	2.7	Bronze Age	HER LI41670	Monument	Human remains, Ingoldmells	1983
160	3.6	Undated	HER LI80732	Monument	Cropmarks and earthworks north of Sea Lane	No date
161	2.6	Iron Age	NMR 355956 HER LI41817	Monument	Iron Age saltern site indicated by briquetage, to north-east of Addlethorpe	1959
162	3.6	Post-medieval	NMR 913199	Monument	Possible remains of amphibious vehicle-DUKW	1969
163	20	Post-medieval	NMR 913206	Monument	Remains of dispersed vessel	1918
164	20	Post-medieval	NMR 913041	Monument	Egret. Remains of Russion merchant steamship, 1917	1917
165	20	Post-medieval	NMR 913204	Monument	Remains of vessel	1963
166	20	Post-medieval	NMR 913205	Monument	Remains of vessel	1963
167	20	Undated	NMR 892359	Monument	Unidentified wreck or obstruction	1921
168	20	Undated	NMR 892358	Monument	Possible obstruction	1960

169	20	Undated	NMR 892357	Monument	Wreck, condition unknown	1963
170	20	Undated	NMR 892356	Monument	Obstruction	No date
171	20	Post-medieval	NMR 943166	Monument	Ahamo. British Tanker 1941	1941
172	3.1	Post-medieval	NMR 1351323	Monument	Admiral. 1891 wreck of Scottish trawler which foundered 14 miles east of Spurn Head while en route from Grimsby for Swansea	N/A
172	3.1	Post-medieval	NMR 1351108	Monument	Mercy. English sloop, 1878	N/A
172	3.1	Post-medieval	NMR 1349980	Monument	York Merchant. English billyboy, 1858	N/A
172	3.1	Post-medieval	NMR 1349950	Monument	Zorgalia. Barque, 1857	N/A
172	3.1	Post-medieval	NMR 1351063	Monument	Beecher Stowe. English barque, 1876	N/A
172	3.1	Post-medieval	NMR 1351833	Monument	Harriet. British cargo vessel, 1824	N/A
172	3.1	Post-medieval	NMR 1349911	Monument	Frederica. British cargo vessel, 1854	N/A
172	3.1	Post-medieval	NMR 1352176	Monument	British drifter, 1941	N/A
172	3.1	Post-medieval	NMR 1366208	Monument	Fortitude. 1836 English brig which was wrecked off or near Mablethorpe, en route from Newcastle-upon-Tyne to London	N/A
172	3.1	Post-medieval	NMR 1343062	Monument	Hurricane MK IIC BN232. British fighter, 1942	N/A
172	3.1	Post-medieval	NMR 1342964	Monument	Friends. British cargo vessel, 1813	N/A
172	3.1	Post-medieval	NMR1318002	Monument	Craft, 1627	N/A
173	3.1	Post-medieval	NMR 1346719	Monument	William. 1819 wreck of English brig which foundered off Trusthorpe after a collision on passage from Sunderland	N/A
173	3.1	Post-medieval	NMR1359929	Monument	Cargo vessel, 1825	N/A
173	3.1	Post-medieval	NMR 1350098	Monument	John and Harriet. Craft, 1823	N/A
174	3.1	Medieval	NMR 1068183	Monument	Probable Medieval settlement and associated ridge and furrow seen as earthworks.	N/A
175	3.2	Post-medieval	NMR 1302347	Monument	Betsey. British craft, 1834	N/A
175	3.2	Post-medieval	NMR 1351186	Monument	Industry. English sloop, 1883	N/A

175	3.2	Post-medieval	NMR 1347849	Monument	Charlotte Augusta. Cargo vessel, 1820	N/A
175	3.2	Post-medieval	NMR 1316673	Monument	Freedom. English craft, 1854	N/A
175	3.2	Post-medieval	NMR 1302127	Monument	Star. English dandy, 1895	N/A
175	3.2	Post-medieval	NMR 1351826	Monument	Lizzie Lee. English schooner, 1893	N/A
175	3.2	Post-medieval	NMR 1316087	Monument	Apollo. English cargo vessel, 1832	N/A
176	3.2	Undated	NMR 1185413	Monument	The cropmarks of two possible sub-rectangular ditched enclosures are visible on air photographs (1998). The enclosures measure approximately 5m by 4m and 10m by 8m. They may be aligned on a ditch boundary to the north	N/A
177	3.5	Post-medieval	1351315	Monument	Vibilia. Norwegian schooner, 1891	N/A
177	3.5	Post-medieval	NMR 1345902	Monument	Charles and Mary. English craft, 1818	N/A
177	3.5	Post-medieval	NMR 1302399	Monument	Vive. English ketch, 1880	N/A
177	3.5	Post-medieval	NMR 1356378	Monument	British heavy bomber, 1943	N/A
178	3.5	Medieval	NMR 355947	Monument	Probable Medieval salt works seen as earthworks and pottery finds	N/A
179	3.5	Medieval	NMR 1059865	Monument	Possible Medieval or Post Medieval water meadow seen as earthworks, now levelled	N/A
180	3.6	Post-medieval	NMR 1336682	Monument	And Esther. 1795 wreck of English craft which stranded on the coast of Lincolnshire; a wooden sailing vessel	N/A
180	3.6	Post-medieval	NMR 1342862	Monument	Gute Mutter. 1813 wreck of Prussian cargo vessel which stranded on the coast of Lincolnshire en route from Riga to Kingston-upon-Hull with logwood; a wooden sailing vessel	N/A
180	3.6	Post-medieval	NMR 1301852	Monument	Greyhound. British cargo vessel, 1762	N/A
180	3.6	Post-medieval	NMR 1348707	Monument	Adventure. 1821 wreck of British craft which stranded on the coast of Lincolnshire during a storm, en route from Whitby to Wisbech; a wooden sailing vessel	N/A
180	3.6	Post-medieval	NMR 1301871	Monument	Ferdinand Elenora. Craft, 1768	N/A
180	3.6	Post-medieval	NMR 1349030	Monument	Prussian cargo vessel, 1821	N/A
180	3.6	Post-medieval	NMR 1301947	Monument	British craft, 1785	N/A
180	3.6	Post-medieval	NMR 1339400	Monument	Union Mary. Craft, 1803	N/A

180	3.6	Post-medieval	NMR 1344658	Monument	Good Hope. 1816 wreck of English cargo vessel which stranded on the coast of Lincolnshire during a gale, on her passage in ballast; a wooden sailing vessel	N/A
180	3.6	Post-medieval	NMR 1301873	Monument	Gouldsberry. Cargo vessel, 1768	N/A
180	3.6	Post-medieval	NMR 1347879	Monument	Gothenburg. Swedish cargo vessel, 1821	N/A
180	3.6	Post-medieval	NMR 1341918	Monument	Hoy, 1810	N/A
180	3.6	Post-medieval	NMR 1301945	Monument	Baltick Merchant. British cargo vessel, 1784	N/A
180	3.6	Post-medieval	NMR 1351781	Monument	Vrow Gesina. 1824 wreck of cargo vessel, probably Dutch, which stranded on the coast of Lincolnshire en route from Lubeck to Grimsby; a wooden sailing vessel	N/A
180	3.6	Post-medieval	NMR 1341872	Monument	Margaret. English craft, 1810	N/A
180	3.6	Post-medieval	NMR 1338899	Monument	George. 1802 incident in which a British craft grounded on the coast of Lincolnshire, to be recovered shortly afterwards; a wooden sailing vessel	N/A
180	3.6	Post-medieval	NMR 1343985	Monument	Armen. British cargo vessel, 1815	N/A
180	3.6	Post-medieval	NMR 1348655	Monument	English sloop, 1821	N/A
180	3.6	Post-medieval	NMR 1301944	Monument	Kent. British craft, 1781	N/A
180	3.6	Post-medieval	NMR 1346563	Monument	Patent. British cargo vessel, 1819	N/A
181	3.6	Undated	NMR 1060753	Monument	Potential boundaries of unknown date seen as earthworks	N/A
181	3.6	Post-medieval	HER LI87076	Monument	Earthwork linear feature, Ingoldmells	No date
182	3.6	Post-medieval	HER LI87074	Monument	Earthwork linear feature, Ingoldmells	No date
183	3.2	Undated	NMR 1060744	Monument	Potential enclosure of unknown date seen as earthworks	N/A
184	3.7	Medieval	NMR 1060734	Monument	Probable Medieval ridge and furrow seen as earthworks	N/A
185	3.7	Post-medieval	NMR 1060735	Monument	Probable World War II hexagonal pillboxes seen on air photographs	N/A
186	3.8	Post-medieval	NMR 1350025	Monument	Alexandra. Sailing vessel, 1867	N/A
186	3.8	Post-medieval	NMR 1349851	Monument	Venelia. Brig, 1852	N/A
186	3.8	Post-medieval	NMR 1301867	Monument	Liberty In The North. Cargo vessel, 1768	N/A
187	3.4	Post-medieval	NMR 1059704	Monument	World War II aircraft obstructions seen as earthworks	N/A
188	3.4	Post-medieval	NMR 1059707	Monument	Banks of unknown function, probably Medieval or post Medieval, seen on air photographs	N/A

189	3.5	Post-medieval	NMR 1363806	Monument	Handley Page Halifax Mark II British heavy bomber. One of a batch of 200 aircraft of this type delivered between January 1942 and July 1943, by the London Aircraft Group	N/A
190	3.7	Post-medieval	NMR 1060684	Monument	Probable Medieval ridge and furrow seen as earthworks	N/A
191	3.1	Post-medieval	HER LI41455	Monument	St Peter's Church, Trusthorpe	N/A
192	3.5	Post-medieval	HER LI83352	Monument	Post medieval earthworks, off Skegness Road	N/A
193	3.6	Medieval	HER LI87066	Monument	Medieval field system, Ingoldmells	N/A
194	3.2	Undated	HER LI87073	Monument	Earthwork linear feature, Ingoldmells	No date
195	3.6	Medieval	HER LI87068	Monument	Medieval field system, Ingoldmells	N/A
196	3.6	Post-medieval	HER LI87079	Monument	Butlins Holiday Camp, Ingoldmells	N/A
197	3.7	Medieval	HER LI87067	Monument	Late medieval ridge and furrow	N/A
198	3.7	Medieval	HER LI87069	Monument	Medieval boundary and enclosure, Ingoldmells	N/A
199	3.2	Undated	HER LI87072	Monument	Earthwork linear feature, Ingoldmells	No date
200	3.8	Post-medieval	HER LI86086	Monument	Settlement of Skegness	N/A
200	3.8	Post-medieval	HER LI86086	Monument	Settlement of Skegness	N/A
201	20	Post-medieval	NMR 1302298	Monument	Achilles. English ketch, 1914	N/A
201	20	Post-medieval	NMR 1302227	Monument	Stockton. English cargo vessel, 1909	N/A
201	20	Post-medieval	NMR 1354135	Monument	Spitfire MK I X4353. British fighter, 1942	N/A
201	20	Post-medieval	NMR 1306205	Monument	Robert. English schooner, 1841	N/A
201	20	Post-medieval	NMR1321617	Monument	Full rigged ship, 1878	N/A
201	20	Post-medieval	NMR 1342677	Monument	Hannah. 1812 wreck of English cargo vessel which stranded on the Inner Dowsing en route from London to Gothenburg	N/A
201	20	Post-medieval	NMR1363714	Monument	English cargo vessel, 1873	N/A

201	20	Post-medieval	NMR 1302364	Monument	Onesta. Italian cargo vessel, 1917	N/A
201	20	Post-medieval	NMR 1316026	Monument	Susannah. British craft, 1827	N/A
202	20	Post-medieval	NMR 1352076	Monument	Laurium. British cargo vessel, 1918	N/A
202	20	Post-medieval	NMR 1349672	Monument	Antiope. English cargo vessel, 1941	N/A
202	20	Post-medieval	NMR 1349656	Monument	Trajan. Norwegian cargo vessel, 1941	N/A
202	20	Post-medieval	NMR 1349717	Monument	Glendalough. British cargo vessel, 1943	N/A
202	20	Post-medieval	NMR 1302111	Monument	Wide Awake. English dandy, 1895	N/A
202	20	Post-medieval	NMR 1349669	Monument	Czestochowa. Polish cargo vessel, 1941	N/A
202	20	Post-medieval	NMR 1348216	Monument	Freidig. Unknown, 1890	N/A
203	20	Post-medieval	NMR 1351292	Monument	Cargo vessel, 1823	N/A
203	20	Post-medieval	NMR 1351111	Monument	Kron Prinz Ernst August. German schooner, 1878	N/A
203	20	Post-medieval	NMR 1354383	Monument	Whitley MK VII Z6960. British heavy bomber, 1942	N/A
203	20	Post-medieval	NMR 1354212	Monument	Wellington MK IV Z1285. British heavy bomber, 1942	N/A

203	20	Post-medieval	NMR 1302304	Monument	Torquay. Norwegian cargo vessel, 1914	N/A
203	20	Post-medieval	NMR 1352096	Monument	Polzella, British cargo vessel, 1928	N/A
203	20	Post-medieval	NMR 1351202	Monument	Wonderful. English ketch, 1883	N/A
203	20	Post-medieval	NMR 1370570	Monument	H Smethhurst. An English dandy which burnt and foundered 22 miles east of Spurn Head	N/A
203	20	Post-medieval	NMR 1354038	Monument	Hampden MK I X3021. British bomber, 1941	N/A
203	20	Post-medieval	NMR 1323066	Monument	Blenheim MK IV R3765. British bomber, 1940	N/A
203	20	Post-medieval	NMR 1351150	Monument	Dora, English smack, 1880	N/A
203	20	Post-medieval	NMR 1371004	Monument	Ipswich. English cargo vessel, 1763	N/A
203	20	Post-medieval	NMR 1351097	Monument	Don Colino. Channel Island schooner, 1877	N/A
203	20	Post-medieval	NMR 1350022	Monument	Olive. English smack, 1865	N/A
203	20	Post-medieval	NMR 1302213	Monument	Seagull. British lugger, 1904	N/A
203	20	Post-medieval	NMR 1352230	Monument	English cargo vessel, 1945	N/A
203	20	Post-medieval	NMR 1350987	Monument	Leonie. French cargo vessel, 1871	N/A

203	20	Post-medieval	NMR 1370547	Monument	William and Susannah. An English dandy which collided with another vessel and foundered 14 miles east of New Sand light vessel in 1889	N/A
203	20	Post-medieval	NMR 1370602	Monument	Sarah. An English schooner which foundered 18 miles south east of Spurn Head in 1891	N/A
201	20	Post-medieval	NMR 1306215	Monument	Hunter. English craft, 1841	N/A
204	3.6	Post-medieval	NMR 1316084	Monument	Jenny. British cargo vessel, 1831	No date
204	3.6	Post-medieval	NMR 1347896	Monument	Brothers and sisters. 1821 wreck of English sloop which foundered off Ingoldmells; a wooden sailing vessel.	No date
204	3.6	Post-medieval	NMR 1316022	Monument	Dutch cargo vessel, 1830	No date
204	3.6	Post-medieval	NMR 1360375	Monument	Drie Zusters. 1826 wreck of Dutch craft which stranded near Ingoldmells after departing from Kingston-upon-Hull for Amsterdam; a wooden sailing vessel.	No date

16 Appendix 4: Supporting data and relevant studies

Resource	Relevance to future assessment
Albone, J, 2001–2002 An Archaeological Resource Assessment of Anglo-Saxon Lincolnshire, *The East Midlands Archaeological Research Framework Project*, http://www.le.ac.uk/archaeology/research/projects/eastmidsfw/pdfs/28lincas.pdf	Useful reference document and bibliography, specific to Lincolnshire
AMEC, 2003 Lynn offshore wind-farm, Environmental Statement, non-technical summary, http://www.entecuk.com/downloads/pp_696.pdf	Good for background information on this general area of Southern North Sea and east coast
Balson, P, Butcher, A, Holmes, R, and Johnson, H, 2001 North Sea Geology: Technical Report produced by the BGS for Strategic Environmental Assessment - SEA 2 & SEA 3. London: Department of Trade and Industry.	Excellent background assessment document outlining geology of North Sea, covers entire east coast of England and Scotland
Bellamy, A, G, 1995 Extension of the British landmass: evidence from shelf sediment bodies in the English Channel, in R C Preece (ed) Island Britain: a Quaternary Perspective, Geological Society, London, Special Publication, 96, 47–62	Excellent academic study of Quaternary of south coast of England, useful background for replenishment schemes in this area
Bellamy, A, G, 1998 The UK marine sand and gravel dredging industry: an application of Quaternary geology, in J P Latham (ed) *Advances in Aggregates and Armourstone Evaluation*, Geological Society, London, Engineering Geology Special Publications, 13, 33–45	Useful document linking archaeological themes with dredging interests, applicable to any replenishment scheme
Bellamy, A, G, 2002 Coastal Defence and Marine Aggregate Dredging off the UK, BMAPA publication, http://www.bmapa.org/pdf/coastal.pdf	Useful for information on the dredging industry, applicable to any replenishment scheme
Bennet, M, 2001–2002 An Archaeological Resource Assessment of the Roman Period in Lincolnshire, *The East Midlands Archaeological Research Framework Project*, http://www.le.ac.uk/archaeology/research/pro	Useful reference document and bibliography, applies to Lincolnshire area only

jects/eastmidsfw/pdfs/23linrom.pdf	
BMAPA, 2002 Aggregates from the sea, http://www.bmapa.org/pdf/brochure.pdf	Useful for information on the dredging industry, applicable to any replenishment scheme
BMAPA, 2002 Seabed Dredging: The Area Involved, http://www.bmapa.org/pdf/brochure.pdf	Useful for information on the dredging industry, applicable to any replenishment scheme
BMAPA, index of pdfs, http://www.bmapa.org/pdf/	Lots of different sorts of documents on dredging and related environmental concerns, applicable to any replenishment scheme
Brampton, A, H, and Evans, C, D, R, 1998 *Regional seabed sediment studies and assessment of marine aggregate dredging*, CIRIA, London	Useful for information on the dredging industry and geology, applicable to any replenishment scheme
Coles, B, J, 2000 Doggerland: the cultural dynamics of a shifting coastline, in K Pye and S R L Allen (Eds) *Coastal Environments: Sedimentology, Geomorphology, and Geoarchaeology*, Geological Society Special Publication No 175, 393–401, The Geological Society, London	Excellent academic study, outlining geology and archaeology of southern North Sea, applicable to any east coast replenishment scheme
Defra, 2002 Futurecoast: Prediction of Future Coastal Evolution for SMP Review, Defra report, http://www.defra.gov.uk/environ/fcd/futurecoast.htm	Excellent guide to shoreline management planning, applicable to any replenishment scheme
Defra, 2003 Procedural Guidance for Production of Shoreline Management Plans, http://www.defra.gov.uk/corporate/consult/smpguidance/consultdoc.pdf	Excellent guide to shoreline management planning, applicable to any replenishment scheme
Fox, R, A, 2002 The Offshore Aggregate Industry in the UK, http://www.bmapa.org/pdf/offshore.pdf	Useful for information on the dredging industry, applicable to any replenishment scheme
Gibbard, P, L, 1988 The History of the great northwestern European rivers during the past 3 million years, Philosophical Transactions of the Royal Society of London, B3 1 8, 559–602	Useful academic study, relevant to east and south-east region
Halcrow, 1989 Historical review of the performance of groynes on the Lincolnshire Coast, Environment Agency report, Anglian Region	General background into history of coastal defence in Lincolnshire, applicable to Lincolnshire coast only
Hollinsworth, C, 1997 The Marine Option, *Quarry Management*, Feb 1997, 17–22	Useful for information on the dredging industry, applicable to any replenishment scheme
Horton, B, 2002 University of Durham, Sea	Excellent academic study outlining geology,

Level Research Unit, web site showing tidal models at different dates for the North Sea and UK coasts, http://www.dur.ac.uk/geography/research/researchclusters/?mode=centre&id=301	archaeology and coastal change in North Sea, applicable to any east coast replenishment scheme
HR Wallingford, 2005 Map of seabed sediment transport indicators, http://www.sns2.org/project-outputs.html	Useful technical information on the dredging industry and coastal/offshore processes, relevant to any replenishment scheme adjacent to Southern North Sea
HR Wallingford, 2005 Review of aggregate dredging and disposal activities in the study area, http://www.sns2.org/project-outputs.html	Useful technical information on the dredging industry and coastal/offshore processes, relevant to any replenishment scheme adjacent to Southern North Sea
HR Wallingford, 2005 Review of shoreline management plans, http://www.sns2.org/project-outputs.html	Useful technical information about shoreline management, relevant to any replenishment scheme
HR Wallingford, 2005 Summary of sediment sources and sinks, http://www.sns2.org/project-outputs.html	Useful technical information on the dredging industry and coastal/offshore processes, relevant to any replenishment scheme adjacent to Southern North Sea
HR Wallingford, 2005 Summary of sediment transport processes including defining and plotting of transport rate, http://www.sns2.org/project-outputs.html	Useful technical information on the dredging industry and coastal/offshore processes, relevant to any replenishment scheme adjacent to Southern North Sea
Humphreys, B, Coates, T, Watkiss, M and Harrison, D, 1996 *Beach recharge materials – demand and resources*, Report 154, CIRIA	Useful for information on the dredging industry and geology, applicable to any replenishment scheme
Kenyon, N, H, Belderson, R, H, Stride, A, H, and Johnson, M, A, 1981 *Offshore tidal sandbanks as indicators of net sand transport and as potential deposits*, Spec. Publs. inst. Ass. Sediment. Vol 5, 257–268	Useful technical information on the dredging industry and coastal/offshore processes, relevant to any replenishment scheme adjacent to Southern North Sea
Masters, P, M, and Flemming, N, C, 1983 *Quaternary Coastlines and Marine Archaeology*, Academic Press, London and New York	Excellent academic study, outlining geology and archaeology of southern North Sea, applicable to any east coast replenishment scheme
Membery, S, 2001–2002 An Archaeological Resource Assessment of the Palaeolithic in Lincolnshire, *The East Midlands Archaeological Research Framework Project*, http://www.le.ac.uk/archaeology/research/projects/eastmidsfw/pdfs/04linpal.pdf	Useful reference document and bibliography, relevant only to Lincolnshire
Membery, S, 2001–2002 An Archaeological Resource Assessment of the Mesolithic in	Useful reference document and bibliography, relevant only to Lincolnshire

Lincolnshire (c.9,000–6,000), *The East Midlands Archaeological Research Framework Project*, http://www.le.ac.uk/archaeology/research/projects/eastmidsfw/pdfs/09linmeso.pdf	
Membery, S, 2001–2002 An Archaeological Resource Assessment of the Neolithic and Early Bronze Age in Lincolnshire, *The East Midlands Archaeological Research Framework Project*, http://www.le.ac.uk/archaeology/research/projects/eastmidsfw/pdfs/13lincneba.pdf	Useful reference document and bibliography, relevant only to Lincolnshire
Membery, S, 2001–2002 An Archaeological Resource Assessment of the Later Bonze and Iron Ages (First Millenium BC) in Lincolnshire, *The East Midlands Archaeological Research Framework Project*, http://www.le.ac.uk/archaeology/research/projects/eastmidsfw/pdfs/18lincs1stmill.pdf	Useful reference document and bibliography, relevant only to Lincolnshire
Murray, L, 1994, Sand and gravel extraction for beach recharge – is conflict with fisheries inevitable? MAFF report, http://www.bmapa.org/pdf/sandand.pdf	Useful reference document
Newell, R, C, and Reeds, K, A 2005 Marine ALSF Science Review: Aggregate Research in UK Waters, annual research review, Defra, Marine Ecological Surveys Limited	Useful reference document
Oxley, I, and O'Regan, D, 2005 The Marine Archaeological Resource, IFA paper no 4,http://www.archaeologists.net/modules/icontent/inPages/docs/pubs/maritime_resource.pdf	Useful background document, relevant to any replenishment scheme
Shennan, I, Lambeck, K, Flather, R, Horton, B, McArthur, J, Innes, J, Lloyd, J, Rutherford, M, and Wingfield, R 2000 Modelling western North Sea palaeographies and tidal changes during the Holocene, in I Shennan and J E Andrews (eds), *Holocene Land–Ocean Interaction and Environmental Change around the North Sea*, Geological Society Special Publication No166, 299–319	Definitive academic study, technical analysis. Useful background for any replenishment related research
Shennan, I, Lambeck, K, Horton, B, Innes, J, Lloyd, J, McArthur, J, and Rutherford, M., 2000 Holocene isostasy and relative sea-level changes on the east coast of England, in I Shennan and J E Andrews (eds), *Holocene*	Definitive academic study, technical analysis. Useful background for any replenishment related research

Land–Ocean Interaction and Environmental Change around the North Sea, Geological Society Special Publication, 166, 275–298	
Tann, G 2004 Lincolnshire Coastal Grazing Marsh Archaeological and Historical Data Collection, Report for Lincolnshire Wildlife Trust, on behalf of English Heritage and Lincolnshire County Council Conservation Section, Lindsey Archaeological Services, Report No. 770, September 2004.	Excellent and up to date study documenting the archaeology of the Lincolnshire coast, emphasis more on marshes than inter-tidal area, however. Useful only for Lincolnshire
The Crown Estate, 2003 The Area Involved – 6th Annual Report http://www.thecrownestate.co.uk/40_aggregate_dredging_6th_arpt_-_inserts.pdf, http://www.thecrownestate.co.uk/40_aggregate_dredging_6th_arpt.pdf	Useful background document, relevant to any replenishment scheme
UK CHM, 2005 Case studies: soft engineering techniques for high and low energy coasts, http://www.chm.org.uk/library/ecosys/marine/ETMC002.pdf	Useful background document, relevant to any replenishment scheme
UK CHM, 2005 Soft engineering techniques for high and low energy coasts, http://www.chm.org.uk/library/ecosys/marine/ETMC001.pdf	Useful background document, relevant to any replenishment scheme
University of Leicesterhttp://www.le.ac.uk/archaeology/research/projects/eastmidsfw/	Useful website detailing up to date archaeological research framework for east midlands area (includes coastal regions)
Wenban-Smith, 2002, Palaeolithic and Mesolithic Archaeology and the Sea-bed: Marine Aggregate Dredging and the Historic Environment, Wessex Archaeology report	Useful background document, relevant to any replenishment scheme
Wessex Archaeology, 2004 England's Shipping: Year 2 Report, Wessex Archaeology	Useful background document, relevant to any replenishment scheme
Wessex Archaeology, 2004, Artefacts From The Sea, English Heritage	Useful background document, relevant to any replenishment scheme
Wright, N, R, 2001–2002 An Archaeological Resource Assessment of Modern Lincolnshire (c. 1750–1960), *The East Midlands Archaeological Research Framework Project*, http://www.le.ac.uk/archaeology/research/projects/eastmidsfw/pdfs/43lincmod.pdf	Useful reference document and bibliography, relevant only to Lincolnshire

17 Appendix 5: OASIS DATA COLLECTION FORM

OASIS ID: molas1-10909

Project details

Project name	BEACH REPLENISHMENT AND DERIVED ARCHAEOLOGICAL MATERIAL
Short description of the project	This project takes the form of a desk-based assessment, to examine the relationship between the historic environment and beach replenishment schemes, by exploring deposition of archaeological material on replenished beaches and their former offshore contexts. The Mablethorpe to Skegness coast has been used as a case study. Analysis has revealed that the Mablethorpe to Skegness coast has a high potential for survival of archaeological remains dating to all periods. In particular, it has potential for Prehistoric and Roman remains. It has also been shown that there is potential for the survival of Palaeolithic and Mesolithic remains in the vicinity of dredging areas 107 and 440, although the probability of such remains being disturbed during dredging is thought to be low. Analysis of coastal processes indicates that any derived archaeological material is likely to be found on the upper beach, where the coarse material from areas 107 and 440 is redistributed to. If such finds are made in an area where post-replenishment erosion is known to be low, then the probability that they have originated from an offshore context increases. Should such finds be made in an erosion hotspot, however, where the beach sometimes erodes back down to the clay substrate level, the probability decreases. This is because it would be virtually impossible to differentiate between pre-existing and derived Prehistoric remains under such circumstances. The study concludes that there is a low risk for the redeposition of archaeological deposits from the North Sea floor onto the beaches between Mablethorpe and Skegness.
Project dates	Start: 05-05-2005 End: 31-10-2005
Previous/future work	Not known / Not known
Any associated project reference codes	4000 MAIN - Contracting Unit No.
Type of project	Desk based assessment
Current Land use	Coastland 2 - Inter-tidal
Current Land use	Coastland 2 - Inter-tidal
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Methods & techniques	'Documentary Search'
Development type	Mineral extraction (e.g. sand, gravel, stone, coal, ore, etc.)
Development type	beach replenishment scheme
Prompt	Research

Project location

Country	England
Site location	LINCOLNSHIRE EAST LINDSEY MABLETHORPE AND SUTTON Mablethorpe to Skegness beach replenishment scheme
Postcode	LN12 2XX
Study area	60000.00 Square metres
National grid reference	TF 50600 85100 Point
Height OD	Min: -5.00m Max: 5.00m

Project creators

Name of Organisation	MoLAS
Project brief originator	English Heritage/Department of Environment
Project design originator	MoLAS
Project director/manager	Richard Malt
Project supervisor	Jo Lyon
Sponsor or funding body	English Heritage

Project bibliography 1

Grey literature (unpublished document/manuscript)

Publication type	
Title	BEACH REPLENISHMENT AND DERIVED ARCHAEOLOGICAL MATERIAL
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