Appendix 5.10-C

Marine Cultural Report by PAL

Appendix 5.10-C-1

Marine Archaeological Sensitivity Assessment

MARINE ARCHAEOLOGICAL SENSITIVITY ASSESSMENT
CAPE WIND ENERGY PROJECT

Nantucket Sound, Massachusetts

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MANAGEMENT ABSTRACT

PAL completed a marine archaeological sensitivity assessment of approximately 24 square miles of sea floor in Nantucket Sound comprising the Cape Wind Associates, LLC's (CWA) offshore "wind park" study area. CWA is proposing to generate electrical energy for the regional electric grid by constructing an offshore energy generation facility consisting of 130 interconnected wind turbine generators (WTG) and an electric service platform (ESP). The WTG array and associated ESP are to be located in federal waters. Energy generated by the WTG array will be transmitted to shore via a buried submarine electrical transmission cable system extending through Commonwealth waters to a proposed landfall within Lewis Bay, in Yarmouth, Massachusetts. An alternative route for the transmission cable system with landfall within Poppenesset Bay Mashpee is also being considered. The proposed project is subject to both state and federal review and permitting.

The goal of the marine archaeological sensitivity assessment was to review existing data and complete a sensitivity assessment of the project area, including historic and Native American contexts, based on an in-depth study of land and water use history, current conditions, proposed plans, and proximity to favorable environmental characteristics and known archaeological sites. The results of the investigation will be used to assist CWA in preparing research design and methodology for an archaeological survey of the overall project study area.

The study's goals were met through a review of existing project geophysical and geotechnical data, MA SHPO archaeological site files and CRM reports, published information on the area's environmental, Native, and Euro-American histories, and shipwreck databases. Source information was synthesized to develop predictive models for Native American and historic archaeological resources that may be present within the project area.

Background research and analyses of preliminary geophysical and geotechnical data performed by PAL has resulted in the conclusion that the Cape Wind Energy Project offshore study area has potential for containing submerged Native American and historic cultural resources. A portion of the study area may also contain submerged Native American cultural resources. However, the data indicate that a majority of the offshore study area has a low probability for containing submerged Native American cultural resources, because of the extensive disturbance to the formerly exposed and inhabitable pre-inundation landscape that has resulted from the marine transgression of the area.

A marine archaeological remote sensing reconnaissance survey of the offshore study area to identify targets that may represent submerged historic cultural resources is recommended. Additional survey to further characterize the origin, nature, and extent of organic sediments observed in vibratory coring samples recovered from the eastern edge of the offshore study area is recommended to further define the potential for Native American cultural resources to be present.

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CHAPTER ONE

INTRODUCTION

Cape Wind Associates, LLC (CWA) is currently planning to develop an offshore "wind park" to generate 420 MW of electrical energy for the regional electric grid. The offshore site being considered for the Cape Wind Energy Project encompasses approximately 24 square miles and is located in waters ranging in depth from approximately seven to 62 feet centered on Horseshoe Shoal, Nantucket Sound, Massachusetts (Figure 1-1 and Figure 1-2). The proposed offshore energy generation facility will consist of 130 wind turbine generators (WTGs) interconnected by 33 kV low voltage electrical cables buried beneath the sea floor to a central offshore electric service platform (ESP) in the wind park. A 115 kV low voltage buried submarine cable system consisting of two paired-cable circuits spaced approximately 20 feet apart will run from the ESP to a horizontally directionally-drilled (HDD) conduit positioned 700 to 500 feet from the cable system's landfall within Lewis Bay, in Yarmouth, Massachusetts. From this landfall, an upland transmission system will be installed in an underground conduit system along existing roadways and an existing NSTAR Electric right-of-way to its terminus at the Barnstable Switching Station. An alternative route for the 115 kV low-voltage buried submarine cable system with landfall in Poppenesset Bay, in Mashpee, Massachusetts, is also proposed.

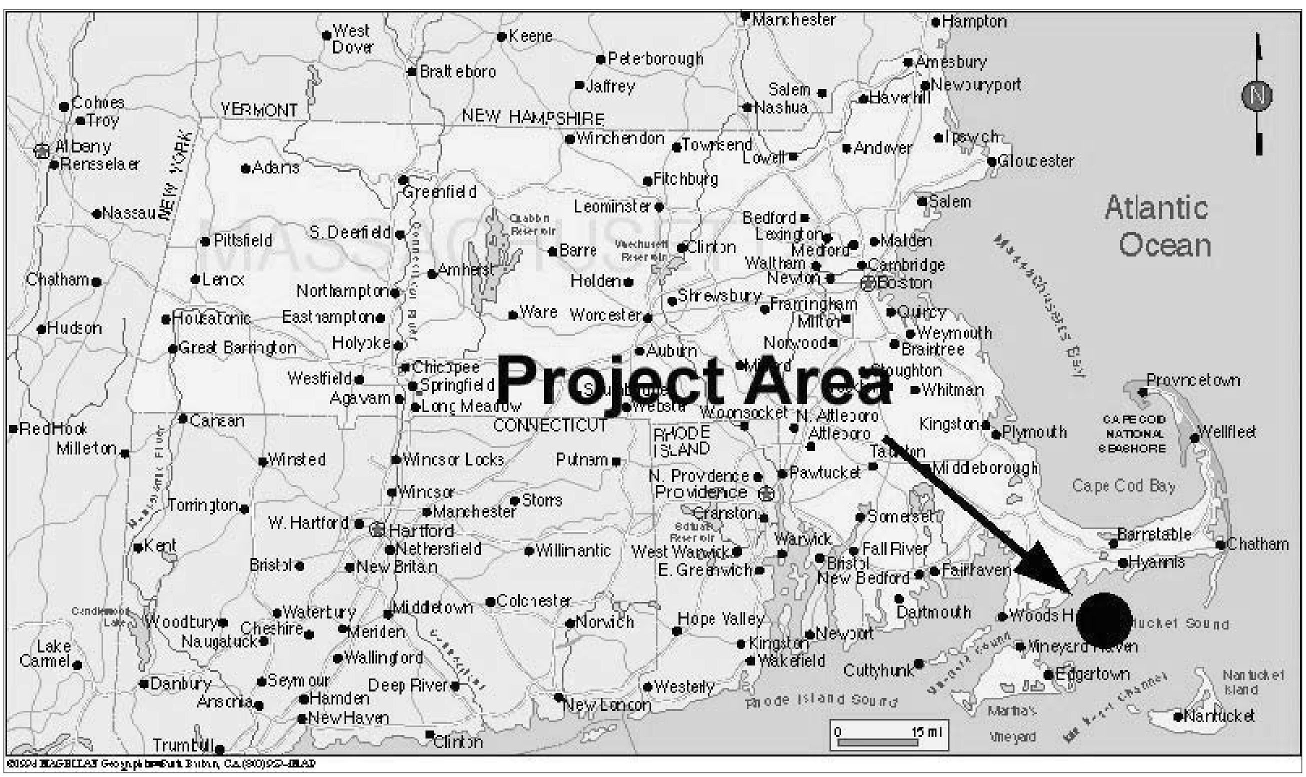

Figure 1-1. General location of Cape Wind Energy Project's offshore wind park.

The project engineering firm, Environmental Science Services, Inc. (ESS), is assisting CWA with engineering and design services and is currently coordinating and completing the project's scoping and regulatory review process. During the course of this process, PAL has been retained to provide cultural resource management services for both the terrestrial and offshore planning and permitting elements of the project related to cultural resources.

Figure 1-2. Cape Wind Energy Project offshore study area.

In response to a request from ESS and CWA to assess the marine archaeological sensitivity of the Cape Wind Energy Project offshore study area, PAL has prepared this technical report to:

- summarize the offshore project study area's environmental and cultural histories;
- inventory known marine archaeological sites (e.g., shipwrecks, submerged habitation sites, etc.) within the project study area, and;
- provide predictive statements about the project study area's archaeological sensitivity for submerged Native American and historic cultural resources.

No archaeological fieldwork was conducted for this study. This document summarizes the results of PAL's background research to determine archaeological sensitivity of the offshore portion of the study area.

Project Description

Current plans for the CWA Wind Energy Project provided to PAL by project engineers, ESS, in February 2003 indicate that the northernmost WTG will be located approximately 4.5 miles from the nearest point of land on the Cape. The southeastern portion of the wind park will be 11 miles from Great Point, Nantucket Island. The westernmost WTGs will be 5.5 miles from Martha's Vineyard.

The WTGs will be arranged in parallel rows, and spaced 0.34 to 0.56 miles apart. Each WTG will be mounted on a steel tower supported by a monopile foundation. The main support tower will have a base diameter of approximately 16 feet. The pile will be driven to a design depth of approximately 85 feet into the sea floor by means of a drop hammer mounted on a jack-up barge with a crane. The jack-up barge will have four to six legs with pads that measure about 15 feet square. Each pile will be hollow and will contain bottom material that is displaced inside the pile. A sea floor scour control system consisting of six, approximately 10 x 15-foot mats with eight anchors will be installed on the sea floor around each WTG monopile.

Each WTG will interconnect with the ESP located within the approximate center of the array field. The ESP will be a fixed template platform consisting of a jacket frame fitted with six, 36-inch diameter piles. Each of the ESP's six piles will be driven to a depth of 90 feet to anchor the platform to the seafloor.

The project's submarine cabling will be installed using a hydroplow embedment process, more commonly referred to as "jet plowing." This installation method entails use of a positioned cable lay barge and a towed hydraulically powered jet plow device that will simultaneously lay and embed the submarine cable in one continuous trench between the WTGs and the ESP.

The lay barge will propel itself along the route and holds position with a six-point mooring system and two, 60-inch diameter spuds. When the lay barge nears the ESP, the barge's spuds will be lowered to secure the barge in place for the final end-float and pull-in operation. The installation barge's anticipated dimensions will be 24 x 100 x 400 feet. Two anchor handling tugs will also be used. Each anchor cable will be 1-1/8-inch thick, have a maximum scope of 2,000 feet, and be fitted with a pendant wire and 58-inch steel balls for deployment and quick recovery. Also on site during installation will be an auxiliary trencher pulling barge, which will be a small barge of 40 x 100 feet in length outfitted with spuds. The actual trenching operation will be performed using a skid/pontoon-mounted jet plow, which will create a four to six-foot wide x eight-foot deep trench for the cable, with minimal deposition of sediment outside the trench. The two circuits of the interconnecting transmission lines linking the ESP to landfall will also be embedded by jet plowing, which will create two parallel trenches of the same dimensions described above, with approximately twenty feet of horizontal separation between them.

Project Personnel

This study was conducted between December 2002 and February 2003. PAL staff involved in the project included Deborah Cox (project manager), David Robinson (principal investigator), Holly Herbster and Joseph Waller, Jr. (project archaeologists), Ben Ford (project historian/CAD technician), and Jessi Halligan (project assistant).

The transfer of project data, reports, figures, and maps generated from previous offshore geophysical and geotechnical survey and environmental analyses was coordinated with ESS's Sarah Faldetta.

Disposition of Project Materials

All supporting documentation collected during the course of this study is on file at PAL, 210 Lonsdale Avenue, Pawtucket, Rhode Island 02860.

CHAPTER TWO

RESEARCH DESIGN AND METHODOLOGY

PAL's research design and methodology employed for this investigation was developed to characterize the potential marine archaeological sensitivity of the Cape Wind Energy Project offshore study area. Archaeological sensitivity is defined as the likelihood for archaeological sites to be present within a particular area based on different categories of information. In the case of the study area, such sites could potentially include submerged Native American settlement loci, historic shipwrecks, and/or inundated historic built resources along the coast. Characterization of the study area's archaeological sensitivity entailed consideration of previously documented offshore archaeological resources, the geomorphological history and sedimentary environments of the Nantucket Sound area, Native American and historic settlement and subsistence patterns, and Euro-American historic settlement and maritime activity patterns. To meet the objectives of this archaeological sensitivity assessment study, PAL completed a review of:

- existing geophysical and geotechnical survey data (seismic sub-bottom profiler, side scan sonar, magnetometer, and bathymetric records) included in OSI's Final Report - *Marine Geophysical Survey and Sediment Sampling Program, Cape Wind Energy Project, Nantucket Sound, MA* (2002), and ESS's vibratory coring logs and photographs;

- cultural resource management reports and site files at the Massachusetts Historical Commision (MHC) and the Massachusetts Board of Underwater Archaeological Resources (MBUAR);

- the National Oceanic and Atmospheric Administration's (NOAA) on-line Automated Wreck and Obstruction Information System (AWOIS 2000);

- Northern Maritime Research's Northern Shipwrecks Database (2002);

- environmental studies providing information on the geomorphological history of Nantucket Sound and the effects of the Holocene marine transgression; and,

- town reconnaissance surveys.

Consultation with Native American Tribal Historic Preservation Officers (THPO) or their representatives was not initiated during the course of this investigation.

CHAPTER THREE

ENVIRONMENTAL CONTEXT

The Cape Wind Energy Project offshore study area is located in Nantucket Sound, a broad passage of water separating Cape Cod, a narrow “elbow-shaped” peninsula situated on the Atlantic Coastal Plain in southeastern Massachusetts, and the islands of Martha’s Vineyard and Nantucket (see Figure 1-1). Nantucket Sound represents a relatively young coastal feature that was formed largely by processes associated with the Laurentide glaciation of southern New England ca. 23,000-18,000 BP, during the final or Wisconsin stage of the Pleistocene Epoch (Oldale 1992) (Figure 3-1). While the basic structure of the system was created by glacial transport and subsequent erosion of sediments during glacial melting and retreat, secondary processes of relative sea-level rise, wave and tidal erosion, and sorting and transport of sediments continue to transform both the land-sea margin and the submarine portion of the Sound (OSI 2002).

Figure 3-1. Laurentide Ice Sheet at its glacial maximum (approximately 23,000 B.P.) (after Oldale 1992).

The area that is now Nantucket Sound was once a broad coastal plain composed of Tertiary and Cretaceous sediments that extended seaward to the approximate location of present day Nantucket, Martha's Vineyard, and Block islands prior to glaciation. The underlying bedrock consists of metamorphic rocks, such as schist and gneiss, and igneous rock. The surface of the bedrock generally slopes southeastward from about sea level on the northwestern shore of Buzzard's Bay to as much as 1,600 ft below sea level at Nantucket (Oldale, 1969). The depth to bedrock beneath glacial sediments on Cape Cod ranges from about 80 to 900 feet below sea level (OSI 2002).

The southern terminus of the portion of the continental ice sheet that advanced across Cape Cod to the islands about 23,000 years ago is marked today by gravel deposits on the Continental Shelf and by the outwash plains and moraines on the islands (Figure 3-2). The Cape and islands are composed primarily of glacial end moraines, which mark the approximate locations of the stalled ice fronts and outwash plains that formed from sediments deposited by melt water streams ahead of the ice front. The moraines are composed of poorly- and well-sorted sand, silt, and clay that were transported in the glacial ice and left behind when the ice retreated. The broad outwash plains are mainly composed of sand and gravel that is mixed in places with till and ice-contact deposits of silt and clay. In addition to the outwash and moraine deposits, deeper and older pre-glacial sand and silt are present on Martha's Vineyard and Nantucket (OSI 2002).

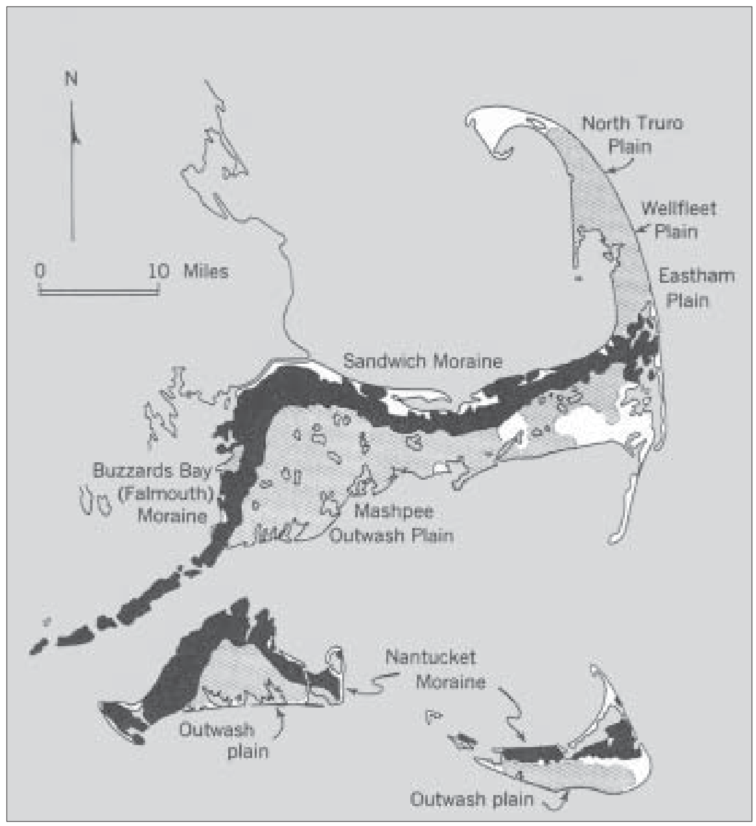

Figure 3-2. Glacial deposits in the Cape and islands region (after Oldale 1992).

The ice sheet that spread across the area was characterized by bulges or "lobes" in the ice front that filled in the large basins in the pre-existing topographic surface. The advance and retreat of these lobes led to the formation of Cape Cod, Nantucket and Martha's Vineyard. The geophysical structure of the Nantucket Sound marine system is most closely linked to the Cape Cod Bay lobe (Figure 3-3), which spread across the Sound to its southernmost point corresponding with northern Nantucket Island. At a point when the glacier's southward advance was halted for more than 1,000 years, a portion of the southern terminal moraine of the Cape Cod lobe was deposited on Nantucket. Glacial till comprising the moraine consisted of soil, decomposed rock, and fragmentary bedrock collected by the ice as it flowed southward across New England (Figure 3-4). Sloping away from the moraine was an outwash plain, formed by deposits of finer materials carried away from the ice front in meltwater flows. Sloping led to a gradation in sediment sorting and a decrease in elevation moving away from the moraine (OSI 2002).

Radiocarbon dating suggests that sometime between 18,000 and 15,000 years BP, climatic warming caused the Cape Cod Bay lobe to rapidly retreat (Oldale 1992) (Figure 3-5). The retreat of the Cape Cod Bay lobe across current Nantucket Sound, coupled with minor re-advances, led to the deposit of recessional moraines, outwash plains, and glacial till sediment. Most, if not all, of the outwash plains were formed as deltas in glacial lakes. The outwash plains on the upper Cape were formed in glacial lakes that occupied Nantucket Sound and Vineyard Sound, and those on the lower Cape were formed in a lake that occupied Cape Cod Bay (Oldale, 1992). The elevation of the terminal and recessional moraines, with outwash plains sloping away from them, helped melt water to erode the outwash plains and to generate outwash channels that were later flooded by rising sea level to create many of the embayments seen today on the southern shore of Cape Cod (Figure 3-6). By about 15,000 years ago, the ice had retreated from the Gulf of Maine and all of southern New England. The post-glacial landscape on the Cape and in the coastal plain area of today's Nantucket Sound was essentially un-vegetated for several thousand years, after which tundra-like conditions prevailed and low bushes, grasses, and stands of arctic trees were common (OSI 2002).

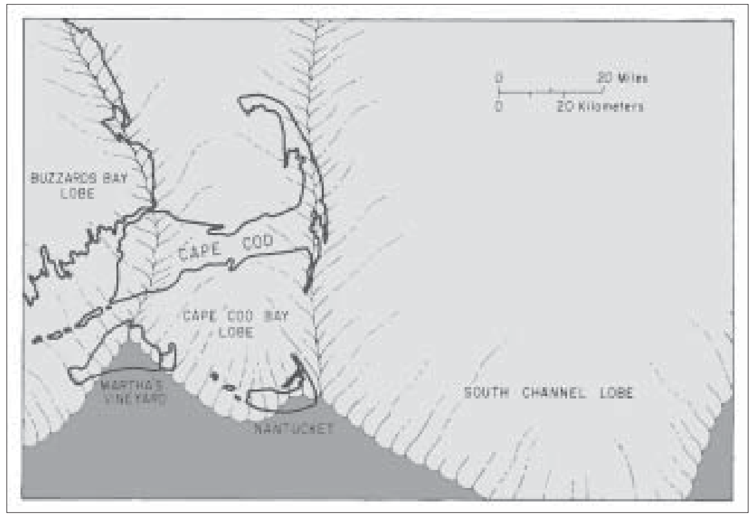

Figure 3-3. Buzzards Bay, Cape Cod, and South Channel glacial lobes (after Oldale 1992).

Nantucket Sound and Sea Level Rise

The retreat, thinning, breakup, and final disappearance of the Laurentide ice sheet did not mark an end to the ice-driven morphological alterations of the New England land-surface. Worldwide melting of the continental ice sheets led to the return of water to the ocean basins and a concomitant rise in global sea level. Initially, up until about 10,000 years ago, sea levels rose quickly at a rate of about 50 feet per 1,000 years. However, as glacial ice volumes decreased, the rate of sea level rise gradually slowed (Figure 3-7). On Cape Cod, the rate of sea-level rise between 6,000 years ago and 2,000 years ago was

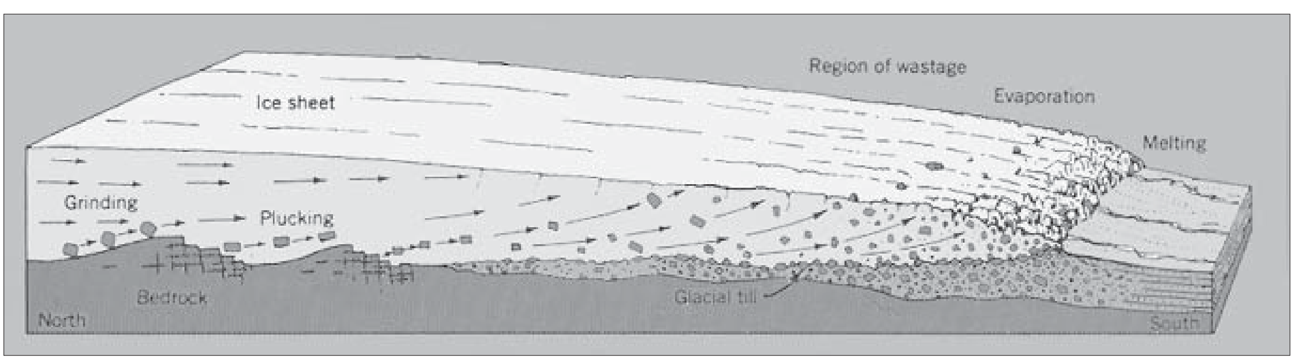

Figure 3-4. Soil, decomposed rock, and fragmentary bedrock collected by the ice as it flowed southward across New England (after Strahler 1966).

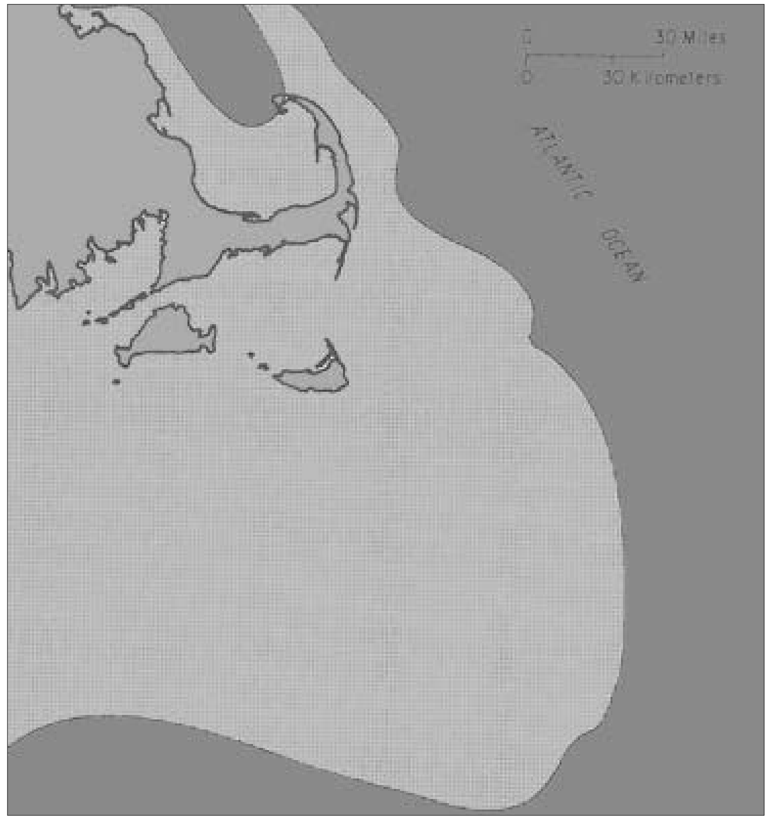

Figure 3-5. Projected extent of sub-aerially exposed outwash plain immediately after glacial retreat (after Oldale 1992).

about 11 feet per 1,000 years. From 2,000 years ago, the rate of sea-level rise was about three feet per 1,000 years. Rates of worldwide sea-level rise have been determined using radiometric ages of submerged shoreline features. Local rates of sea-level rise have been determined through radiocarbon dating of salt-marsh peats, which are considered an accurate indicator of relative sea level (Redfield and Rubin 1962; Oldale 1992; OSI 2002).

In the Cape and islands region, this rise in sea level resulted in the inundation by Atlantic Ocean waters of Cape Cod and Buzzards bays, and Nantucket, Vineyard, and Long Island sounds. As relative sea levels rose, Martha's Vineyard and Nantucket became islands, and the lowland between the Sandwich terminal moraine at Cape Cod and the frontal moraines of Nantucket Island became Nantucket Sound. The lower topography of today's Nantucket Sound probably resulted from a unique combination of events, the first of which was sub-aerial erosion during a period of extremely low sea level in the late Tertiary, and erosion due to meltwaters from the later retreat of the Cape Cod Bay lobe (OSI 2002).

By about 6,000 B.P., the rising sea inundated the low lands that once occupied today's Vineyard and Nantucket sounds, and reached the Cape. The Cape's glacial drift headlands east of the present eastern shoreline were eroded as waves attacked the headlands to form marine scarps or sea cliffs. Eroded material was reworked and transported along the shore by wave-generated longshore drift and currents and re-deposited along the shore to form bay mouth bars, spits, and barrier islands across embayments (OSI 2002).

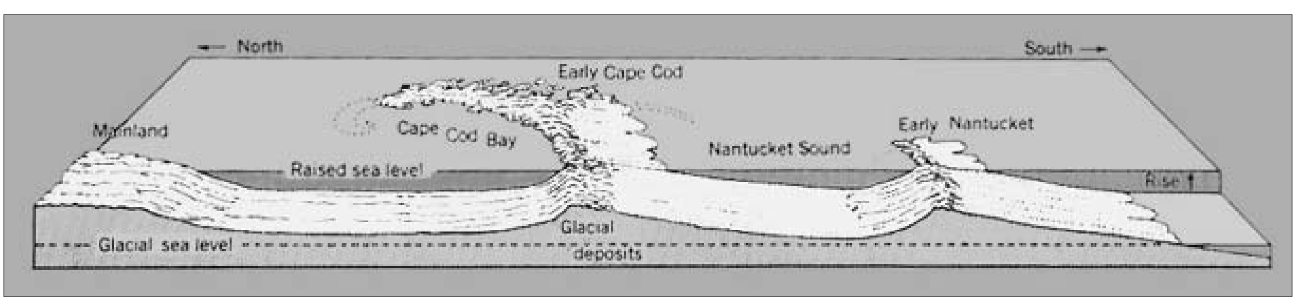

Figure 3-6. Cape and islands topography before and after inundation (after Strahler 1966).

Sediments of Nantucket Sound

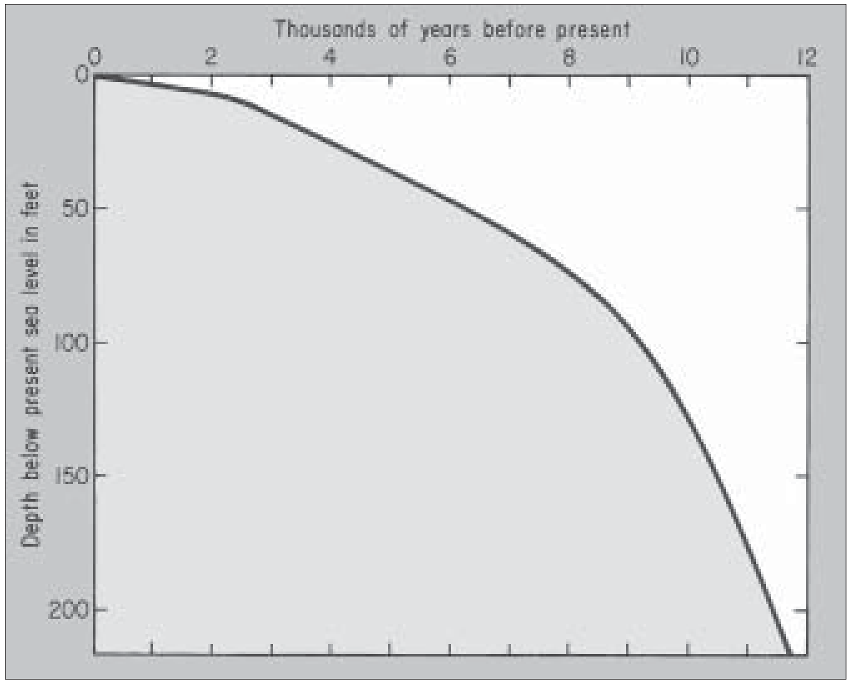

Figure 3-7. Sea level rise – 12,000 B.P. to present (after Oldale 1992).

Surficial sedimentary deposits within the Nantucket Sound are Pleistocene and Holocene in origin. The texture of the glacial drift is coarse with sand size particles most abundant and with little silt and clay (Hough 1940). Gravels and rocks fragments are common within the moraines. The tidal and wind-driven currents are the most important source of energy for sediment transport and sorting within Nantucket Sound. Sediments within the Sound range from muds and silts in the deeper regions, to sands, gravels, and boulders in shallower areas near-shore and near the eastern shoals of the sound.

Silt is found in the deeper, central regions of the sound generally below the 40-foot bathymetric contour, with fine sand along the north side near-shore depositional areas, with medium sand close to shore on the south side. Coarse sand is also associated with the north and northeast shoal areas of the upper sound. Coarse sand areas are swept by stronger currents, which remove finer grained sediments (Moore 1963). Fields of sand waves have been observed and described in Nantucket Sound (OSI 2002).

In addition to providing a mechanism to alter basin sediments, the flooding of the basin allowed for erosion of shoreline deposits by wave action. To date, erosion of headlands and island shores has cut them back many meters. Overall, however, the change in the shoreline has been modest due to the abundant boulders in the glacial drift areas (Hough 1940). The sub-tidal topography of Nantucket Sound has undergone alterations as well, mainly smoothing resulting from erosion of shoals and increased deposition in hollows. However, like the beaches, the shoals (formed from the same materials) also form a coarse surface layer slowing their erosion. An example of this is the Nantucket Shoal, which is a conspicuous submerged sand and gravel shallow ridge extending southeastward from Nantucket Island (Limeburner and Beardsley, 1982) (OSI 2002).

Existing Environmental Conditions

A program of integrated geophysical/hydrographic survey and sediment sampling conducted in the offshore project area by OSI in June, July, August, and November of 2001 provided data for project engineers to assess and characterize seafloor and sub-seafloor conditions prior to the design, construction, and installation of the Cape Wind Energy Project's wind turbine array field and associated cable system. The primary objectives of the survey were to identify water depths, seafloor morphology and structural features (bedrock/till outcrops, silt, clay, sand, etc.), sub-seafloor stratigraphy, and any natural or anthropogenic obstructions on and below the seafloor. Five, east to west oriented lines spaced 5,236 feet apart, and 14 lines oriented north to south and spaced 2,743 feet apart were investigated within the WTG array field area. Three lines, spaced 500 feet apart, were surveyed along the centerline routes of the proposed 115 kV low voltage buried submarine cable system to Yarmouth and to Cotuit (OSI 2002). Geophysical data contained in the OSI report and geotechnical data provided by ESS were reviewed by PAL to identify potential shipwrecks and assess the current environmental conditions within the Cape Wind Energy Project's offshore study area.

WTG Array Field

Water depths within the WTG array field measured between 7.7 and 62.5 feet in depth. The shallowest depths were recorded along southern leg of Horseshoe Shoal. The area of maximum depth is located in the eastern limit of the study area. A 60-foot deep basin-like bathymetric low exists within the east-central portion of the array field area between the northern and southern legs of Horseshoe Shoal. A 50-foot deep east to west trending channel feature was documented on the southern leg of the shoal.

The surface of the seafloor within the array field was observed to include areas that were flat and featureless, areas with pronounced sand wave features, and an irregular area in the western portion of the array field probably caused by patches of submerged aquatic vegetation. The sand waves are oriented north to south and range in height from one to 16 feet, with four to five feet being the average height. The largest sand waves were recorded within the aforementioned east to west trending channel. During the course of the survey, sands were observed to migrate with the ebb and flow of tidal currents between east and west. The WTG array field's shallow (i.e., 10 feet or less), sub-surface stratigraphy consisted predominantly of fine to medium grain sands, with localized fractions of clay, silt, gravel and/or cobbles, and shell fragments.

Yarmouth Cable Route

The seafloor along the cable route to Yarmouth displayed minor irregularities and had a maximum depth of 40 feet. Three- to five-foot tall sand waves are present in areas along the route. The upper ten feet of the seafloor was determined to contain approximately 10 feet of unconsolidated sediments, ranging in size from clay to gravel with a fraction of shell fragments. Except for an acoustic basement outcrop, there are no notable geological features within this area.

Cotuit Alternative Cable Route

The seafloor along the Cotuit alternative cable route, while relatively flat, contains some irregularities, consisting of sand waves, and what are probably patches of submerged aquatic vegetation. Unconsolidated sediments consisting primarily of fine to medium grain sands, clay, cobbles, and shell fragments comprise the upper 10 feet of the sea floor substrate. A deeply buried sub-surface channel trending to the north was mapped along the route. ESS vibratory core specimens (VC01-C4 and VC01-C5) recovered from opposite sides of what appear in the sub-bottom profiler data to be the banks of this sub-surface channel contained little physical evidence of this feature.

CHAPTER FOUR

NATIVE AMERICAN CULTURAL CONTEXT

Archaeologists and anthropologists have documented almost 12,000 years of human settlement in the de-glaciated terrestrial terrain of southern New England. Professional archaeologists commonly divide the Northeastern Native American record into three general temporal periods: PaleoIndian, Archaic, and Woodland. The latter two periods are further subdivided into Early, Middle, and Late categories with the Late Archaic and Early Woodland periods being separated by a distinct transitional period to which it is referred as the Terminal or Transitional Archaic (Table 4-1). Each general period of the Native American archaeological record is distinguishable on the basis of material culture, specific land use patterns, and occasionally by social indicators.

Following the retreat of thick glacial ice from the region, Cape Cod (part of the Northeast's physiographic Coastal Plain Province) and the then sub-aerially exposed Cape Wind Energy Project's offshore study area were probably populated by relatively small bands of migratory people collectively referred to as PaleoIndians. The timing of the initial population of the Eastern Seaboard by PaleoIndian peoples is presently debated by archaeologists with the discovery of apparent cultural strata and artifacts predating the PaleoIndian "Clovis Culture" or fluted point tradition at the Topper Site in South Carolina and the Cactus Hill Site in Virginia. Similarly, an averaged date of 15,960 radiocarbon years B.P. from reported cultural strata at the Meadowcroft Rock Shelter Site in Pennsylvania predates accepted Clovis dates in the Northeast by nearly 3,000 years (Adovasio 1993). Nevertheless, the earliest unequivocal evidence for the human occupation of the Northeast is associated with the Clovis Culture and dates to 11,120+/- 180 B.P. at the Vail Site in Maine (Gramly 1982). The presence of thick glacial ice in the Northeast until roughly 16,000 years B.P. makes any discussion of a pre-Clovis presence in the region largely academic.

The configuration of Cape Cod has changed significantly since the retreat of the glaciers. Sea levels, low during the glacial period, gradually increased following glacial retreat resulting in the inundation of former shorelines and increasing the levels of fresh water in the groundwater supply, as well as in the ponds and rivers. For at least part of the Native American period, shorelines were much farther offshore than they are today. It is likely that an array of site types and locations have been destroyed or obscured by the rising sea levels on both the northern and southern shores of Cape Cod. By about 4,500 years ago sea levels stabilized and by 3,500 years ago the majority of marshes and swamps on the Cape had formed (Goudie 1977:169).

Up until just a decade ago, early Native American artifacts and/or documented archaeological sites dating from the PaleoIndian and Early and Middle Archaic periods (ca. 12,000 to 5000 B.P.) along the Atlantic Coastal Plain were quite rare. This lack of archaeological data initially led researchers to conclude that unfavorable environmental conditions had resulted in an apparent depopulation of the

Table 4-1. Native American Cultural Chronology for Southern New England.

Period	Years	Identified Temporal Subdivisions[1]	Cultural Aspects
PaleoIndian	12,500–10,000 B.P.[2] (10,500–8000 B.C.)	• Eastern Clovis • Plano	Exploitation of migratory game animals by highly mobile bands of hunter-gatherers with a specialized lithic technology.
Early Archaic	10,000–7500 B.P. (8000–5500 B.C.)	• Bifurcate-Base Point Assemblages	Few sites are known, possibly because of problems with archaeological recognition. This period represents a transition from specialized hunting strategies to the beginnings of more generalized and adaptable hunting and gathering, due in part to changing environmental circumstances.
Middle Archaic	7500–5000 B.P. (5500–3000 B.C.)	• Neville • Stark • Merrimack • Otter Creek • Vosburg	Regular harvesting of anadramous fish and various plant resources is combined with generalized hunting. Major sites are located at falls and rapids along river drainages. Ground-stone technology first utilized. There is a reliance on local lithic materials for a variety of bifacial and unifacial tools.
Late Archaic	5000–3000 B.P. (3000–1000 B.C.)	• Brewerton • Squibnocket • Small Stemmed Point Assemblage	Intensive hunting and gathering were the rule in diverse environments. Evidence for regularized shellfish exploitation is first seen during this period. Abundant sites suggest increasing populations, with specialized adaptations to particular resource zones. Notable differences between coastal and interior assemblages are seen.
Transitional	3600–2500 B.P. (1600–500 B.C.)	• Atlantic • Watertown • Orient • Coburn	Same economy as the earlier periods, but there may have been groups migrating into New England, or local groups developing technologies strikingly different from those previously used. Trade in soapstone became important. Evidence for complex mortuary rituals is frequently encountered.
Early Woodland	3000–1600 B.P. (1000 B.C.–A.D. 300)	• Meadowood • Lagoon	A scarcity of sites suggests population decline. Pottery was first made. Little is known of social organization or economy, although evidence for complex mortuary rituals is present. Influences from the midwestern Adena culture are seen in some areas.
Middle Woodland	1650–1000 B.P. (A.D. 300–950)	• Fox Creek • Jack's Reef	Economy focused on coastal resources. Horticulture may have appeared late in the period. Hunting and gathering were still important. Population may have increased from the previous low in the Early Woodland. Extensive interaction between groups throughout the Northeast is seen in the widespread distribution of exotic lithics and other materials.
Late Woodland	1000–450 B.P. (A.D. 950–1500)	• Levanna	Horticulture was established in some areas. Coastal areas seem to be preferred. Large groups sometimes lived in fortified villages, and may have been organized in complicated political alliances. Some groups may still have relied solely on hunting and gathering.
ProtoHistoric and Contact	450–300 B.P. (A.D. 1500–1650)	• Algonquian	Groups such as the Wampanoag, Narragansett, and Nipmuck were settled in the area. Political, social, and economic organizations were relatively complex, and underwent rapid change during European colonization.

[1] Termed Phases or Complexes
[2] Before Present

Northeast at that time (Fitting 1968; Ritchie 1971). This hypothesis has been rejected in light of new paleoenvironmental data to the contrary (Dincauze and Mulholland 1977; Robinson and Petersen 1992). While sites dating from the PaleoIndian, and Early and Middle Archaic periods remain comparatively rare along the Atlantic Coastal Plain, recent archaeological investigations on Cape Cod (Dunford 1999), in eastern Massachusetts (Cross 1999; Doucette and Cross 1998), in Connecticut (Forrest 1999; Forrest and Jones 2000; Jones 1999; Perry and McBride 2000), and elsewhere (Carr 1996; Gardner 1987) have dramatically increased our existing knowledge about early Native American settlement patterns. These studies also bring into question current survey paradigms for locating sites from these periods in Southern New England. Increasingly, evidence of lowered water levels and an emergent correlation between large wetlands and major water bodies and early Native American archaeological sites suggests that water and its associated food resources were a critical factor in site selection. Hypotheses are now proposed that assert that large Early and Middle Archaic period archaeological sites in proximity to large lakes, rivers, and extensive wetlands with inlets and outlets flushing the system may have been more common on the Coastal Plain, but were submerged by rising sea level (McWeeny and Kellogg 2001).

Virtually every documented PaleoIndian and Early Archaic find reported on the Cape and islands lacks detailed contextualinformation. A single Neville-type projectile point recovered from the Davis Beach Site (19-BN-568), located east of Lewis Bay in Dennis, represents the only evidence for early Holocene occupation in proximity to the mainland portion of the study area. Similarly, Neville and Stark type projectile points have been found at the Felix Neck 4 Site in Edgartown. Known Middle Archaic sites on Nantucket have been discovered within the Nantucket outwash plains near freshwater ponds, creeks, wetland margins, and shoreline bluffs.

Coastal archaeological sites dating from the Late Archaic Period are more common and are documented on mainland locations, such as the Davis Beach Site (19-BN-568) in Dennis, the Snows Creek Drive Site (19-BN-531) in Barnstable, and the Maushop Site (19-BN-791) in Mashpee. Numerous sites are also reported from coastal and inland locations on nearby Nantucket and Martha's Vineyard islands. On Martha's Vineyard, the majority of the Late Archaic through Woodland Period archaeological sites is located along ponds and the shoreline, where fishing and shellfish collection would have taken place. For Nantucket, Late/Transitional Archaic period materials in the central outwash plains are commonly identified from isolated projectile finds. Documented Late Archaic sites include 19-DK-24, 19-DK-25, 19-DK-98, and 19-DK-117 on the Vineyard and the Herrecater Swamp Site, 19-NT-157, and 19-NT-99 on Nantucket. A propensity for Late Archaic sites to be located in coastal settings along with Martha's Vineyard and Nantucket's isolation from the mainland during this period bespeaks of a well-developed maritime economic subsistence base for the period. Most documented Late Archaic sites in the area are components of larger sites with longer-term habitation.

The Woodland Period that followed the Late Archaic in regional prehistory appears to have been a time of dynamic development for local indigenous peoples. The archaeological data suggests that throughout the period there was a gradual but distinct diversification of food sources, along with an increased reliance on shellfish, the refinement of pottery manufacturing, and eventually year-round settlement. The transformation from a foraging way of life toward a more sedentary existence associated with the introduction of plant domestication likely was related to the formation of stable coastal or estuarine environments that supported a varied, rich, and reliable subsistence base. This pattern is preserved along the mid-Cape in proximity to the study area with local collections being dominated by triangular Levanna-type projectile points. Woodland Period sites are similarly the most prevalent cultural components represented in the archaeological records on each of the islands with dozens of habitation, resource extraction and utilization, burial, and habitation sites being documented in immediate proximity to the islands' large salt ponds and estuaries.

Woodland Period archaeological sites are reported all along the mainland coastline and estuaries of Popponesset, Cotuit, East, North, Lewis, and Shoestring bays and Centerville Harbor. Reported Woodland Sites include the Maushop Site (19-BN-791) in Mashpee, the Davis Farm (19-BN-780), Snow Creek Drive (19-BN-531), Bay Street Landing (19-BN-775), Butler (19-BN-511), Birdsall (19-BN-676), and Dunbar Point (19-BN-577) sites in Barnstable, the horticultural Sandy's Point Site (19-BN-647) in Yarmouth, and the Davis Beach Site (19-BN-568) in Dennis (MHC Site Files). Long-term habitation with evidence for horticulture was also recently diagnosed at archaeological site 19-NT-50 on Nantucket and the Hornblower II Site on Martha's Vineyard. The Dunbar Point Site, diagnosed through the recovery of isolated projectile points, overlooks the study area to the southeast. Considering the known aspects of the Woodland settlement system, it is likely that most of the 29 archaeological sites with virtually no reported information in the MHC's archives other than "shell-heap" or mortuary are Woodland in origin, reflecting extensive exploitation and habitation of the southeastern coastal plain throughout the period.

PaleoIndian Period (12,500–10,000 B.P.)

The variability in shorelines and change in levels of fresh water have raised questions about what the Cape looked like and what resources were available when Native American groups first occupied this area. The known early Holocene (post-"Ice Age") sites are nearly all interior or near-interior sites, although it is assumed that saltwater fishing was an important resource and that campsites were located along the coastline as it existed at that time. Projectile points diagnostic of the PaleoIndian Period have been found in riverine and kettle pond settings on the Cape (Davin 1989; Mahlstedt 1987). These projectile points have generally been Eden-like points that appear to associate the occupations of these sites with late PaleoIndian or Early Archaic period occupations. These points are generally manufactured from stone materials that were available from local cobbles in the glacial drift in the moraines or along the beaches.

Early Archaic (10,000–8000 B.P.)

Diagnostic Early Archaic bifurcate-based projectile points have also been found along rivers in the mid-Cape area. On the outer Cape a few Early Archaic sites have been found in interior locations several miles from the current shoreline. Two reported finds are known in the Herring River/Harwich section of the mid-Cape (Bells Neck Road and Halls Field sites) and one bifurcate point was recovered from the outer Cape at Indian Rock (Mahlstedt 1987:4; Towle 1984:304).

In general, the known sites show that Cape Cod was occupied during the early Native American period and that freshwater locations were an important part of the land use patterns. However, known sites dating to these early periods are relatively scarce and components are relatively small compared to those identified for later periods. Archaeological research concerning both the PaleoIndian and Early

Archaic periods on the Cape needs to focus on understanding the resources that would have been exploited at this time. The effects of glaciation and deglaciation were significant factors in determining local environmental conditions. The most obvious was the much greater landmass that was present, because of the lower sea levels. Today, distance to the coast is no more than 10 miles at the widest point. Eight thousand years ago, the distances may have been appreciably greater. Then, the headwaters of the rivers were more than 30 miles from the coast. These rivers, which today are brackish, would have been sources of fresh water, as well as of fish and related plants, waterfowl, and other animals.

Middle Archaic Period (8000–5000 B.P.)

As has been well documented in other locations in southern New England, the number of known sites with diagnostic materials increases greatly in the Middle Archaic Period. Riverine settings continued to be a focus of exploitation during this temporal period. Diagnostic artifacts have been located both in situ and as surface collections in significantly greater numbers than those of the earlier periods. The locations of Middle Archaic sites strongly suggest a broad base subsistence pattern with a particular focus on anadromous fishing.

Middle Archaic depositions have been located adjacent to kettle ponds in both the inner and outer Cape, where rivers are not in close proximity to each other (Davin and Gallagher 1987; McManamon et al. 1984). For example, a Stark projectile point was found at the Round Swamp Site in Bourne (Davin and Gallagher 1987). On the outer Cape, there are only a few scattered indications of Middle Archaic utilization and these are primarily located around kettle hole ponds. The locations of these known sites indicate that freshwater and associated resources were important to Middle Archaic groups (McManamon et al. 1984).

The Bass and Herring rivers on the mid-Cape both contained significant Middle Archaic depositions. In particular, the Farham Collection contains 56 Middle Archaic projectile points, primarily from the Bells Neck Road I (West Harwich), Swan River (19-BN-31)(Dennis), and Blue Rock (19-BN-562) (Yarmouth) sites (Mahlstedt 1987). A concentration of Middle Archaic deposits has been identified in Dennis along the Bass River, including multicomponent sites such as Narrows River 2 (19-BN-761) and 4 (19-BN-763), Mayfair Narrows (19-BN-599), Bass River Lane (19-BN-566), and Nickerson/Bush (19-BN-563) (MHC site files). Middle Archaic stemmed biface and Stark points were also recovered from the Fox-4 and Fox-5 sites, adjacent to the Santuit River in Mashpee (Shaw and Savulis 1988:48, 57).The Kelly's Bay (19-BN-570) and Sea Street Beach (19-BN-586) sites along Dennis's southern shoreline also contained Middle Archaic deposits, indicating that both coastal and interior environments were utilized during this period in the mid-Cape area.

Late/Transitional Archaic Period (4500–3000 B.P.)

Land use patterns on the Cape during the Late Archaic Period are similar to the rest of southern New England. Small Stemmed projectile points, the most frequently found artifact on the mid- and inner Cape areas, have been recovered from a wide variety of environmental settings (Mahlstedt 1985). On the outer Cape, Small Stemmed points are second only to Late Woodland Levanna projectile points (McManamon 1984). The widespread prevalence of these projectile points has been attributed to several different causes including population growth and environmental stress. The latter explanation suggests that a dry spell occurred during the Late Archaic Period. Native American groups would have responded to this by using a wider range of exploitation areas in order not to deplete the existing resources. The majority of the evidence indicates that this style of projectile point was more functional than stylistic or representative of a certain time period or cultural group. Small Stemmed points have frequently been located with Woodland Period ceramics in radiocarbon-dated contexts (Halligan 2000). They appear to have been used from 4000–2000 B.P. and maybe even into the Late Woodland Period (1000–450 B.P.) (Herbster and Cherau 1999, 2001).

Transitional Archaic sites and artifacts are relatively well represented on riverine sites in the mid-Cape area. Artifact collections from the Bass River area show that Susquehanna Tradition projectile points are numerous (Mahlstedt 1987:62). Atlantic and Susquehanna Broad points occur in relatively high densities at the Blue Rock Site in Yarmouth. In comparison, the Herring River area contains a much lower density of Susquehanna artifacts and sites. The Coburn Phase of the Susquehanna Tradition has a relatively strong presence on the outer Cape, and this cultural tradition was first identified through avocational excavations at a cremation burial site in Orleans (Kremp 1961). In Dennis, sites along the Bass River indicate continued use of this waterway from the Middle to Late Archaic periods. Late Archaic deposits have been identified at a number of the same sites discussed above including Narrows 2 and 4, Mayfair Narrows, Bass River Lane, and Nickerson/Bush as well as at Dutch's Way (19-BN-565). Types of sites other than burials are relatively rare for the Coburn Phase, and as a result the Oak Ridge Site, a Coburn lithic manufacturing area, was particularly important (Loparto 1985:38). Transitional Archaic artifacts have also been found at the Spruce Swamp Site in Sandwich and at Hathaway Pond in Barnstable (Davin 1989; Davin and Gallagher 1987).

Early Woodland Period (3000–1600 B.P.)

The Early Woodland Period is generally not well-understood or well-defined in southern New England. As previously stated, basic questions as to which projectile points may or may not be diagnostic of this period have yet to be determined. As a result, it has been traditional to view the Early Woodland Period as a period of possible regional population decline, from which fewer sites are known. The earliest local manufacture and use of ceramics are attributed to this period. Only a few site locations containing evidence of probable Early Woodland activity have been identified on the inner and mid-Cape. These locations are primarily based on the presence of diagnostic Meadowood and Rossville projectile point types.

While definite Early Woodland Period sites are infrequent, archaeological deposits dating to this period have been located in all sections of the Cape. In Bourne, the Round Swamp Site contained a Meadowood point (Davin and Gallagher 1987). A slight concentration of Early Woodland Period activity has been identified for the Herring River area, based primarily on the recovery of diagnostic Rossville projectile points and pottery (Mahlstedt 1987:72). At least seven Early Woodland sites have been identified in the town of Harwich. Few Early Woodland components have been located on the outer Cape (McManamon 1984). Early Woodland components have been identified at several of the multicomponent Bass River sites (Narrows 2 and 4, and Nickerson/Bush) (MHC site files).

Middle Woodland Period (1650–1000 B.P.)

Middle Woodland sites and depositions are relatively numerous in southeastern Massachusetts, including Cape Cod. During the archaeological investigations of the Cape Cod National Seashore, a number of Middle Woodland components were discovered. One site along Nauset Marsh contained eight Jack's Reef points, as well as evidence of winter exploitation of shellfish (Borstel 1984:244). In the mid-Cape area, Middle Woodland sites have been identified along the Herring and Bass rivers, particularly at the Blue Rock Site in Yarmouth.

Sites from the mid and outer Cape areas containing Early and Middle Woodland depositions do not indicate the degree of contact with extra-regional groups evidenced at mainland sites in southern New England during this period. There is a general lack of "imported" finished goods (Adena-like points, elbow and tubular pipes made of clay and stone) and raw materials (Pennsylvania Jasper, New York cherts) at the Cape sites. The majority of the sites on the Cape indicate that a local procurement of stone for tool manufacture, retrievable from local beaches, river channels, and exposures in the drift, was the strategy followed throughout the Woodland, if not the entire Native American period. While long-distance contacts cannot be ruled out, it does appear that the insular nature of the Cape may have influenced how the Woodland (and probably Archaic) populations interacted with other peoples (MHC 1987).

Late Woodland Period (1000–450 B.P.)

Late Woodland Period sites, depositions, and artifacts dominate the archaeology of the outer Cape (McManamon 1984). Levanna projectile points are the single most numerous artifacts east of Harwich. Sites on the mid- and inner Cape areas also consistently contain Levanna projectile points, but not in the same densities as on the outer Cape. While artifacts are numerous, site locations are not as varied as those associated with earlier periods. On the outer Cape, shell middens located adjacent to protected embayments and estuaries are a dominant pattern. Shell middens are located next to both saltwater and freshwater on the inner and mid-Cape areas. The diversity of density of the materials within these middens indicate that these may be remnants of sedentary, relatively long-term occupations (McManamon 1984:409).

CHAPTER FIVE

EURO-AMERICAN CULTURAL CONTEXT

Contact and Plantation Period (1500-1675)

The initial incursion of Europeans into eastern Massachusetts prior to 1620 followed the expansion of fishing, exploration, and limited trade in the region. The first Europeans to arrive in the area found Native American villages established along major river drainages that were interconnected via land by extensive trail systems (Figure 5-1). Some of the earliest contact between aboriginal peoples and Europeans took place in the name of exploration (Calloway 1991). For example, Bartholomew Gosnold landed off of Cape Ann in 1602, Samuel de Champlain explored the coast in 1604, and Henry Hudson touched at Cape Cod in 1609 (Weeden 1890:8). Before these formal expeditions, fishermen and trappers had frequented the area in search of fish and animal pelts for markets in Europe. France, Spain, and Portugal were the nations with major fishing fleets in the northwest Atlantic, including Nantucket Sound, during the early sixteenth century (Holmes et al. 1998). In 1618, eight vessels departed London and Plymouth to fish the Massachusetts coast, eventually carrying large quantities of fish and oil to Portugal and Spain (Weeden 1890:10). By the late sixteenth century, trade in fur between fishermen and Native Americans was common (Muir 2000:25).

Following initial local success in fishing and trapping, permanent European settlements were established in the region. The majority of settlement north of Nantucket Sound was clustered near Barnstable, which was settled in1637. Edgartown was settled in 1641. Nantucket was purchased by a partnership of ten investors in 1659, and officially became part of Massachusetts in 1692 (MHC 1987:77). On Nantucket there were approximately two to three thousand native residents at the time of European contact, many of who were engaged in fishing and collecting shellfish. The immigration of Europeans and their endemic diseases to North America caused a precipitous and disastrous decline in the Native American population. Regional estimates indicate that between 80 and 90 percent of the native population was killed off through disease, with some individual Native American groups suffering even higher mortality rates. Prior to European contact, an estimated 120,000 Native Americans inhabited the region. A century later, that number had plummeted to just 16,000 (Muir 2000). At contact with Europeans the native population of Martha's Vineyard was between 1,500 and 300, and the native population of Nantucket was approximately 2,400 (MHC 1987:61). By 1640, approximately 35,000 Europeans were estimated to reside in Massachusetts.

The death of such a large portion of the native population left many prepared fields vacant, facilitating the development of European agriculture. During this period, agriculture was the primary economic base for the region. Corn, wheat, and livestock were raised on both sides of Nantucket Sound (MHC 1984a; MHC 1984b). Industrialization during this period was limited to smithy and gristmill operations.

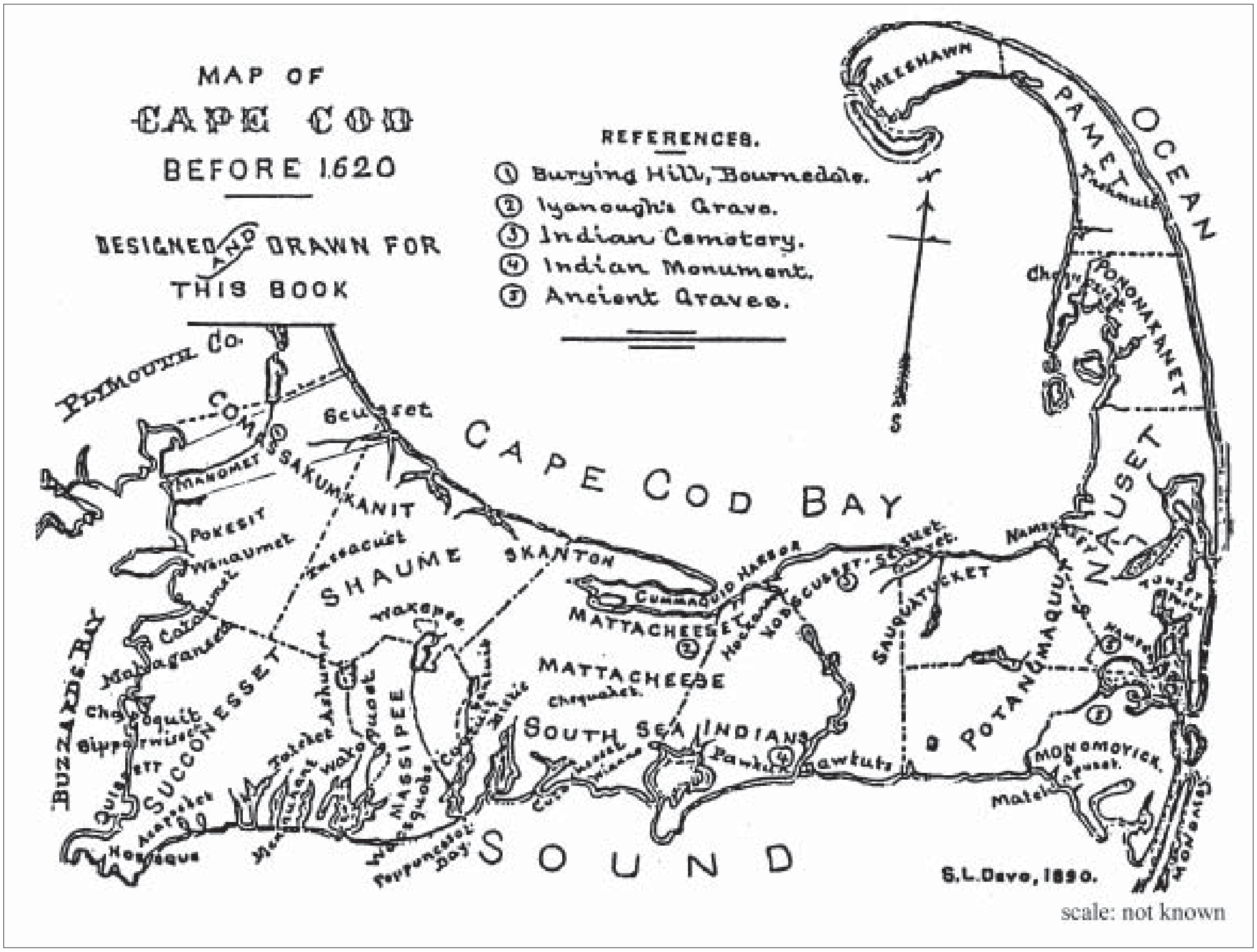

Figure 5-1. "Map of Cape Cod Before 1620" (Deyo 1890).

Nantucket Sound was not highly traveled by Europeans during much of this period. On the mainland, settlement tended to be on the north side of Cape Cod, which provided easier access to Boston across Cape Cod Bay. With the settlement of Nantucket there was an increase in the number of vessels in the Sound, because the island's residents had to import the majority of their goods. During this period, the main port and center of settlement on Nantucket was Cappamet Harbor. While the major occupation of Nantucket's residents was agriculture, the islanders were also involved in whaling (as early as 1640) and cod fishing (as early as 1672) (Bauer 1988:230; MHC 1984b).

Although the Sound was not heavily traveled during this period, both ocean going vessels and small fishing and coastal traders occupied its waters. The ocean going vessels of this period consisted primarily of ships, barks, and pinks, while the most common coastal and riverine watercraft were pinnaces, shallops, ketches, and sloops (Lawson 1895:111-115). All of the coastal and oceanic vessels of the period were of wooden construction, fabricated from hand-cut planks and timbers, and iron-, copper alloy-, and treenail-fastened. Unfortunately, the copper alloy fasteners and treenails used throughout the historic period have few specifically datable attributes. Sheet lead and copper were also used in ship construction during this period for protective hull sheathing (Kemp 1976:205). Larger vessels of the period tended to be carvel-built, while the clinker or lapstrake construction technique was the more common planking scheme of the smaller, coastal craft. Ballast carried on-board ships of the period was generally of stone, although vessels inbound from Europe were occasionally ballasted in brick for resale in the colonies. Due to the threat of piracy, trans-oceanic vessels were typically armed, though usually only lightly, with a few guns that fired shot of four to six pounds. By today's standards, the oceanic vessels of the period were small; a 300-ton vessel was considered large and vessels of the period seldom exceeded 100 feet in length (Kemp 1976). Most oceanic vessels measured 60 feet or less. Due to the fact that capacity rather than speed was of principal import to the merchants of the day, trans-oceanic ships of the period tended to be broad of beam, with a length-to-breadth ratio of around 3:1. Coastal vessels were generally smaller (in the 30- to 40-foot range) (Bauer 1988:31), and had only a quarterdeck if decked at all.

Common ceramics of the period, which are useful for dating wreck sites, included majolica, early tin-glaze earthenware, and Rhenish and Bellarmine stoneware. Kaolin clay smoking pipe stem bores tended to be widest (7/64 to 9/64 of an inch) during this period. Glass bottles of the period are "free-blown," and, therefore, lack pontil scars and mold marks. Cannon of this period are a mixture of cast copper alloy and banded wrought iron, with cast iron appearing towards the end of the period. Shot of the period was a mixture of varieties, including stone and cast iron. Cast iron became the predominant shot material by the 1540s.

Colonial Period (1675-1775)

During the Colonial Period, the Euro-American population of the region continued to expand through immigration and natural growth, which led to expanded settlement and the establishment of additional towns throughout the area. Hyannis was settled in ca. 1690, Centerville 1690, Hyannis Port 1696, and Osterville in the early 1700s (MHC 1984a; MHC 1985b). The lands for these settlements were purchased from the Mattacheesett and South Sea Indian Tribes. Both tribes were subgroups of the Wampanoag Indian Tribe (Mair 2000).

The physical and material expression of this Euro-American expansion was apparent in the continuation of earlier social and economic patterns that originated from the previous period (MHC 1985a). For example, roads were expanded and improved (though many roads of the period remained nearly impassable after a heavy rain). The best roads were those in the more developed coastal areas, while roads leading to the west were not well maintained and tended be to more dangerous (Weeden 1890:408). By 1665, the Cape's County Road extended across the northern portion of Barnstable. On the islands, most transportation routes continued to be based on native paths, although the first Euro-American roads were built on Martha's Vineyard around 1642 (MHC 1987:67). Expansion of the area's road system led to an increasingly extensive network of inns that were developed during this period to service travelers. The first express rider service in the area began in 1721.

A dichotomy between rural and urban life emerged during this period as well. The interior hinterlands continued to support themselves through agricultural and raw material harvesting, while in the urban centers along the coast, especially in Boston, New England's largest city, industrial and commercial pursuits developed. Due to the dominance of Boston, the northern half of Barnstable continued to be the preeminent commercial and urban center nearest the project area. The southern half of the town remained sparsely populated and primarily agrarian. Nantucket followed a similar pattern, as the commerce of its inhabitants increasingly focused on sheep and livestock production and maritime pursuits. The economy of Martha's Vineyard, and Edgartown in particular, focused also on agriculture and maritime trade. Wind powered gristmills were established on the island in 1750 (MHC 1984c).

Farms of the period tended to be primarily subsistence- and family-oriented operations, with most farms producing just enough to sustain their residents and provide a small market crop that could be used to procure other necessary goods and improvements for the homestead. The production and sale of small home industry products, such as wool and/or hides were common sources of income. The extractive industries of the region involved a number of resources, among the most notable of which were wood, stone, and iron. Much of the agricultural, extractive, craft, and industrial pursuits were driven by the labor of indentured servants and slaves. Use of slave labor initiated during the previous period only expanded during colonial times. African and Native American slaves were forced to serve in most occupations, including that of a seaman (Bolster 1998). Commercial trade prospered during this period as well. After the Peace of Utrecht (1713) ended the War of Spanish Succession and gave England dominance, the seas became a relatively safe place for merchant vessels, and trade flourished (Weeden 1890:552). The primary trade network that engaged most Massachusetts merchants during the period was the infamous "Triangle Trade," in which sugar and molasses, rum, and slaves were transported between Africa, the Caribbean Islands, and the North American colonies. Export of natural resources, such as pelts and lumber remained major sources of wealth as well (MHC 1984b).

While Euro-American colonists worked to develop the infrastructure and network of an independent nation at this time, the continent remained colonial property divided among England, Spain, and France. Following the same rationale applied by modern core nations to those of the periphery, England viewed their colonies as a source of raw materials that could be processed in England and sold back to the colonies as a finished product for the profit of English merchants. In exchange, the colonies were provided with established trade networks, financial support, and military protection. With the removal of France to Canada at the end of the French and Indian War (1689-1763), the incentive of military protection was effectively removed from the Massachusetts region. Similarly, the establishment of a native-born merchant class reduced the need for England's assistance. However, in an attempt to maintain control over the financial fortunes of their colonies, the British passed a series of new laws that included the Townshend Act (1767) and the Stamp Act (1770), which were aimed at restricting the economic growth of the colonies. The Boston Massacre (1770), the burning of *Gaspee* (1772), and the Boston Tea Party (1773) were colonial revolts against the effects of these acts leading up to the April 19, 1775 running battle of Lexington and Concord and the beginning of the American Revolution.

Because of its sparse population and focus on agriculture, the mid-Cape's south shore adjacent to the project area was not heavily involved in maritime trades during this period. Nantucket, conversely, was beginning to develop fishing and commerce traditions. The region's cod fishing industry expanded, and Nantucket's whaling industry began during this period.

Prior to 1725, cod fishing crews were composed of primarily Native Americans. Native Americans remained heavily involved in both cod fishing and whaling throughout the period (Little 1992). Cod fishers lived in camps along the coast, some of which later became permanent towns (e.g. Siasconset). Whaling on Nantucket began with the taking of drift whales. The native inhabitants of Nantucket had been harvesting drift whales since before 1668, and as they sold off their lands they retained the rights to any drift whales that might wash up on their former property (Little and Andrews 1982). Europeans also engaged in drift whaling. Eventually whaling crews began to pursue whales at sea. Whaling crews sailed out of Smith Point, Hummock Pond, Weweder, and Siasconset. Throughout the period the whaling industry continued to expand, and by 1775 Nantucket had more whaling vessels than any other colonial whaling port. Commercial trade also expanded during this period. The increase in population and wealth that whaling brought gave rise to merchant and trade classes. In 1715, Nantucket had six deep-water vessels. By 1730, this number had risen to 25, and then to 150 in 1775.

Cape Cod, Nantucket, and Martha's Vineyard were connected to Plymouth, Salem, Boston, Providence, and New York by water transportation routes (MHC 1987:67). It was also during this period that the commercial and population center of the islands' shifted from Cappamet Harbor on Nantucket to Great Harbor on Martha's Vineyard after a 1722 storm closed the former. The requisite shift between harbors may have resulted in a change in trade routes to the mainland (MHC 1984b).

The major classes of maritime occupations in eastern Massachusetts during this period were: commerce, fishing, whaling, the slave trade, and privateering/piracy. The increased differentiation of maritime trades led to a corresponding need for more specialized vessel types. The schooner appeared in Boston in 1716 (Bauer 1988:31), the sloop surpassed the pinnace, shallop, and ketch, and the brigantine replaced the bark (Goldenberg 1976:39). However, the general methods of ship construction remained largely the same. Hull timbers and planking were hand-cut or sawn, fasteners were fashioned from hand-wrought iron, copper alloy, or wood (treenails), and ballast generally consisted of stone. The practice of carrying brick in ballast from Europe for resale in the colonies reached its peak during this period. Similarly, English colliers were known to carry scrap iron as ballast (Robinson et al 2001:130).

Besides the changes in rigging and mast placement that occurred during the transition to schooners and sloops, coastal and riverine vessels otherwise changed little during this period. They continued to be built 30 to 40 feet long and 10 to 15 feet wide, and were lightly, or heavily timbered depending on their intended purpose. Fishing and coastal boats were of this class, with displacements that ranged between 25 and 40 tons (Weeden 1890:372). While most vessels did not exceed 300 tons, increasingly larger vessels began to be produced as trade improved, such as the 400-ton *Sea Nymph* and 600-ton *Thomas and Elizabeth*, both of which were launched at Taunton in 1710 (Goldenberg 1976:38). However, there was not a drastic increase in the sizes of most vessels during this period. Larger vessels were proportionately more expensive to build, harder to fill to capacity with cargo, and represented a more significant risk for investors if the ship was lost. Consequently, the dimensions of most large vessels of this period were still generally no more than 120 feet long with a 40-foot beam.

This period saw the widespread expansion of the slave trade and was the golden age of pirates/privateers (Cordingly 1995:XVII). Both of these occupations required medium sized, maneuverable, fast sailing vessels. Vessels used in these trades tended to be less than 100 feet in length, with slavers covering the upper portion of the range and privateers the middle portion. To improve performance and increase hull speed, these vessels tended to have increased length-to-breadth ratios, with vessel breadth usually restricted to less than one-third that of the hull's length. Pirate vessels were also sometimes surprisingly small, as short as 30 feet in length, but all tended to be heavily armed. Pirate vessels carried a substantial number of cannon, both of the cast iron and cast copper alloy type, and smaller rail-mounted guns.

Many of these vessels were originally built as merchant vessels, and, in many cases, were structurally similar.

As whaling became more prevalent, ships were either built specifically for the industry, or were converted from medium-sized merchantmen. Vessels employed as whalers had to be large enough to sustain a sizable crew for a year at sea and capacious enough to contain the rendered whale products. Consequently, many of them tended to be 60 to 80 feet long. The most identifiable feature of a whaling ship built after circa 1720 was the substantial brick hearth located amidships for rendering the whale blubber. These onboard try-works permitted whalers to extend their cruising limits to the coast of Brazil and the Arctic Ocean (Morison 1979:20).

A number of artifacts are useful for dating vessels of this period. Ceramics of the era include imported tin-glaze earthenware, and white salt-glazed, English brown, Westerwald, and scratch-blue stoneware. The 4-6/64-inch mean pipe stem bore of the period is narrower than that of the previous period, and glass bottles include those that were free-blown and those that were molded. Cannon shot was almost entirely made from cast iron.

Federal Period (1775-1830)

The Federal Period in the region is characterized by economic growth and population expansion and the emergence of the Cape's south shore, particularly the Hyannis area, as a growing population and commercial center. The period began with the Revolutionary War, which effectively disrupted many of the region's traditional trades until well after the Treaty of Paris (1783) was signed and relative peace was restored. Maritime trades, such as commerce and whaling, were almost destroyed by British predation and raids. Agricultural pursuits saw some decline as men joined the Continental Army. However, others made substantial money by supplying the Colonial Army with goods and food (Weeden 1890:821). Some farmers stayed at the plow and supplied the troops and local economy. While there was substantial rebuilding after the war, the commercial diversity of Massachusetts allowed the region to rebound quickly economically.

Immigrant laborers from Europe, and freedmen African Americans found work in the region's growing industrial centers. In 1776, the populations of Barnstable, Edgartown, and Nantucket reached 2,300, 1,020, and 4,412, respectively (MHC 1987:84). Villages began to develop around rural mills and furnaces. It was during this period that the rural economy began to shift from agriculture to industry. As competition along the eastern seaboard became more pronounced and industry became more prevalent, many young men left the fields for the factories. One of the major causes for the proliferation of industrial facilities, especially mills, was the improvement of waterpower technology and the development of new mill privileges (Muir 2000). While Barnstable and Nantucket continued to focus much of their land on agriculture, there was an increase in the number of mills operating in the region during this period (MHC 1984a, 1984b).

Numerous important improvements to the fledgling nation's transportation infrastructure also came during this period. New roads were developed and increased effort was invested in their maintenance. Numerous canals were dug, including the Erie Canal (completed 1825), which linked the deep-water port of New York with the fertile lands and abundant resources of the Great Lakes, and steamships were introduced and began to see widespread use.

During the last decades of the eighteenth century, Yankee merchants opened trade with the Orient, a region that had always attracted Europeans for its wealth and exotic goods (Weeden 1890:820). In addition to China, Americans found a number of willing markets for their raw materials and finished goods after the war. However, the Embargo Act (1807), the War of 1812 (1812 to 1815), and the Great Panic of 1819 all caused depressions in the economy. These disruptions caused hardships in the short-term, but encouraged merchants to be more self-reliant and seek out alternative trade opportunities that eventually produced economic growth (Adams and Jenkins 1995).

Maritime commerce and shipbuilding in the region continued to expand during the Federal period. Without the ships of English merchants to transport goods to market, American merchants were forced to hire or build their own fleets to carry their wares. Furthermore, ships were needed to protect the coast and America's maritime trade routes. The American Revolution greatly disrupted the maritime trades of the region. Towns like Gloucester, Beverly, New Bedford, and Nantucket had developed into major fishing and whaling ports prior to the war. With the inception of hostilities and the predation of British warships on American vessels, these ports suffered a major decline. Nearly every vessel in Nantucket's whaling and commercial fleet was destroyed during the war. Out of 200 vessels in Nantucket and Dartmouth, only four or five survived the war (Morison 1979:31).

In an effort to offset their losses, many of the fishermen and merchants of the region re-rigged and armed their sailing vessels and turned to privateering. The effectiveness of these vessels as privateers is questionable, because most fishing vessels of the time were slow and unwieldy (Morison 1979:31). Nantucket had a substantial Quaker population who opposed war on moral grounds, and had an even larger mercantile population that was hesitant to break off relations with England for financial reasons. The Nantucket merchants were continually caught between the requirements of the Congress and General Court and the danger of being caught by British ships while sailing under Colonial permits. Given these dangers, many Nantucket merchants attempted to import goods to the island at night using long, narrow, lightly built vessels. These vessels were built for speed but under full sail they were often swamped drowning the entire crew (Starbuck 1924). It was during this period that the American seagoing navy was founded.

Commerce rebounded during the intervening years between the Revolutionary War and the War of 1812. Nantucket became the nation's most important whaling port by 1804. The War of 1812 led to another recession in whaling (Bauer 1988). Following the wars, commerce and fishing again flowered in the Cape and islands region. The region's commercial focus shifted from agriculture to maritime trades, particularly cod fishing, and the southern shore of Barnstable began to take precedent over the north. By 1830, Hyannis had developed into a major port and replaced Barnstable Village as the largest population center in the area.

The growth of Hyannis was accompanied by navigational improvements to its harbor. The Point Gammon Light was built in 1815, and the breakwater was built in 1826. The Hyannis breakwater is one of the oldest breakwaters in the nation. Boatyards, salt works, ship chandlers, and other maritime trades also developed in and around Hyannis during this period (MHC 1984a). Nantucket also saw an expansion of its whaling and maritime commerce trades during this period. By 1789 Nantucket had at least 36 vessels pursuing both right and sperm whales (Morison 1979). That same year saw the construction of the first lighthouse on the island. Prior to that time, the increased marine traffic around the island had led to a number of shipwrecks on unrecorded hazards (e.g. sand bars, rock outcrops) (Holmes et al. 1998). There were at least five wharves, in addition to warehouses, ship chandlers, whale oil processing plants, approximately 20 candle making factories, ten rope-walks, and other whaling and trade related industries. By this time, much of the island had been denuded and a large portion of the population was involved in trades other than agriculture. The islanders consequently had to import much of their own supplies, which made maritime commerce a natural choice for a number of the inhabitants.

During this period, Nantucket's shipping network stretched internationally, reaching North Carolina, England, and the Falkland Islands (Bauer 1988:239). In 1828, the first steamer ran between Nantucket and New Bedford, and packet ships shuttled between most of the coastal towns (Morison 1979; MHC 1984b; Adams and Jenkins 1995). Coastal packet vessels traveled throughout the Nantucket Sound, taking goods between Nantucket, Barnstable, Edgartown, New Bedford, and New York (MHC 1987) (Figure 5-2). Trans-Atlantic packets also began traveling regularly to and from Europe, and the Sound was part of the primary shipping corridor through the area. Edgartown became a port of entry in 1789 and served as the county seat for Martha's Vineyard making it an important commercial center. Whaling and fishing were the major sources of local revenue during this period (MHC 1984c).

Besides giving rise to the American Navy, the wars of this period produced significant changes in ship design. The danger of being seized during wartime caused ship owners to place a higher premium on speed over cargo capacity, although this requirement was slightly relaxed after the War of 1812. This was also a time of experimentation with steam engines. John Fitch introduced commercial steam navigation on the Delaware River in 1790 (Gould 2000). In 1825, the first iron-hulled, steam-powered vessel, *Cordus*, was launched. However, neither of these innovations saw widespread use in the Massachusetts area until well into the next period.

While America's largest ships were being built in New York and Philadelphia, and the Chesapeake's builders were becoming known for their fast designs, vessels constructed in Massachusetts' shipyards retained the more traditional designs, characterized by their broad beams, usually not less than a quarter of the vessel's length, and "bluff," full bows of the "cod's head" variety (Morison 1979). Prior to 1830, it was still uncommon to see large vessels under construction in the Boston yards. This absence of larger vessels may have been a result of a commonly-held notion at that time that 500-tons was the upper limit of safe ship size, and that any vessel larger then this would split in a heavy sea (Morison 1979:97). Consequently, most ships of the period were under 300-tons, with lengths that ranged from approximately 90 to 125 feet. The whaling vessels of this period were constructed with full bows and square sterns, with displacements that ranged from 200 to 300 tons (Morison 1979). Large vessels built in other regions, such as the Baltimore Clipper, a vessel type whose origin dates to the American Revolution, were relatively narrow as compared to the Massachusetts-built vessels of the period. Smaller, coastal vessels were not significantly changed during this period. Whaling continued to expand and coastal trade continued to employ a large number of sloops and schooners.

Both small and large vessels of this period were built almost exclusively of wood, with the remainder being of iron. Timbers and planks used in ship construction were both pit-sawn and hand-hewn, though

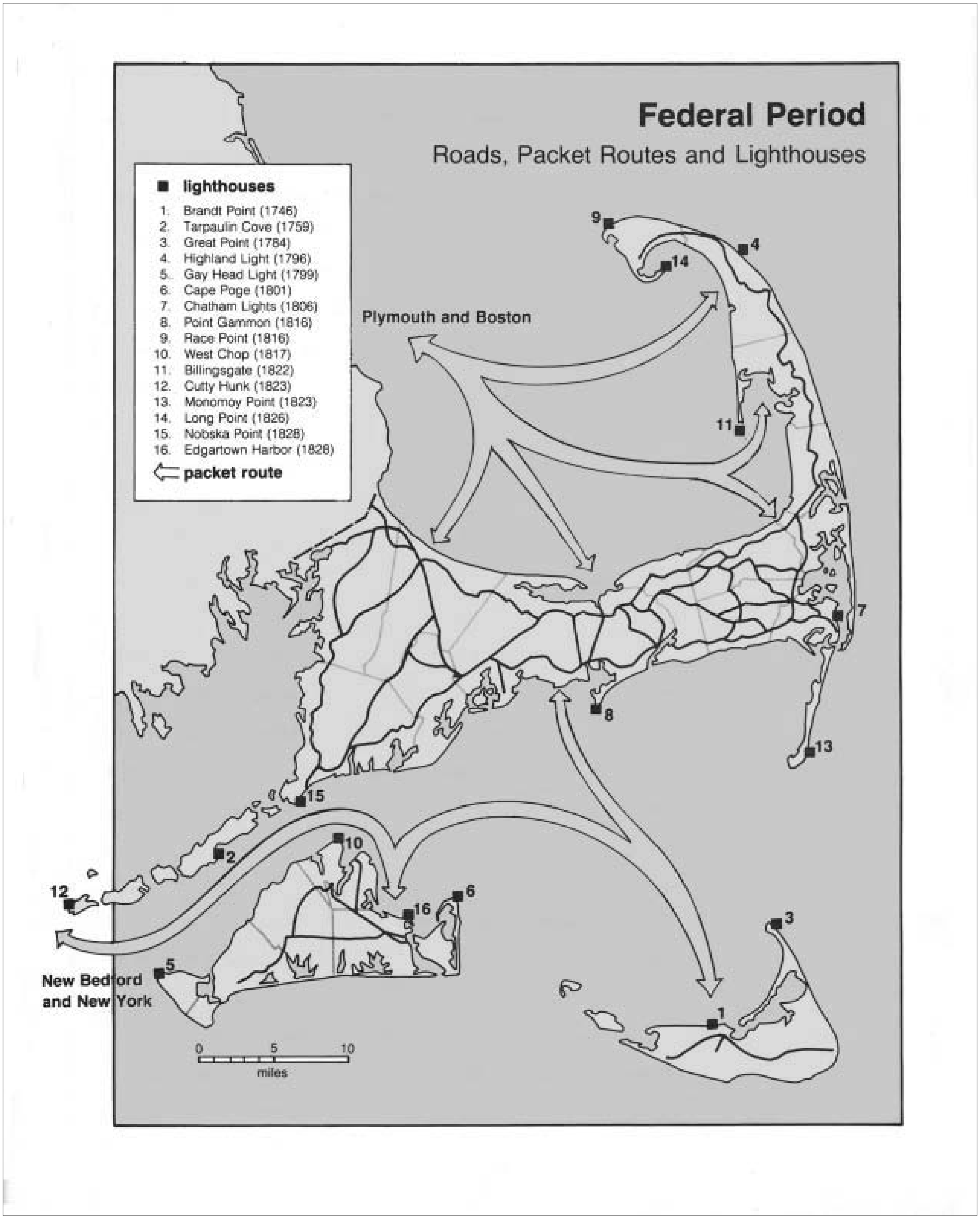

Figure 5-2. Federal Period roads, packet routes, and lighthouses (after MHC 1987).

towards the end of the period, the water-powered sash-saw came into use. Sash-saws leave a ragged saw mark along the cut face of the timber every one-half to one-inch (Visser 1997:26). Fasteners used during this period continued to include those manufactured from copper alloy, iron, and wood, with copper used for many of the larger, harder to replace fasteners (e.g., keel fasteners). Hand-wrought nails were replaced by cut-nails by around 1790 in terrestrial contexts. However, given the larger sizes and special shapes needed for many of the timbers used in ship construction, hand-wrought spikes may have survived slightly longer in maritime uses. Copper sheathing began to see widespread use during this period. The idea of sheathing the hull of a vessel below the waterline dates from at least 2000 B.P., and was used in the British Navy as early as 1761. Universal application of hull sheathing dates from about 1780. The 1783 replacement of iron with copper-alloy fasteners in British naval ship construction lead to the general use of copper sheathing, especially for vessels bound for warmer southern waters (Kemp 1976; Throckmorton 1969). It is likely that commercial vessels adopted copper sheathing earlier than naval vessels.

Items found on the wreck site of a vessel dating from this period might include wrought iron, forge-welded anchors of the “Old Admiralty” design (Robinson et al. 2001). Cannon and shot would have been made from cast iron. Creamware and pearlware, most with hand-painted or transfer printed decorations, predominate the ceramic assemblages of this period. Generally datable pipe-stem bores reach their smallest size (4/64 of an inch), and the first tin cans (post-1819) appear during this time. After 1810, three-piece mold glass bottles begin to appear as well. Ballast during this period continues to be predominantly stone, although “pigs” of iron were also used to a lesser extent.

Early Industrial Period (1830-1870)

Many of the trends begun in the previous era continued to accelerate during the Early Industrial Period, as the continued maritime prosperity of the previous decades led to significant growth and expansion of towns along the Cape’s southern shore adjacent to the Cape Wind Energy Project study area. A southward shift in the economic focus of the mid-Cape area to Nantucket Sound after 1850 resulted in the area’s south shore becoming the dominant focus in the region.

The development of the region’s transportation infrastructure (roads, canals, railroads, steamships) continued to expand, primarily in the form of railroads, which proliferated after circa 1835 (MHC 1981; Tindall 1984). The Cape Cod Railroad, which began construction in 1848 and reached Hyannis in 1854, solidified the port’s position as the region’s most populous center (MHC 1984a). The expanded network of roads and railroads effectively opened up the interior of the country to mass settlement. Coastal commerce and travel, however, continued to depend heavily on waterborne transportation.

Large-scale agriculture in New England began its final decline during this period. The removal of native populations from the Midwest in the 1830s, the success of the Erie Canal, and the expansion of the nation’s railroads provided an opportunity for emigration from the overcrowded rural lands of the East by permitting settlement of the Old Northwest. Railroads also provided the most efficient means of transport for the produce of the large mid-western farms to the East Coast. Massachusetts’ farmers found it hard to compete with the prices of the mid-western mass-produced crops. Consequently, much of the remaining rural population turned to mills and industrial centers for their livelihoods. Some farmers also began to engage in cranberry agriculture during this period.

The influx of European immigrants into the region, primarily Irish, driven across the ocean by the potato famine (1845-1846), as well as the Italian and Portuguese immigrants, filled the labor needs of area mills and factories. Many of the region's Portuguese immigrants also became deeply involved in the local fishing industries. By 1870, the population of Barnstable had reached 4,793, and the Vineyard and Nantucket's populations had reached 1,516 and 4,123, respectively (MHC 1987).

Trade continued to be a source of income for the region, as was fishing, although commercial fishing, especially whaling, saw a decline during this period as production and use of petroleum began to surpass that of whale oil. Efforts to expand commerce with Europe and the Orient, as well as the allure of the west fueled by the "Gold Rush," provided ample opportunities for continued expansion of maritime trade.

While cod fishing continued to be a major industry during this period, especially out of the Cape Cod ports, whaling peaked in the 1840s and then collapsed during the 1850s. In 1835 a Nantucket whaler took the first right whale off the northwest coast of America, opening a new fishing ground for whalers and ushering in a brief period of prosperity. However, Nantucket was beginning to lose its dominance over the industry.

New Bedford first became a rival to Nantucket in the 1820s. By 1823, the New Bedford fleet outnumbered Nantucket's. The reason for this change in market dominance was primarily related to the size of the ports. As the whale population declined, vessels had to go farther from port to hunt. These longer cruises required larger vessels. Nantucket lacked the capital to dredge the bar that blocked its harbor so it was difficult for large ships to enter, causing them to take their catch elsewhere (Bauer 1988). Other causes for the decline of the Nantucket whaling fleet include the drop in the price of whale oil in 1842, the 1846 fire, and the 1849 Gold Rush. One quarter of Nantucket's voting population left the island over a nine-month period during 1849 (Morison 1979:333).

The decline of whaling in Nantucket was a harbinger for the entire industry, which was pushed nearly out of existence by the end of the period due to the introduction of petroleum oil. In 1839, Nantucket's whaling industry made it the third most important commercial center in Massachusetts. In 1855, Nantucket had 44 whaling ships, a substantial decrease from the more than 100 vessels involved in whaling a few decades earlier. By 1865 that number had fallen to seven. The last whaling ship out of Nantucket, *Oak*, cleared the port in 1869 (Newell 2001). Despite this decline, 69 percent of the region's population was engaged in navigation or maritime commerce in 1870 (MHC 1987). Large-scale shipbuilding was discontinued on the island after 1840, because of the prohibitively high costs associated with importing the necessary raw materials (MHC 1984b). While the role of whaling in the Nantucket maritime economy had diminished, the industry continued to be a major economic force in the economy of Edgartown, on Martha's Vineyard. For example, the Edgartown-based, Dr. Daniel Fisher's oil and candle works were claimed to be the largest in the world (MHC 1984c).

Changes in and expansion of the national economy and the rapid progression of new technological developments have led scholars to describe this period as the time that "the Industrial Revolution went to sea" (Gould 2000). While the tonnage of steam-driven vessels did not surpass that of sail-powered ships until the 1880s (Gould 2000), steel and steam began to assert their dominance and the "golden age" of the large wooden sailing vessel had arrived. In Massachusetts, steam navigation was almost non-existent in maritime commerce until after the Civil War (Morison 1979). Although ships driven by the wind cost less to build and operate, they could not maintain as regular a schedule as a could a vessel propelled by steam-power.

With the proliferation of railroads, a modern concept of time developed during this period that made wind-power an undesirable source of power for the transportation of cargo. Similarly, with long-range trade reaching the Orient, it became desirable to build ships that were both larger and faster. During the Early Industrial period, from about 1846 to1859, wooden "clipper" ships briefly filled this need. Representative of the vessel class was the clipper ship, *Flying Cloud*, which measured 229 feet on deck and had a breath of 41 feet. As the period progressed, iron-hulled vessels became increasingly common. Another product of the increased industrialization and technology of this period was more advanced underwater salvage techniques. During this period, marine salvage became increasingly common.

It was during this era that New York began to usurp Boston in its maritime commercial dominance, which possibly caused a shift in shipping patterns throughout Nantucket Sound (MHC 1981). As the period progressed, more vessels from the north passed around Cape Cod (or later through the Cape Cod Canal), either went through Nantucket Sound or passed south of Nantucket on their way to New York City. Alternatively, ships coming from points south of New York City stopped there instead of traveling further north through the Sound to Boston.

Sailing ships of this period, both those of wood and iron, tended to be longer and narrower, and were faster sailors than any of the wind-powered ships of earlier generations, because of the increased value placed on rapid transportation. Wooden cargo vessels of the first portion of the period were generally less than 150 feet long, with a beam that was less than one-quarter that of their length (Morison 1979). As with their predecessors, most of these vessels were carvel planked with stone or, in some cases, iron ballast and copper sheathing. Due to the fact that the whaling industry went into decline prior to the wholesale introduction of steel hulls, the vast majority of whaling vessels were of wooden construction. The last surviving example of a New England whaler, *Charles W. Morgan*, was built in New Bedford in 1841. The whaler *Morgan* is representative of other whaling vessels of the period and measures 113 feet overall with a beam of 26 feet. Most whaling vessels strongly resembled the merchant ships of the age, although they were fitted with a large rendering hearth in the center of the main deck.

Steam engines were found on both wooden and iron vessels from this period. Early wooden steamships had hull designs very similar to those of sailing ships, but had wider decks amidships to accommodate the paddlewheels extending from both sides of the vessel. Side-paddlewheel steamers were the predominant steamship type in the area's coastal waters throughout the period, although screw-propelled vessels became increasingly common elsewhere after their introduction in the United States during the early 1840s (Bauer 1988:100; Robinson 1999).

Small-scale coastal trade continued to be economically important in the area during this period, and sloops and schooners saw use as both coastal traders and fishing vessels. Coastal commerce was also shared with the area's railroads and larger, steam-driven vessels. Coastal fishing vessels of the era, like those of most of the preceding and subsequent periods, continued to be built with comparatively low freeboard, which permitted the haul to be brought onboard more easily.

In terms of identifiable shipbuilding technologies of the period, most vessels of still carried stone and iron ballast (Kemp 1976). Copper spikes continued to be used for attaching sheathing, copper bolts were commonly used to attach some types of timbers, and hand-wrought spikes were used for special purposes, although the primary, lighter fasteners were cut-nails (Visser 1997). The circular saw replaced the sash- saw in most mills between 1850 and 1870. Circular saw cuts are identifiable by the familiar arc-shaped scars they leave in cut wooden surfaces (Visser 1997). During the transition from wood- to iron-built vessels in the middle nineteenth century, a large number of composite-construction ships were built. These vessels were fabricated from iron frames sheathed in wooden planking (Kemp 1976:191). The steel- and iron-hulled vessels of this period were constructed of plates that were bolted or riveted in place and did not greatly exceed the dimensions of the clipper ships. Wooden ships, however, continued to far outnumber iron vessels during this period, which did not become prevalent until the subsequent period.

In terms of datable artifacts associated with the wrecks of this period, the most common forms of ceramic wares used at the time included pearlware (especially early in the period), white earthenware, yellowware, and domestic stoneware. Decoration on ceramic wares was dominated by those applied through the transfer printing process. Rubber products began to be used widely after about 1839. Glass bottle manufacture underwent a number of changes during this period. By 1840, two-piece bottle molds began replacing the three-piece variety, and "snap-case" bottle manufacture, which leaves no pontil scar, became prevalent after 1857. Lettered panel bottles began being produced in 1867.

Late Industrial Period (1870-1915)

The Late Industrial Period on the Cape and islands is one of adjustment on regional and local scales with the decline of the maritime economy and the general loss of population in the region. Fishing and shipping activities became more centralized, rail connections were extended, and the area started to develop as a resort destination. The mid-Cape's South Shore remained the primary commercial focus in the region.

The years prior to World War I bore witness to a number of major technological developments, including the widespread use of steam, electrification, and gas lighting. These advances resulted not only in more comforts at home, but also in improved industrial production. While some industry was present along the margins of Nantucket Sound, the area largely reverted to agriculture during this period. This transition was largely caused by the collapse of the shipping and whaling industry and the resultant decrease in local populations (MHC 1984a, 1984b, 1984c).

Transportation routes in the region expanded during this period. By 1890 every town on Cape Cod except Mashpee had local train connections. Rail service was also introduced on Martha's Vineyard and Nantucket during this period. The Cape Cod Canal opened in 1914. In 1915, the population of Barnstable numbered 4,995, the population of Nantucket was 3,166, and the population of Edgartown was 1,276 (MHC 1987:129-134).

Coastal Massachusetts began to see the development of vacation and resort industries aimed at individuals wealthy enough to vacation. This transformation was aided by the Cape Cod Railroad, and, later, the automobile. In 1872, steamboat ferry service commenced between Nantucket and Woods Hole, effectively opening the island as a vacation destination. At approximately the same time, Hyannis, Hyannis Port, Edgartown, and surrounding towns experienced increased development related to the tourist trade. Despite the shift in the economy, commercial fishing and maritime trades remained a major source of employment in the area. Cod fishing continued off of Cape Cod, and in 1881, commercial scalloping commenced in the waters around Nantucket (MHC 1984a, 1984b, 1984c).

Following the Civil War, most large-scale shipbuilding in the country had shifted to iron and steel construction. The success of the "ironclads" during the Civil War, and the increasing absence of suitable lumber were among the principal causes for the transition to metal shipbuilding. At the beginning of World War I, there were only 14 major metal hull shipbuilding yards in the United States. This fact attests to the huge amount of capital that was needed to build iron- and steel-hulled vessels. Consequently, their construction was limited to major firms. Wooden shipbuilding also persisted during this period, primarily in medium and small vessels (Bauer 1988). Iron- and steel-hulled vessels did not push wooden ships out of the market until World War II. Metal-hulled ships of this period tended to be 260 feet or less in length with beams of 40 feet or less (Bass 1988; Gould 2000). Hulls were constructed of riveted metal plates secured over metal frames. Trim-control was provided by ballast tanks, which took on and expelled water as needed, bilge keels, or through stone, iron, or concrete ballast stowed in the hold. Sail continued to be used into the twentieth century (Bass 1988), but an increasing number of vessels were powered by steam-driven propellers. Most of the vessels of this period, both sail- and steam-powered, were constructed differently as the period progressed due to the development of naval architecture as a science.

Besides oceangoing vessels, a number of smaller commercial vessels traveled up and down the East Coast and through the Nantucket Sound. Large three- to seven-masted schooners, with displacements ranging from 500 to 900 tons, were used to transport inexpensive bulk cargoes of coal and ice to Boston, New York, and other ports. Some of these vessels passed through the sound. Additionally, lime mined from Penobscot Bay, near the towns of Thomaston and Rockland, was transported to Boston, New York and Europe in schooners of various sizes. Most of these working schooners did not see the end of the period, especially the colliers, as they were eventually replaced by iron-hulled, steam-powered, bulk-carriers.

Many of the small vessels of this period were workboats, such as cat- boats, which were used by small-scale commercial fishing operations. Other workboats used in the area were the pound-net scow, beach skiff, and V-bottomed garvey (Chapelle 1951). As time progressed and the tourist industry flourished, the hull forms of many of these small workboats were adapted for use as recreational vessels. Most of these vessels were of wooden construction with copper alloy or iron fasteners (wire nails were common after 1900), and did not exceed 30 or 40 feet in length. Many were also open hulled, while others were decked with a bow cabin. Ballast for many of these vessels, especially the pleasure craft, which seldom altered their load, was provided by iron or lead affixed to the keel (Kemp 1976:55). In addition to the increased production of small recreational craft, large steam-powered passenger liners began to see common use both in ocean and coastal service.

This era also witnessed the expanded use of barges. Like canal boats of previous periods, barges do not supply their own propulsion. While oxen could be used to tow a canal boat, widespread use of barges on the ocean along the coast was precluded until the adoption of steam-power. Generally, barges are heavily timbered, or iron/steel-hulled rectangular-shaped craft, with square-sides, blunt ends, and flat-bottoms that used for hauling bulky, heavy loads. They can have either an open hull with decking only around the sides for carrying items such as trash or coal, a full deck designed for carrying items such as building supplies. Barges can also be modified to carry construction equipment, such as a derrick (Basnight 1996:23; Kane 2001). The size and morphology of barges depends entirely on the tasks for which they were intended. Barges of the period were used on the ocean, but generally only along the coast or in protected harbor waters. Transits over the rougher seas of the open ocean usually fell to the schooners (Bauer 1988:270).

All of these vessel types were used in Nantucket Sound during this period. Steamships made runs to Nantucket, cod and scallop fishing boats worked the sound, and pleasure boats related to the tourist industry also sailed in the area. Cargo vessels transporting goods to New York, Boston and other ports were also present in the sound, especially prior to 1914. After the Cape Cod Canal was opened on July 29, 1914 much of the commercial traffic bypassed the sound by traveling through the canal (Farson 1993). The Cape Cod Canal was built to shorten the water route between Boston and New York by 135 miles. The canal also made travel safer by eliminating the dangers of rounding the Cape. An average of two vessels per week were lost off Cape Cod prior to the construction of the canal.

A number of diagnostic artifacts are associated with vessels of this period. Modern, stockless anchors began to see use at this time. High-fired white earthenware, yellow ware, and domestic stoneware dominate the ceramic assemblages of the period. Developments in glass bottle manufacture accelerated during this period: the semi-automatic bottling machine became prevalent after 1881, only to be replaced by the fully automatic machine after 1903. The Hutchinson stopper was developed post-1872, the canning jar closure after 1875, and the crown bottle cap after 1892. The double seamed tin can is introduced in 1904.

Modern Period (1915-present)

During the Modern Period, the dominance of the mid-Cape locus of settlement and activity established during the early twentieth century continued, with increased residential development, resort growth, and automobile-oriented commercial expansion focused in the mid-Cape area. Proliferation of the automobile and major transportation thoroughfares during this period made it possible for companies to be situated away from the dense population centers. Many of the service and professional companies located themselves in proximity to major roads. The ease of automobile travel increased the desertion of the urban core for the suburbs, and led to a gradual decline of the urban core. Many of these people settled on traditionally agricultural lands of the Cape and islands (Adams and Jenkins 1995). This influx of people increased local populations. In 1940, Barnstable had 8333 residents, while Nantucket and Edgartown had 3401 and 1370, respectively.

Improved transportation also aided agriculture. After the decline of previous periods, agriculture had stabilized at a reduced, but still important, level. The rural economy was bolstered by market gardens and truck farming, which shipped their produce to the suburban centers. Much of the region continued to rely on the recreation industry for its economic base. The Edgartown Yacht Club came to the harbor in 1927 and since 1950 resort development has played an important role in restructuring the town

(MHC 1984c). Airports were built in Barnstable and on both Nantucket and Martha's Vineyard during this period (MHC 1987:148).

This period saw the near total disappearance of large sailing wooden vessels. The few that remain are generally training and museum ships. Instead, large vessels of this period were primarily those built of iron and steel, and were assembled initially with rivets, and later with arc-welded seams (Bauer 1988:295). Propulsion for these large vessels was initially in the form of reciprocating steam engines, but by World War II, diesel and steam turbines had nearly replaced the older style engines. During the middle part of the century, turbo-electric and diesel-electric engines were installed in large vessels with varying degrees of success (Bauer 1988:293). This period saw the proliferation of specific vessel shapes, sizes, and rigging to fit the intended use of the ship. Merchant vessels became very niche-oriented. Based on the silhouette of the hull, the position of the superstructure, and the type of cargo-handling equipment, the different types of large merchant vessels can be easily identified (Basnight 1996). Ballast for most of these vessels consisted of seawater flooded into ballast tanks.

Small vessels underwent a number of developments during this period as well. Steel hulls became prevalent in small commercial vessel construction during the second half of the twentieth century. Hulls fabricated from fiberglass became increasingly common during the past few decades. Today, 90 percent of dinghies, yachts, and small craft up to75 feet in length are made of fiberglass (Kemp 1976:300). In 1886, the first naphtha-powered motor-launches appeared along the East Coast. Shortly after the turn of the century, the naptha-burning launches were replaced by those powered by gasoline-combustion engines. Diesel engines became available on the civilian market during the 1920s, but their use did not become widespread until after World War II. Gasoline and diesel engines were used to power wooden, fiberglass, and steel commercial and recreational craft. Sail persisted in small recreational vessels, and is generally used in conjunction with a wood or fiberglass hull and sometimes supported by a gasoline engine. Until the 1920s, barges continued to be constructed of heavy timbers (Kane 2001). However, by the end of World War II, steel- hulled barges began to become more common. Other working boats of this period are distinctive as well. Many of the region's fishing boats are recognizable by their low freeboard and open transoms; however, finer distinctions can be made based on the shape of the hull and the type of superstructure (Basnight 1996). Ballast tanks or a ballast keel, depending on the use of the vessel, are employed on many smaller vessels to adjust the trim.

The twentieth century saw new safety regulations applied to the sea. Drastically improved navigational aides and the presence of radios combined with radio-dispatched tugs to call for help made it easier for mariners to stay out of or get out of harms way. With the addition of more reliable power sources to keep vessels off of rocks, the mortality rate at sea dropped significantly during this period.

A number of different artifacts are associated with this period. Modern stockless anchor predominate during this era. Similarly, hard white earthenware, stoneware, porcelains, and melamine (post World War II) dominate the ceramic assemblages. All bottles of this period are "full automatic," machine-made, and use of purple manganese glass predominated in the first portion of the era. The beer can was introduced in 1935 with the pull-tab opening in 1962. Plastic products were introduced to the mass market in circa 1900 and since then have become widespread.

CHAPTER SIX

PREDICTED ARCHAEOLOGICAL SENSITIVITY

Native American Submerged Cultural Resources

Preliminary background research and a review of existing geophysical and geotechnical data provided information necessary to generally characterize the environmental conditions and physical integrity of marine sediments, and develop an inventory of reported shipwrecks within the Cape Wind Energy Project's offshore study area for the purpose of assessing its archaeological sensitivity. Archaeological sensitivity is defined as the likelihood for Native American and/or early Euro-American submerged cultural resources to be present.

The study of Native American land-use and settlement systems in the Northeast has benefitted from cultural preservation movements supported by local and federal legislation. The resultant body of data has documented more than 10,000 years of human occupation in the region. However, recession of the glaciers, alterations of the landscape, successions in plant and animal communities, subsidence of the coastline due to rising sea levels, and the effects of the marine transgression on the formerly exposed paleolandscape complicate interpretation of the early archaeological record offshore. Furthermore, settlement system information that has been assembled is biased in favor of durable material types, such as stone artifacts, and toward sites that have resisted destruction and are on land. Consequently, the types of data presently available for interpretation provide only a partial and incomplete view of prehistoric Native American culture. Systematic identification, documentation, and data recovery of submerged prehistoric cultural resources can potentially supply various categories of information presently unavailable to researchers working in the Northeast. These classes of data would be extremely useful for refining or revising our current perception of the earlier periods of prehistoric human settlement and subsistence patterns.

The accumulation of data resulting from the extensive archaeological research conducted to date on land in the Cape and islands region indicate that certain types of environmental and topographical settings are strongly associated with the presence of prehistoric archaeological deposits. Archaeological research has repeatedly demonstrated that prehistoric peoples in North America and elsewhere sought the most productive areas within their landscape, especially those areas that offered diverse resources available on a seasonally consistent basis. Some of the richest habitats of diverse flora, fish, and wildlife are found near the junction of land and water, both fresh and salt. Riparian corridors consisting of rivers, streams, and estuaries, their beds, banks, and floodplains, along with the soils, plants, and animals that exist there are among the most productive biological systems in the world.

Stright (1990) and others (Crock 2003; Dencker 2003; McBride 2003; Merwin 2003; Robinson 2003; Robinson and Waller 2002) have provided discussions of ways to predict the location of inundated sites, including those on the North American continental shelf, as well as the methods of locating these sites. Generally, the prerequisite for site preservation on the continental shelf is site burial in terrestrial or low-energy marine sediments prior to the transgression of the ocean (Waters 1992). The site will be preserved if it remains below the depth of shore face erosion during and after the marine transgression process. The "fishing site model," developed and tested with positive results by Danish researchers (Pedersen et al. 1997), asserts that submerged prehistoric site locations may be expected at resource-rich water/land interfaces in locales that were good for fishing with stationary nets or traps. Such locales include lands around river mouths, narrows within bays, and on projecting points of land and islands with shallow, evenly sloped shorelines that have not undergone substantial sediment reworking.

The possibility that submerged prehistoric sites may be present in the study area is supported by the density and diversity of known archaeological resources on the Cape and islands, and the fact that spot finds of prehistoric cultural material, as well as large prehistoric assemblages (e.g., the "Corcione" assemblage, Sandy Hook, New Jersey), in the offshore waters of the northeastern United States are documented (Lynch et al. 2002).

Although submerged prehistoric archaeological sites are reported within the study area, published rates of local sea level rise indicate that much of the offshore project area may have been available for human occupation from about 12,500 to 7000 BP, with progressively smaller portions of the area available thereafter up until about 1000 BP. (Redfield and Rubin 1962; Oldale 1982, 1992). Based on available data, it is theoretically possible that prehistoric archaeological deposits with contextual integrity may be present within isolated portions of the study area in areas where natural soil strata are present. Site types could include small, special-purpose activity areas, transportation corridors, semi-permanent habitations, and burial sites as described in the Native American cultural context.

The development of predictive models for locating cultural resources onshore is somewhat applicable to submerged cultural resources located offshore, since any intact submerged prehistoric archaeological deposit offshore would be located in a former sub-aerially exposed terrestrial landscape. The criteria used in the prehistoric sensitivity model for the study area is essentially the same as that used on land, with some modifications to factor in the erosional effects of the marine transgression and post-submergence effects of waves and currents. The criteria used to assess the archaeological sensitivity of the study area are its physical condition, environmental characteristics, proximity to documented prehistoric cultural resources, detectable submerged intact buried paleosol geomorphic features that may correlate with known site locations on land, and regional prehistoric land use patterns.

Based on the application of these criteria to the data collected during the background research and the geophysical and geotechnical engineering surveys, the study area was characterized for expected archaeological sensitivity. A majority of the study area may be described as having low archaeological sensitivity for containing submerged prehistoric cultural resources. This assessment is based on the extensive disturbance of sediments that is apparent in both the geophysical and geotechnical survey data. A majority of the formerly exposed landscape within the study area was either destroyed, disturbed, or deeply buried by the marine transgression and subsequent modern wave and tidal current regimes.

One relatively small zone that may contain intact paleosols with potential for containing submerged prehistoric cultural resources has been identified within the study area. This area corresponds with evidence exhibited in sub-bottom profiler data and vibratory core specimens. Project vibratory cores ESS VC01-G4, ESS VC01-G7, and a core specimen collected in the 1970s by U.S. Geological Service (USGS VC-4939), collected from the perimeter of the basin-like feature described above on the eastern side of the WTG array field, all contain a distinctive, one to three-foot thick, layer of sediments buried beneath eight to ten feet of overlying marine sediments. Organic materials (e.g., wood, peat, and charcoal) in vibratory core sample VC01-G4 are stratified and appear to include a sequence of estuarine or lagoonal sediments overlying peat and an organic-rich "A-horizon" soil with wood debris above an orange-brown "B-horizon" of coarser-grained, oxidized sub-soils. These sub-soils overlay very lightly colored, glacial outwash sands forming a "C-horizon" (Figure 6-1). The layer is also visible in the seismic sub-bottom profiler data as a discontinuous, reflective, unconformable surface. Organic material recovered in USGS VC-4939 was determined in the 1970s through radiocarbon dating methods to have an age of 6470 +/ 200 BP. Calibration of this date using OxCal (ver. 3.5) computer software provided a date range of 7513 to 7233 CalBP with 88 percent probability (Figure 6-2).

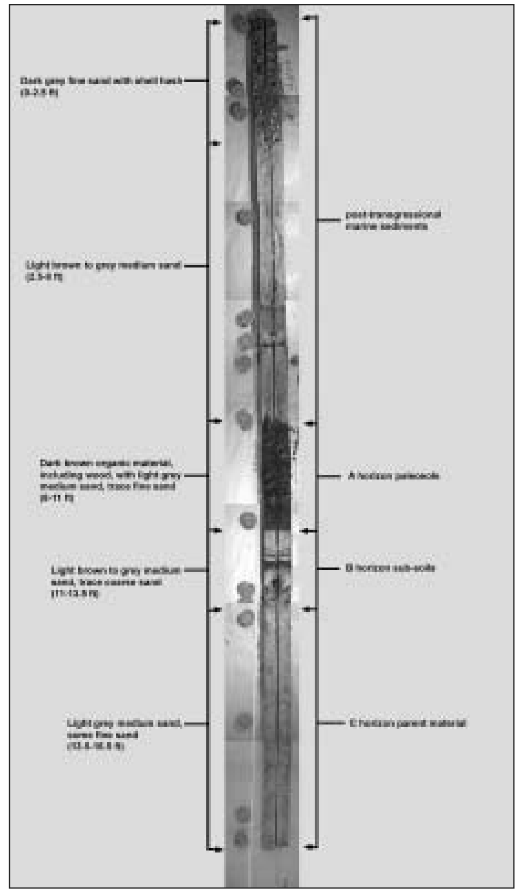

Figure 6-2. Photographs of ESS vibratory core VC01-G4 (individual images comprising mosaic courtesy of ESS).

All three cores were collected from the present 45 to 55-foot depth contour along the perimeter of the eastward facing, bathymetric low forming the interior portion of Horseshoe Shoal. Reconstructed projections of sea levels from 3000, 3400, 6000, and 7250 BP onto the study area's existing bathymetry suggest that the 45 to 55-foot depth contour from which the vibratory core samples were taken may have once been a sub-aerially exposed land surface, possibly located along the perimeter of one large kettle pond, or a cluster of smaller kettle ponds, at circa 7250 BP. The kettle pond or ponds were eventually transgressed by rising sea level some time before 6000 BP to become a prominent embayment on the southeast end of a large, peninsula-like, topographic high encompassing today's Horseshoe Shoal. Resource-rich lakes and coastal embayments are known to have been attractive landscapes for ancient human habitation, and archaeological evidence exists in southern New England for coastal adaptation and regular harvesting of anadramous fish by the Middle Archaic Period (7500-5000 BP).

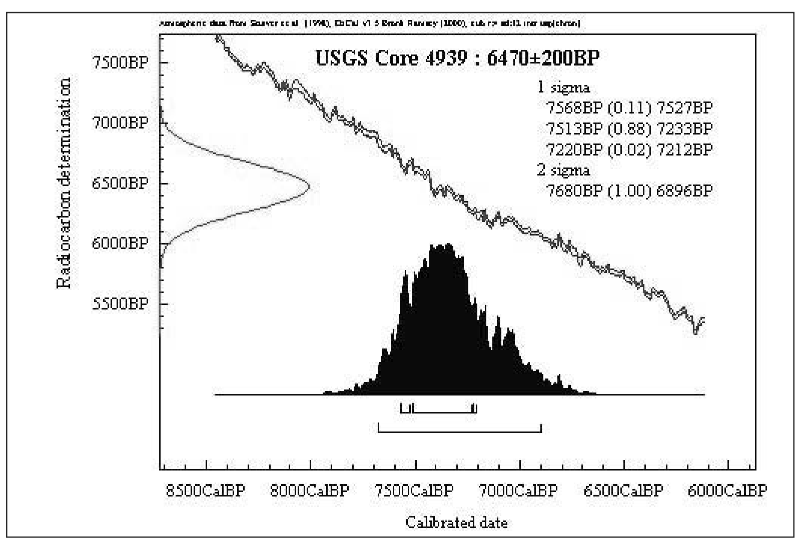

Figure 6-3. OxCal (ver. 3.5) calibrated C-14 date for USGS vibratory core specimen no. 4939.

Euro-American Submerged Cultural Resources

A list of shipwrecks obtained from MBUAR, the Northern Shipwreck Database, and AWOIS indicates that there are 45 vessels reported lost within and in proximity to study area (Appendix A). Dates for the reported wrecks included in these databases range from that of the sloop *Platina* lost off Half Moon Shoal in 1841 to the US Navy oil-screw *P. C. 1203* lost off of Horseshoe Shoal in 1963. The breakdown of reported vessel losses per century is as follows:

- 1600s: 0 vessels reported lost
- 1700s: 0 vessels reported lost
- 1800s: 19 vessels reported lost
- 1900s: 7 vessels reported lost
- No date: 19 vessels reported lost

The temporal distribution of reported shipwrecks exhibits a correlation with the post-1850 expansion of settlement and commercial activity on the mid-Cape's southern shore. Other vessel casualties from the earlier periods undoubtedly occurred in the area, but either went unreported, or have been referred to only obliquely, without any locational information, in the available literature. Detailed information regarding the size and construction of the majority of the vessels recorded lost in Nantucket Sound is poor. However, losses of both steel- and wooden-hulled vessels ranging in size from 78 tons (*Colleen*) to 1,962 tons (*Governor Powers*) are reported. Among the recorded types of vessels lost in the Sound (e.g., barges, motor boats, oil-screws, schooners, ships, and sloops), the formerly ubiquitous schooner is the most commonly reported vessel type.

Besides those vessel casualties that occurred while underway, others would have sunk at their moorings near shore, been intentionally scuttled, or were simply abandoned in shallow water. It is likely that some of the area's shipwrecks were salvaged after wrecking. Wrecks of this nature are more likely to be present in the shallower, near-shore portion of the study area.

Although useful for characterizing the geomorphology of the study area and assessing its potential for containing submerged *prehistoric* cultural resources, the results of the preliminary geophysical and geotechnical surveys conducted for the project in 2001 were less useful for identifying discrete targets that could be attributed to submerged historic cultural resources (e.g., shipwrecks). Such targets, especially those associated with the wrecks of older, wooden-hulled vessels, are typically represented by subtle acoustic anomalies and/or patterned distributions of complex magnetic anomalies that are distinguishable only in geophysical data collected at a relatively close (e.g., 50 feet) survey track line interval.

No evidence of a shipwreck was apparent in the preliminary 2001 geophysical or geotechnical data. However, given the extremely wide track line interval employed during the geophysical survey, the absence of evidence of shipwrecks in the study area is considered to be a function of the survey data's limitations for locating such wrecks, rather than an indicator of low archaeological sensitivity for submerged historic cultural resources.

The long history of extensive Euro-American maritime activity in the area, the treacherous nature of the waters in and around Horseshoe Shoal, and the number of reported wrecks within and in the vicinity of the study area leads PAL to conclude that the entire offshore study area has the potential to contain submerged historic cultural resources (e.g., shipwrecks).

CHAPTER SEVEN

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Background research and analyses of preliminary geophysical and geotechnical data indicated that the offshore study area has potential for containing submerged prehistoric and historic cultural resources. However, the data indicate that a majority of the offshore study area has a low probability for containing submerged prehistoric cultural resources, because of extensive disturbance to the formerly exposed and inhabitable pre-inundation landscape that has resulted from the marine transgression of the area.

Recommendations

Based on the examination of existing project data and Native American and historic background research, a marine archaeological remote sensing reconnaissance survey of the offshore study area to determine the presence or absence of potentially significant submerged historic cultural resources is recommended. This survey should be performed using DGPS, side scan sonar, a sub-bottom profiler, a marine magnetometer, and a recording fathometer. A survey track line interval of 50 feet is recommended for those portions of the project area in which sub-surface impacts during construction are anticipated, such as where installation of the submarine electrical transmission cables, WTGs, and the ESP are proposed.

Additional geotechnical survey to characterize the origin, nature, and extent of organic sediments observed in several vibratory coring samples recovered from the eastern edge of the offshore study area is also recommended to further define the potential for submerged Native American cultural resources to be present.

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Appendix A

REPORTED SHIPWRECKS WITHIN AND IN THE VICINITY OF THE CAPE WIND ENERGY PROJECT OFFSHORE STUDY AREA

ID #	Vessel Name	Vessel Type	Hull Material	Year Built	Year Lost	Notes	Reference
1	*P.C. 1203*	Oil-screw	Steel	Unknown	1963	Owned by US Navy	MBUAR; AWOIS; Northern Shipwreck Database
2	*Angela*	Schooner	Unknown	Unknown	1858	App. 1.25 miles west/northwest of Cross Rip	MBUAR
3	*Benjamin Gartside*	Schooner	Unknown	Unknown	1889	App. 2.5 miles northwest of Handkerchief Shoal	MBUAR
4	*Benjamin H. Hold*	Schooner	Wood	Unknown	1853		Northern Shipwreck Database
5	*Charles S. Simmons*	Schooner	Unknown	Unknown	1856		Northern Shipwreck Database
6	*Charles Smith*	Schooner	Unknown	Unknown	1856		Northern Shipwreck Database
7	*Charm*	Schooner	Wood	Unknown	1852		Northern Shipwreck Database
8	*Cheryl Ray*	Unknown	Unknown	Unknown	Unknown		MBUAR; AWOIS; Northern Shipwreck Database
9	*Colchis*	Ship	Wood	Unknown	1849	Salvaged	Northern Shipwreck Database
10	*Colleen*	Oil-screw	Unknown	1925	1932	Burned	Northern Shipwreck Database
11	*Constance*	Motorboat	Unknown	Unknown	1949		Northern Shipwreck Database
12	*Edward E. Briry*	Schooner	Wood	1896	1917		Northern Shipwreck Database
13	*Elect*	Schooner	Wood	Unknown	1858		Northern Shipwreck Database
14	*Forest City*	Schooner	Wood	Unknown	1888	Derelict	Northern Shipwreck Database
15	*G.M. Porter*	Schooner	Unknown	1871	1914		Northern Shipwreck Database
16	*George W. Elzey, Jr.*	Schooner	Unknown	Unknown	1932	Near Cross Rip Lightship	MBUAR; Northern Shipwreck Database
17	*Governor Powers*	Schooner	Wood	1905	1918	Collided with SS *San Jose*	MBUAR; Northern Shipwreck Database
18	*Helen Thompson*	Schooner	Unknown	Unknown	1891		MBUAR; Northern Shipwreck Database
19	*Isaac Rich*	Schooner	Unknown	Unknown	1856		Northern Shipwreck Database
20	*Jennie French Potter*	Schooner	Unknown	1899	1909		MBUAR; Northern Shipwreck Database

ID #	Vessel Name	Vessel Type	Hull Material	Year Built	Year Lost	Notes	Reference
21	*John Paul*	Schooner	Wood	1891	1914		MBUAR; Northern Shipwreck Database
22	*Mary F. Cushman*	Schooner	Unknown	1872	1918		Northern Shipwreck Database
23	*Mary Farrow*	Schooner	Unknown	Unknown	1911		Northern Shipwreck Database
24	*Palow*	Schooner	Wood	Unknown	1844		MBUAR; Northern Shipwreck Database
25	*Panope*	Schooner	Wood	1881	1888		Northern Shipwreck Database
26	*Pelican*	Unknown	Unknown	Unknown	Unknown		MBUAR; Northern Shipwreck Database
27	*Pelon*	Schooner	Wood	Unknown	1844		Northern Shipwreck Database
28	*Platina*	Sloop	Wood	Unknown	1841		Northern Shipwreck Database
29	*Seneca*	Unknown	Unknown	Unknown	Unknown		MBUAR; AWOIS; Northern Shipwreck Database
30	*Susan*	Schooner	Wood	Unknown	1852		Northern Shipwreck Database
31	Unknown	Unknown	Unknown	Unknown	Unknown		Northern Shipwreck Database
32	Unknown	Unknown	Unknown	Unknown	Unknown		Northern Shipwreck Database
33	Unknown	Barge	Unknown	Unknown	20th c	Appears on chart	MBUAR; Northern Shipwreck Database
34	Unknown	Unknown	Unknown	Unknown	Unknown		Northern Shipwreck Database
35	Unknown	Unknown	Unknown	Unknown	Unknown	Appears on chart	Northern Shipwreck Database
36	Unknown	Unknown	Unknown	Unknown	Unknown	Appears on chart	AWOIS
37	Unknown	Unknown	Unknown	Unknown	Unknown		AWOIS
38	Unknown	Unknown	Unknown	Unknown	Unknown		Northern Shipwreck Database
39	Unknown	Unknown	Unknown	Unknown	Unknown	Possibly the same as 41	MBUAR; AWOIS
40	Unknown	Unknown	Unknown	Unknown	Unknown	Possibly the same as 40	Northern Shipwreck Database
41	Unknown	Unknown	Unknown	Unknown	Unknown	On Dogfish Bar near mouth of Parkers River	MBUAR

ID #	Vessel Name	Vessel Type	Hull Material	Year Built	Year Lost	Notes	Reference
42	Unknown	Unknown	Unknown	Unknown	Unknown	On Bishop & Clerks Ledge app. 2 miles south of Point Gammon	MBUAR
43	Unknown	Packet	Wood	Unknown	1819	Partial loss, made port	Northern Shipwreck Database
44	Unknown	Barge	Wood	Unknown	Unknown	Appears on chart	AWOIS
45	Unknown	Unknown	Unknown	Unknown	Unknown	Appears on chart	MBUAR; AWOIS

Locational data omitted from publicly distributed copies.

Appendix 5.10-C-2

Marine Archaeological Reconnaissance Survey

TECHNICAL REPORT

MARINE ARCHAEOLOGICAL RECONNAISSANCE SURVEY CAPE WIND ENERGY PROJECT

Nantucket Sound, Massachusetts

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with contributions from

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MANAGEMENT ABSTRACT

PAL conducted a marine archaeological reconnaissance survey in Nantucket Sound along an approximately 12-mile-long offshore transmission cable route and within an approximately 24-square-mile area comprising the proposed offshore site location of the Cape Wind electrical energy generation facility. The project area is located in both federal and Commonwealth of Massachusetts waters within the corporate boundaries of Yarmouth and Mashpee, Massachusetts. The investigation involved conducting archival research to review existing project data; archaeological site files and technical reports; published information about the area's environmental, Native, and Euro-American histories; and shipwreck databases. The survey also involved the performance of field studies consisting of geophysical (remote sensing) and geotechnical (vibratory coring) surveys of the project area of potential effect within the offshore wind park site areas.

The marine archaeological reconnaissance survey resulted in the identification of several zones on the eastern edge of the project study area with contextually intact paleosols and three remote sensing targets that are considered to be archaeologically sensitive. These zones have a moderate to high potential for containing submerged prehistoric cultural resources, while the targets have moderate potential to represent submerged historic cultural resources. If avoidance of these areas and targets is not feasible, PAL recommends that an intensive marine archaeological survey be conducted to determine the presence or absence of submerged cultural resources.

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CHAPTER ONE

INTRODUCTION

This technical report presents the results of a marine archaeological reconnaissance survey conducted between June and October 2003 by PAL and project partners ESS Group, Inc. (ESS) and Ocean Surveys, Inc. (OSI) within the submerged portion of an offshore "wind park" and marine cable route to shore and landfall area within Lewis Bay proposed by Cape Wind Associates, LLC (CWA) for construction in federal and Commonwealth of Massachusetts waters within Nantucket Sound (Figures 1-1 and 1-2). The purpose of the wind park as it is currently designed is to generate 454 MW of electrical energy for the region's electrical grid. To assist CWA in their compliance with federal, state, and local legislation pertaining to the preservation and protection of submerged historic properties within the offshore project area, archival research and geophysical (i.e., marine remote sensing) and geotechnical (i.e., vibratory coring) survey were performed over a study area encompassed within the approximately 15,360 acre proposed offshore wind park site area. The goals of this investigation were to:

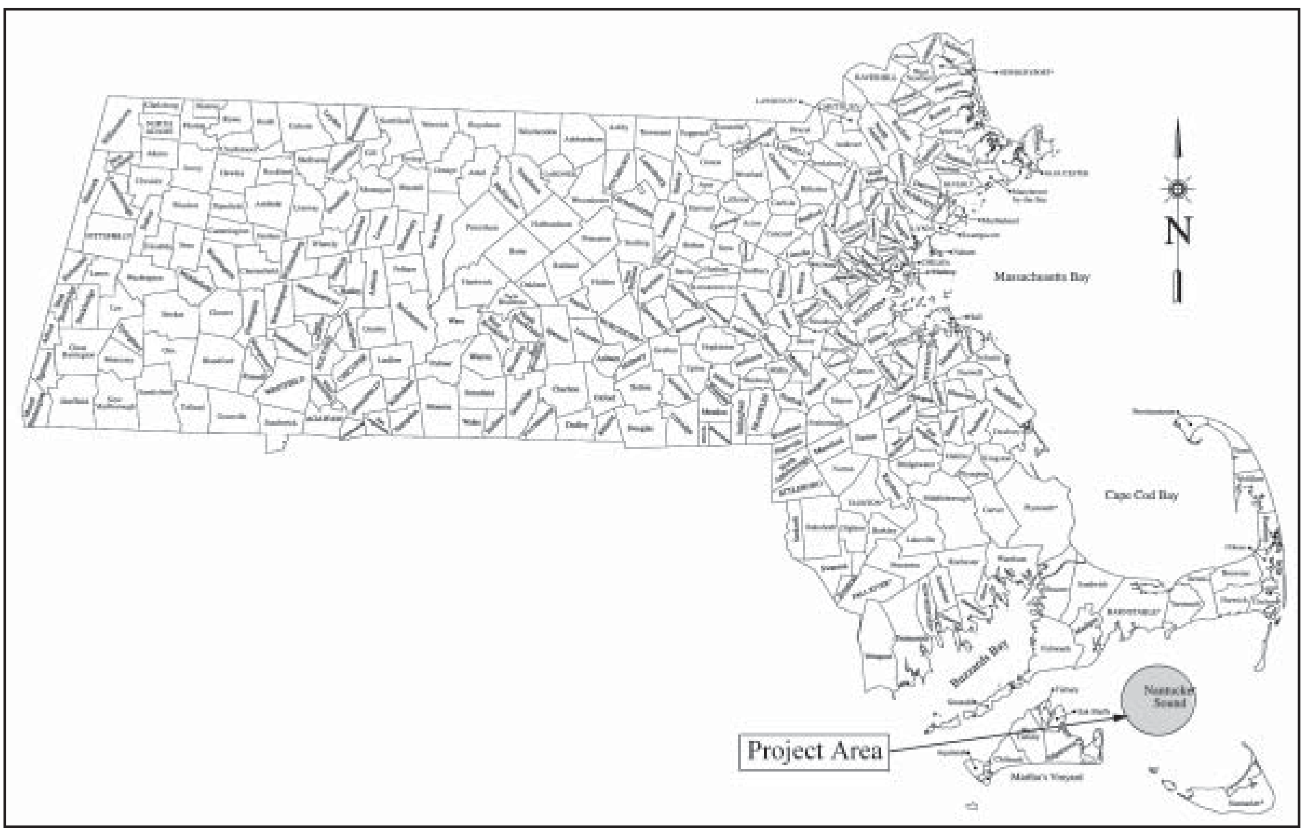

Figure 1-1. Map of Massachusetts showing the general location of the Cape Wind Energy Project's proposed offshore wind park.

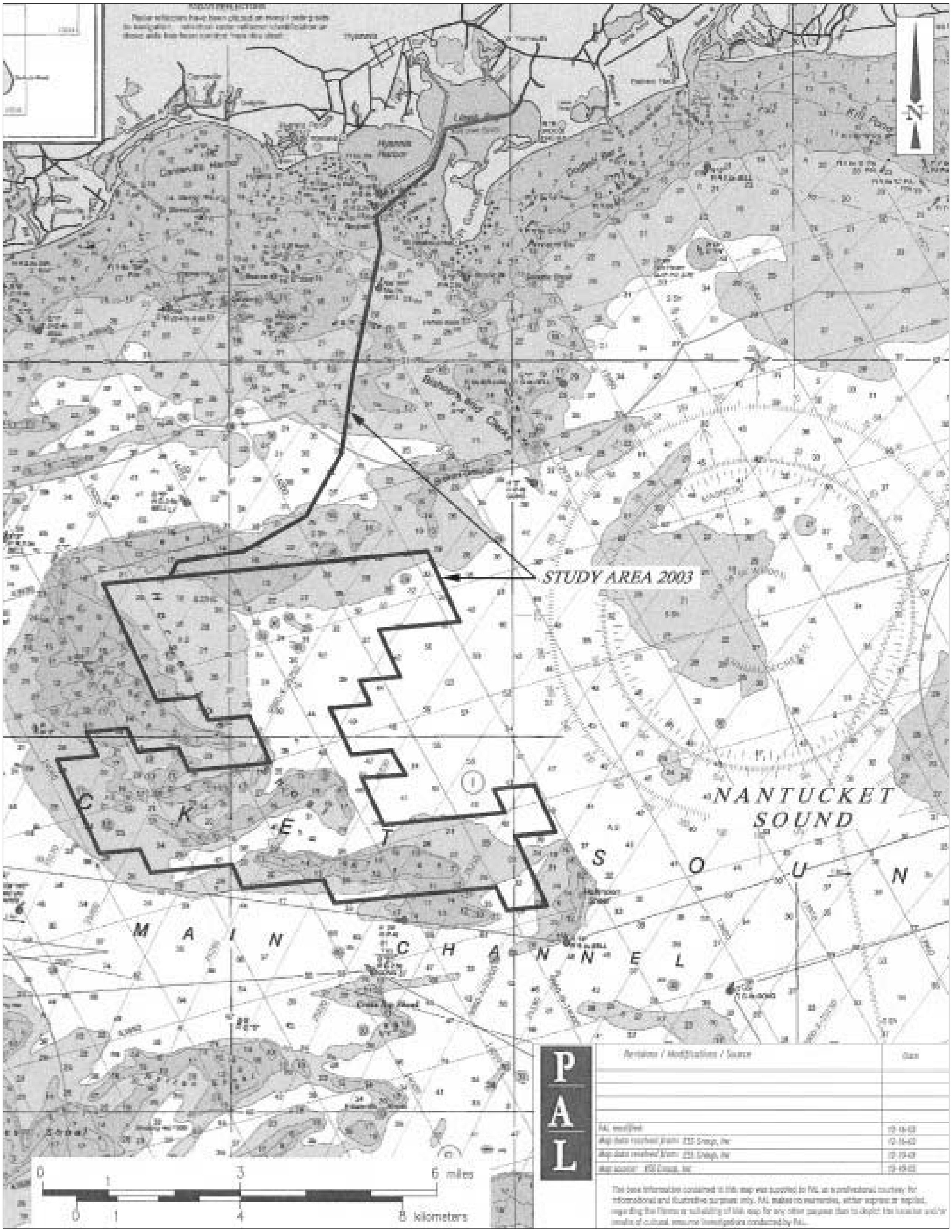

Figure 1-2. Location of the Cape Wind Energy Project offshore study area on NOAA chart no. 13237.

- inventory remote sensing targets with potential for representing submerged Euro-American cultural resources (i.e., shipwrecks, wharfs, camps, fishing gear, etc.) and;

- further characterize the origin, nature, and extent of organic sediments associated with a bathymetric low on the eastern edge of the offshore study area to refine the assessment of the area's ancient Native American archaeological sensitivity.

Archaeological sensitivity of the overall offshore project area and recommendations concerning the proposed scope and methodology of this marine archaeological reconnaissance survey were addressed previously in PAL's report *Marine Archaeological Sensitivity Assessment - Cape Wind Energy Project* (Robinson et al. 2003), filed with the U.S. Army Corps of Engineers (USACE), the Massachusetts Historical Commission (MHC), and the Massachusetts Board of Underwater Archaeological Resources (MBUAR) for their review and comment in June 2003 (Faldetta, personal communication 2003 [Appendix A]). These reviewers concurred with both the conclusions of the assessment and its proposed methodology for the reconnaissance survey, provided that the survey evaluated all of the anticipated project-related impact areas and that the anchor spreads of the construction vessels were considered along with all other project-related impacts (Simon, personal communication 2003; Mastone, personal communication 2003 [see Appendix A]). Portions of the sensitivity assessment have been incorporated into this report.

Project Location and Description

The approximately 24-square-mile offshore site being considered for the Cape Wind Energy Project is located in waters ranging in depth from approximately 7 to 62 feet and centered on Horseshoe Shoal in Nantucket Sound. The facility will consist of an array of 130 wind turbine generators (WTGs) interconnected by a network of 33 kV low voltage electrical cables terminating at a central offshore electric service platform (ESP) within the array. A 115 kV low voltage submarine cable system consisting of two paired-cable circuits spaced approximately 20 feet apart will run from the ESP to the cable system's landfall within Lewis Bay, in Yarmouth, Massachusetts. From this landfall, an on-shore transmission system will be installed in an underground conduit system along existing roadways and an existing NSTAR Electric right-of-way to its terminus at the Barnstable Switching Station. Current plans for the Cape Wind Energy Project indicate that the northernmost WTG will be located approximately 4.7 miles from the nearest point of land on the Cape, the southeastern portion of the wind park will be 13.8 miles from Great Point, Nantucket Island, and the westernmost WTGs will be 9.3 miles from Martha's Vineyard.

The WTGs will be arranged in parallel rows, and spaced 0.34 to 0.54 nautical miles apart. Each WTG will be mounted on a steel tower supported by a monopile foundation. Each monopile will have a base diameter of approximately 16.75 to 18 feet. The pile will be driven to a design depth of approximately 85 feet below the sea floor by means of a drop hammer mounted on a jack-up barge with a crane. The jack-up barge will have four to six legs with pads each measuring about 13-x-13 feet. Each pile will be hollow and will contain bottom material that is displaced inside the pile. A sea floor scour control system consisting of six, approximately 10-x-15-foot mats with eight anchors will be installed on the sea floor around each WTG monopile.

Each WTG will interconnect with the ESP located within the approximate center of the array field. The ESP will be a fixed template platform consisting of a jacketed frame fitted with six, 42-inch diameter piles. Each of the ESP's six piles will be driven to a depth of approximately 90 feet to anchor the platform to the seafloor.

The project's submarine cabling will be installed using a hydro-plow embedment process, more commonly referred to as "jet plowing." This installation method involves use of a positioned cable lay barge and a towed hydraulically powered jet plow device that will simultaneously lay and embed the submarine cable in one continuous trench between the WTGs and the ESP, thus minimizing disturbance of the seafloor.

The lay barge will propel itself along the route and hold its position with a six-point mooring system and two, 60-inch diameter spuds. When the lay barge nears the ESP, the barge's spuds will be lowered to secure the barge in place for the final end-float and pull-in operation. The installation barge's anticipated dimensions will be 24-x-100-x-400 feet. Two anchor handling tugs will also be used. Each anchor cable will be 1-1/8-inch thick, have a maximum scope of 2,000 feet, and be fitted with a pendant wire and 58-inch steel balls for deployment and quick recovery. Also on-site during installation will be an auxiliary trencher pulling barge, which will be a small barge of 40-x-100 feet in length outfitted with spuds. The actual trenching operation will be performed using a skid/pontoon-mounted jet plow, which will create a 4 to 6-foot wide by 8-foot deep trench for the cable, with minimal deposition of sediment outside the trench. The two circuits of the interconnecting transmission lines linking the ESP to landfall will also be embedded by jet plowing, which will create two parallel trenches of the same dimensions described above, with approximately 20 feet of horizontal separation between them.

Project Scope and Authority

The Cape Wind Energy Project is the first offshore wind park ever proposed for the waters of the United States and the largest offshore utility construction project proposed to date within and adjacent to the waters of the Commonwealth, with approximately 15,000 acres of sea floor within Nantucket Sound estimated to be encompassed by the project. Prior to constructing the project, CWA is required to obtain federal permitting from the USACE, under 33 CFR Parts 320 and 322, which stipulate that such permitting is required for the "Construction of artificial islands, installations, and other devices on the outer continental shelf" (33 CFR 320.1[b]([4]), and give authority to the Secretary of the Army to authorize and permit the construction of "obstructions to navigation in navigable waters of the United States" (33 CFR 320.2[b]). Since the Cape Wind Energy Project is subject to permit review by a federal agency (USACE), compliance with Section 106 of the National Historic Preservation Act (NHPA) of 1966 (16 US 470f), as amended, is required. Section 106 (36 CFR 800) of the NHPA requires of all federal agencies, including the USACE, that they consider the effects of their permitted activity on historic properties listed in or eligible for listing in the National Register of Historic Places (NRHP) (36 CFR 60), including those underwater. The agency must also afford the Advisory Council on Historic Preservation, the State Historic Preservation Officer (SHPO), the Tribal Historic Preservation Officer (THPO), and other consulting parties the opportunity to comment on the permitted activity.

The primary goals for archaeological projects conducted under Section 106 review are to:

- locate, document, and evaluate buildings, structures, objects, and landscapes that are listed, or eligible for listing, in the NRHP

- assess potential impacts of the project on those resources and;

- provide recommendations for subsequent treatment to assist with compliance with Section 106.

PAL was contracted by CWA to address the concerns of the USACE and SHPO (i.e., the MHC and the MBUAR) in meeting their obligations under the NHPA. This investigation was performed in accordance with the Secretary of Interior's *Standards and Guidelines for Archaeology and Historic Preservation* (48 Fed. Reg. 44716-42, Sept. 29, 1983); the Massachusetts Environmental Policy Act (MEPA); Massachusetts General Laws, Chapter 9, sections 27-27c, as amended by the Acts of 1988 (95 CMR 70); MBUAR Regulations (312 CMR 2.00); MHC's *Historic Properties Survey Manual: Guidelines for the Identification of Historic and Archaeological Resources in Massachusetts* (1992), and the Secretary of the Interior's *Standards and Guidelines for Identification* (1983).

Project Personnel

PAL staff involved in this investigation included Deborah Cox (project manager) and David Robinson (offshore principal investigator). Holly Herbster, Joseph Waller, Jr., and Ben Ford (project archaeologists), and Jessi Halligan (project assistant), also contributed to the investigation.

Geophysical and geotechnical survey data utilized for this investigation were collected by field personnel from OSI, PAL, and ESS in 2001, 2002, and June, July, September, and October of 2003. Analyses and interpretation of the geophysical and geotechnical data was completed by OSI's Justin Bailey, PAL's David Robinson, ESS's Sarah Faldetta, and the University of Rhode Island Graduate School of Oceanography's (URI-GSO) John King. The transfer of project data, reports, figures, and maps generated from this and previous offshore geophysical and geotechnical survey and environmental analyses was coordinated with OSI's Ted Nowak, Justin Bailey, and Peter Lackey, as well as ESS's Sarah Faldetta, Payson Whitney, and Jesse Baldwin.

Disposition of Project Materials

All supporting documentation collected during the course of this study is on file at PAL, 210 Lonsdale Avenue, Pawtucket, Rhode Island 02860. Select vibratory core specimens collected in 2003 are frozen and being temporarily stored at the URI-GSO's Bay Campus in Narragansett, Rhode Island 02882.

CHAPTER TWO

RESEARCH DESIGN AND METHODOLOGY

PAL's research design and methodology employed for this marine archaeological reconnaissance investigation were developed to achieve two principal goals:

- assess the archaeological sensitivity of the offshore portion of the project area; and

- to determine the presence or absence of historic properties within it.

These goals were met through a combination of archival research and marine archaeological field survey.

Archaeological sensitivity is defined as the likelihood for archaeological sites to be present within a particular area based on different categories of information. In the case of the Cape Wind Project's offshore study area, such sites could potentially include submerged Native American settlement loci, fishing gear, and watercraft, as well as historic shipwrecks, and/or inundated historic built resources along the coast.

Assessment of the Cape Wind project area's archaeological sensitivity involved consideration of previously documented offshore archaeological resources, the geomorphological history and sedimentary environments of the Nantucket Sound area, Native American and historic settlement and subsistence patterns, and Euro-American historic settlement and maritime activity patterns. For this aspect of the investigation, PAL completed a review of:

- existing geophysical and geotechnical survey reports and project-generated engineering data (e.g., U.S. Geological Survey [USGS] and National Oceanic and Atmospheric Administration [NOAA] documents and project-generated seismic sub-bottom profiler, side-scan sonar, magnetometer, and bathymetric survey data, as well as vibratory coring and boring logs and photographs);

- cultural resource management reports and site files at the MHC and the MBUAR;

- NOAA's on-line Automated Wreck and Obstruction Information System (NOAA 2000);

- Northern Maritime Research's Northern Shipwrecks Database (2002);

- environmental studies providing information about the geomorphological history of Nantucket Sound and the effects of the Holocene marine transgression; and

- town reconnaissance surveys.

In addition to the archival research that was performed, marine archaeological reconnaissance field study, consisting of geophysical (remote sensing) and geotechnical (vibratory coring and boring) survey, was conducted between June and October 2003 to aid in the determination of the presence or absence of historic properties within the offshore project study area (Figures 2-1 and 2-2).

The geophysical portion of the field survey was performed using a Trimble 4000 Global Positioning system (GPS) with a Trimble ProBeacon U.S. Coast Guard (USCG) differential receiver interfaced with Coastal Oceanographic's *Hypack* navigation and data-logging computer software package. This system, used in conjunction with an onboard notebook computer, allowed the survey team to maintain precise horizontal survey control with an accuracy of ± 3 feet and navigate the vessel along pre-designed survey lines throughout the investigated area.

Differential corrections to the GPS data were transmitted in real time to the survey vessel via the USCG reference station at Acushnet, Massachusetts. Geodetic coordinates (latitude, longitude) output by the DGPS referenced the "WGS84" (World Geodetic System established in 1984), which is equivalent to the "NAD83" (North American Datum established in 1983). The horizontal coordinate system for the project is the Massachusetts State Plane Grid, Island Zone (2002), referenced to NAD83 in feet.

Prior to the start of survey operations, the accuracy of the vessel's GPS was checked by placing the antenna over the National Geodetic Society (NGS) horizontal control point "Red Beacon" in Woods Hole, Massachusetts, and the USACE control point "Coleman" (1991), located in Hyannis, Massachusetts. Position checks showed differences of less then 3 feet off of the published coordinates of the control points.

Vertical control was checked by referencing all the survey depth data to the Mean Lower Low Water (MLLW) datum using NOAA predicted tidal information. The closest tide station (Hyannis Port, Station ID 1027) was used for adjusting the sounding data.

In addition to the navigation system, survey equipment used to complete the field investigation included:

- Innerspace Model 448 digital depth sounder (208 kHz);

- Benthos SIS-1500 high-resolution CHIRP technology side-scan sonar system operating at a central "swept" frequency of 200 kHz;

- EdgeTech Geostar Model SB-216 CHIRP sub-bottom profiler operating at a "swept" frequency of 2–16 kHz and;

- Geometrics Model G-881 cesium vapor marine magnetometer.

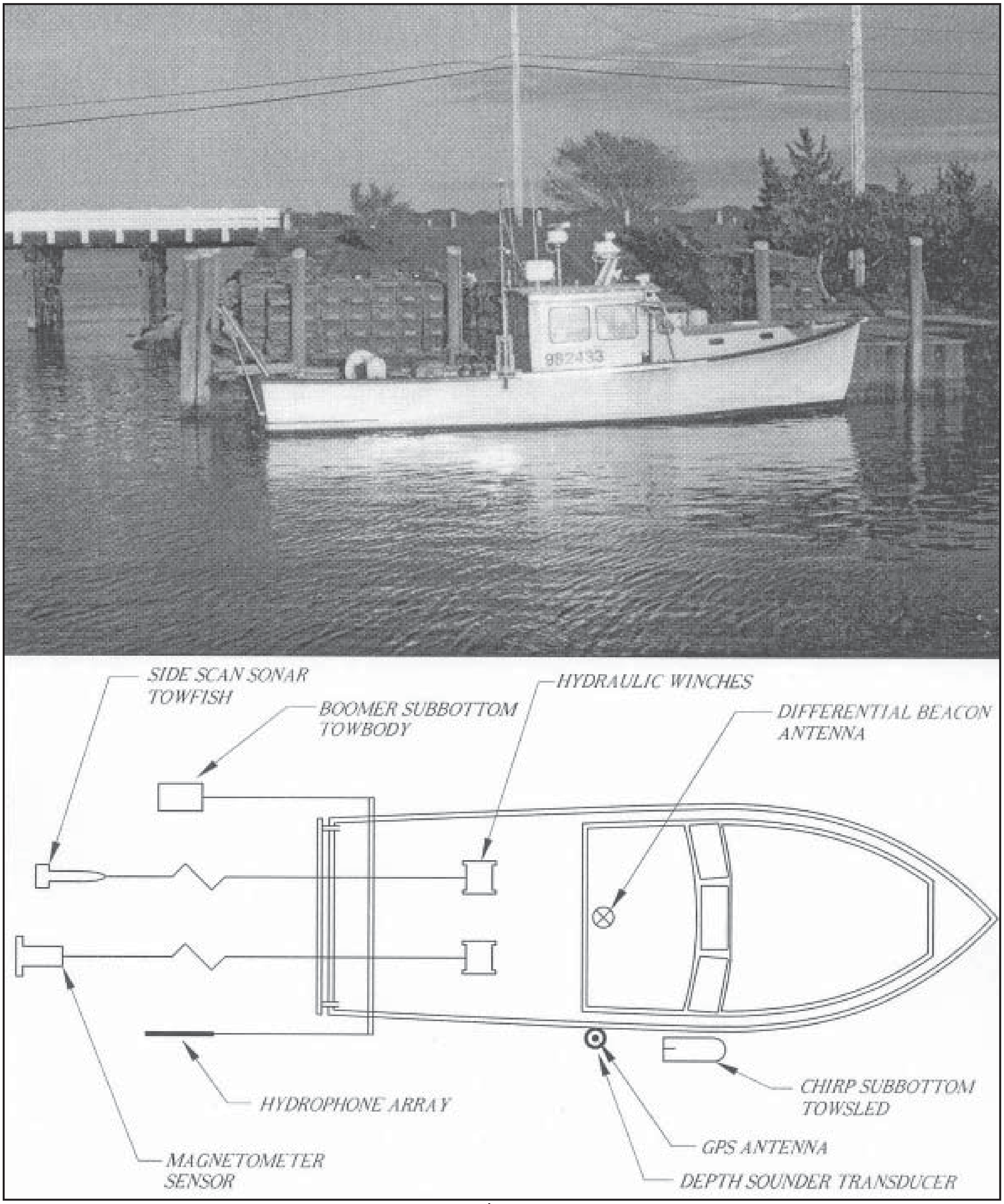

Figure 2-1. Survey equipment configuration for R/V West Cove (image courtesy of OSI).

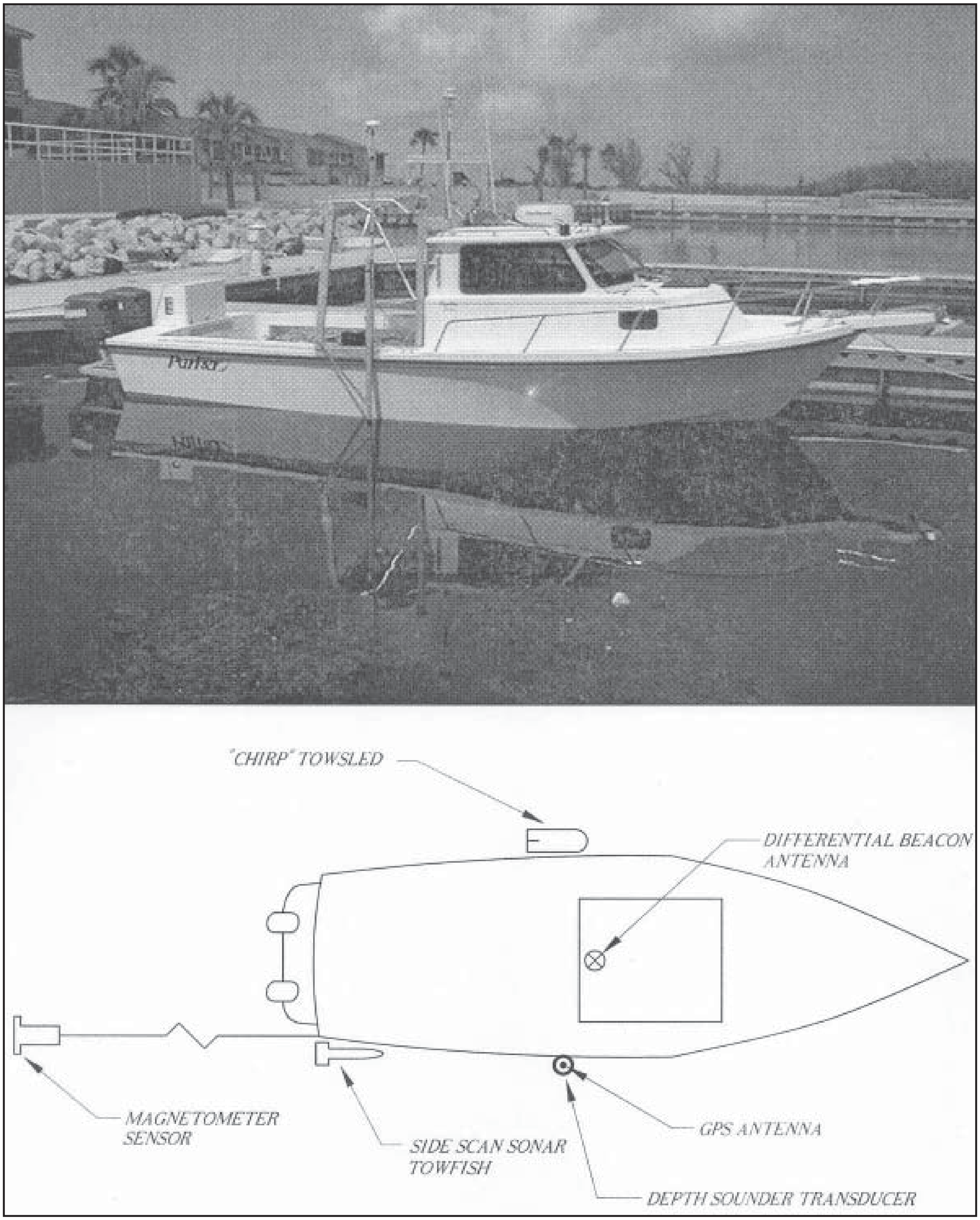

Figure 2-2. Survey equipment configuration for R/V Parker (image courtesy of OSI).

Geophysical survey data were acquired throughout the project impact area along a series of parallel survey track lines spaced 50 feet apart. Sixty-five parallel track lines were surveyed across a 3,350-foot-wide area encompassing the location of the ESP and the converging WTG array interconnect cables running to it. Three parallel survey lines effectively covering an approximately 150-foot-wide corridor were run along the northwest-southeast oriented WTG array interconnect cable routes and over the WTG node locations. Two parallel survey lines spaced 50 feet apart and offset 25 feet from the centerline provided approximately 100 feet of survey coverage along the routes of the remaining WTG array interconnect cables and the supply cable extending to shore from the ESP.

Archaeological survey data were collected simultaneously on every survey line. Side-scan sonar data were recorded at a 50-meter swath width to provide overlapping coverage of each survey track line. The vertical display range of the sub-bottom profiler data extended to a depth of approximately 14 meters below the surface of the seafloor.

Geophysical survey data were reviewed as they were collected in the field. Information concerning the approximate location (i.e., run and event numbers), anomaly type (e.g., magnetic, side-scan sonar, and/or CHIRP sub-bottom profiler) and depth of water at each anomaly location, as well as on its size, duration, and depth below the surface of the seafloor, was recorded.

Upon completion of the survey, the data were post-processed and correlated with field observations to produce final inventories of magnetic, side-scan sonar, and sub-bottom profiler anomalies. Locations of anomalies and surveyed track lines were plotted digitally using AutoCad computer software to create plan-view maps for review. Sub-bottom profiles recorded throughout the site were reviewed in combination with the results of the project's preliminary 2001 geophysical and geotechnical survey programs to interpret and characterize the nature of the stratigraphy below the surface of the seafloor.

In addition to the geophysical survey that was conducted for this investigation, additional geotechnical survey was performed as well. The purpose of the additional geotechnical survey was to collect physical evidence in 3.5-inch diameter vibratory cores that could be correlated with the 2003 sub-bottom profiler data, and, more specifically, used to further characterize the origin, nature, and extent of organic sediments observed in several vibratory coring samples collected within the project area in 2001 and by the USGS in the 1970s (O'Hara and Oldale 1987). The 2003 geotechncial survey focused on sampling sub-bottom reflectors in the east-southeast portion of the project area considered to have potential archaeological sensitivity for containing ancient Native American submerged cultural resources (Robinson et al. 2003).

A composited representative sample of the 2001 project core with organic sediments (VC01-G4), and the nine new core samples collected in 2003 for this investigation were examined and logged by a specialist in marine geology and limnology from the URI-GSO and staff from PAL and ESS (Figure 2-3). Samples of approximately 5 cubic centimeters in volume were extracted from one-half of each split core containing organic materials and wet sieved through two nested sieves with 1 millimeter and 0.5 millimeter mesh sizes. Recovered materials from both size fractions were examined and picked for plant macrofossils (i.e., seeds, leaves, wood, roots, etc.) using a Nikon SMZ-U micropaleontological

Figure 2-3. URI-GSO, PAL, and ESS staff examining vibratory core for evidence of intact paleosols.

microscope to determine conclusively whether or not the recovered organic sediments were terrestrial in origin, and, if so, whether or not they retained primary depositional context.

Recommendations regarding additional archaeological investigation of anomalies comprising specific targets and/or areas exhibiting geological evidence of containing archaeologically sensitive, intact, buried paleosols within the offshore project area were made on the basis of the results of the archival research and the analyses of the geophysical and geotechnical data collected for this investigation.

CHAPTER THREE

ENVIRONMENTAL CONTEXT

The Cape Wind Energy Project offshore study area is located in Nantucket Sound, a broad, relatively shallow passage of water separating the narrow "elbow-shaped" peninsula of Cape Cod situated on the Atlantic Coastal Plain in southeastern Massachusetts, and the islands of Martha's Vineyard and Nantucket (see Figure 1-2). Nantucket Sound represents a geologically "young" coastal feature that was formed largely by processes associated with the Laurentide glaciation of southern New England ca. 23,000–8,000 years before present (B.P.), during the final or Wisconsin stage of the Pleistocene Epoch (Oldale 1992) (Figure 3-1). While the basic structure of the system was created by glacial transport and subsequent erosion of sediments during glacial melting and retreat, secondary processes of relative sea-level rise, wave and tidal erosion, and sorting and transport of sediments continue to transform both the land-sea margin and the submarine portion of the Sound (OSI 2002).

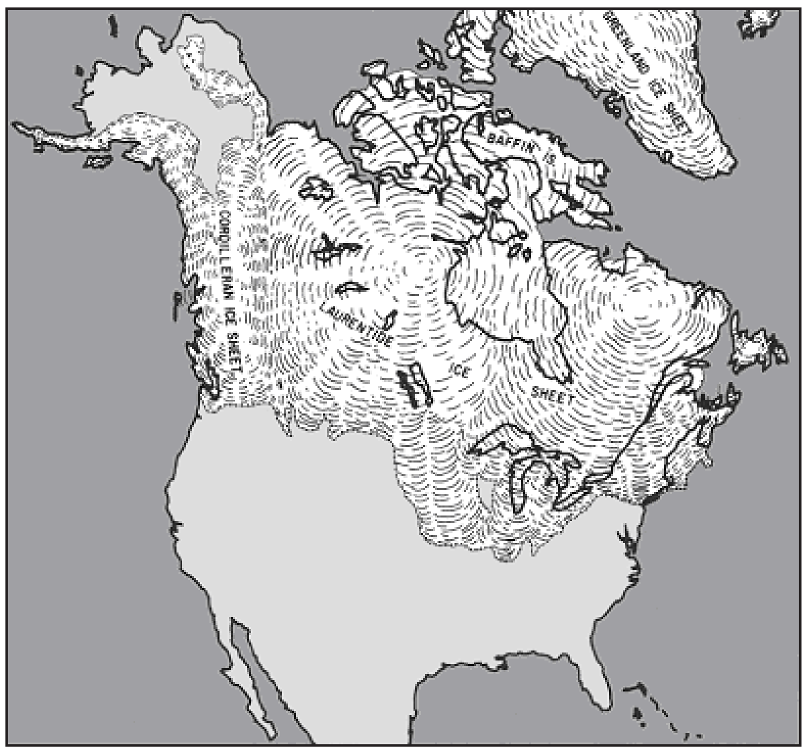

Figure 3-1. Laurentide Ice Sheet at its glacial maximum (approximately 23,000 B.P.) (after Oldale 1992).

The area that is now Nantucket Sound was once a broad coastal plain, inferred to be Upper Cretaceous strata consisting predominantly of unconsolidated to semi-consolidated sand and silty clay containing some gravel, which extended seaward to the approximate location of present day Nantucket, Martha's Vineyard, and Block islands prior to glaciation (O'Hara and Oldale 1987). The underlying bedrock consists of metamorphic rocks, such as schist and gneiss, and igneous rock. The surface of the bedrock generally slopes southeastward from about sea level on the northwestern shore of Buzzard's Bay to as much as 1,600 ft below sea level at Nantucket (Oldale 1969). The depth to bedrock beneath glacial sediments on Cape Cod ranges from about 80 to 900 feet below sea level (OSI 2002).

The southern terminus of the portion of the continental ice sheet that advanced across Cape Cod to the islands about 23,000 years ago is marked today by gravel deposits on the Continental Shelf and by the outwash plains and moraines on the islands (Figure 3-2). The Cape and islands are composed primarily of glacial end moraines, which mark the approximate locations of the stalled ice fronts and outwash plains that formed from sediments deposited by meltwater streams ahead of the ice front. The moraines are composed of poorly and well-sorted sand, silt, and clay that were transported in the glacial ice and left behind when the ice retreated. The broad outwash plains are mainly composed of sand and gravel that is mixed in places with till and ice-contact deposits of silt and clay. In addition to the outwash and moraine deposits, deeper and older preglacial sand and silt are present on Martha's Vineyard and Nantucket (OSI 2002).

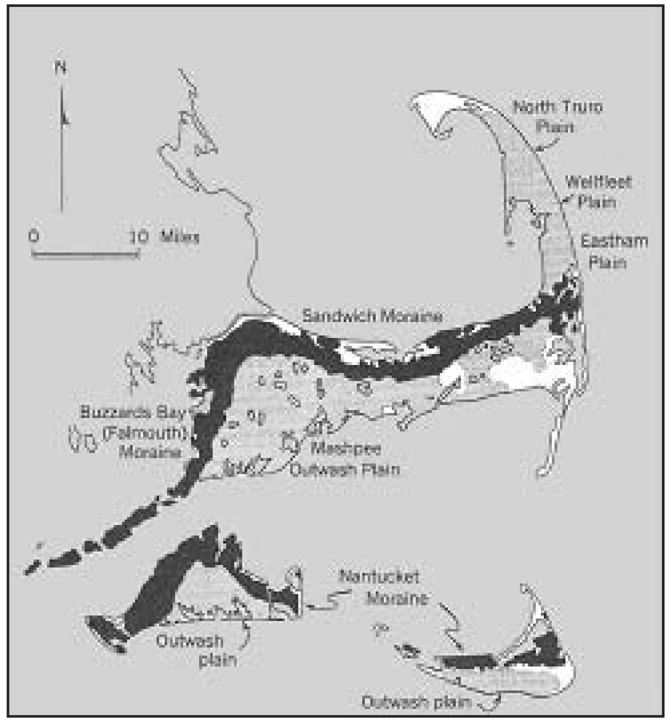

Figure 3-2. Glacial deposits in the Cape and islands region (after Oldale 1992).

The ice sheet that spread across the area was characterized by bulges or "lobes" in the ice front that filled in the large basins in the pre-existing topographic surface (Oldale and Barlow 1986). The advance and retreat of these lobes led to the formation of Cape Cod, Nantucket and Martha's Vineyard. The geophysical structure of the Nantucket Sound marine system is most closely linked to the Cape Cod Bay lobe (Figure 3-3), which spread across the Sound to its southernmost point corresponding with northern Nantucket Island. At a point when the glacier's southward advance was halted for more than 1,000 years, a portion of the southern terminal moraine of the Cape Cod lobe was deposited on Nantucket. Glacial till comprising the moraine consisted of soil, decomposed rock, and fragmentary bedrock collected by the ice as it flowed southward across New England (Figure 3-4). Sloping away from the moraine was an outwash plain, formed by deposits of finer materials carried away from the ice front in meltwater flows. Sloping led to a gradation in sediment sorting and a decrease in elevation moving away from the moraine (OSI 2002).

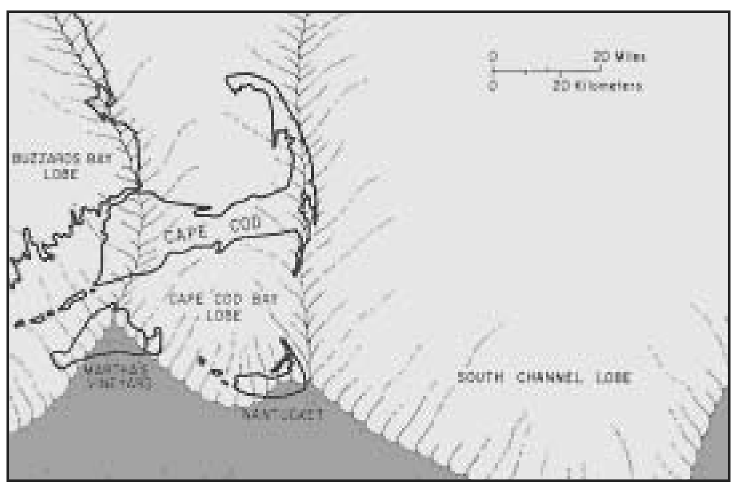

Figure 3-3. Buzzards Bay, Cape Cod, and South Channel glacial lobes (after Oldale 1992).

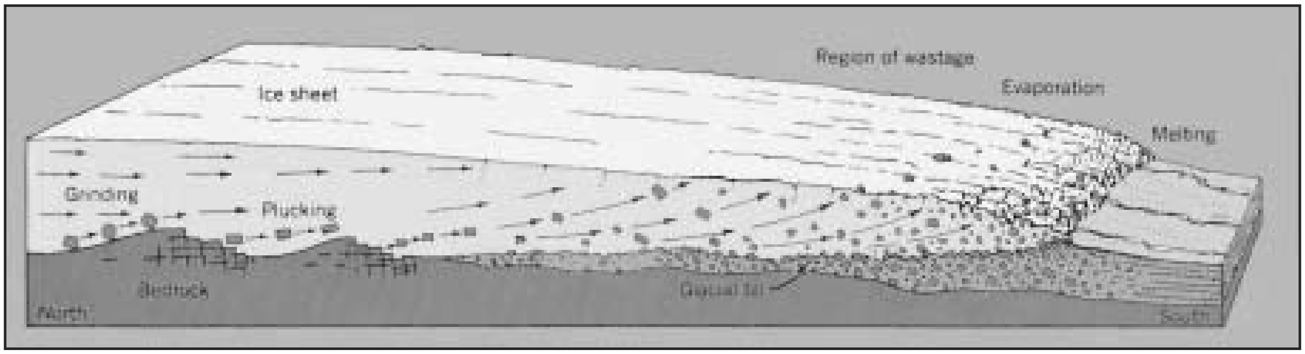

Figure 3-4. Soil, decomposed rock, and fragmentary bedrock collected by the ice as it flowed southward across New England (after Strahler 1966).

Radiocarbon dating suggests that sometime between 18,000 and 15,000 B.P., climatic warming caused the Cape Cod Bay lobe to rapidly retreat (Oldale 1992; Oldale and O'Hara 1980, 1993) (Figure 3-5). The retreat of the Cape Cod Bay lobe across current Nantucket Sound, coupled with minor readvances, led to the deposit of recessional moraines, outwash plains, and glacial till sediment. Most, if not all, of the outwash plains were formed as deltas in glacial lakes. The outwash plains on the upper Cape were formed in glacial lakes that occupied Nantucket Sound and Vineyard Sound, and those on the lower Cape were formed in a lake that occupied Cape Cod Bay (Oldale 1992). The elevation of the terminal and recessional moraines, with outwash plains sloping away from them, helped meltwater to erode the outwash plains and to generate a network of braided outwash channels that were later flooded by rising sea level to create many of the embayments seen today on the southern shore of Cape Cod (Figure 3-6). By about 15,000 years ago, the ice had retreated from the Gulf of Maine and all of southern New England. The postglacial landscape on the Cape and in the coastal plain area of today's Nantucket Sound was essentially unvegetated for several thousand years, after which tundra-like conditions prevailed and low bushes, grasses, and stands of arctic trees were common (OSI 2002).

Figure 3-5. Projected extent of subaerially exposed outwash plain immediately after glacial retreat (after Oldale 1992).

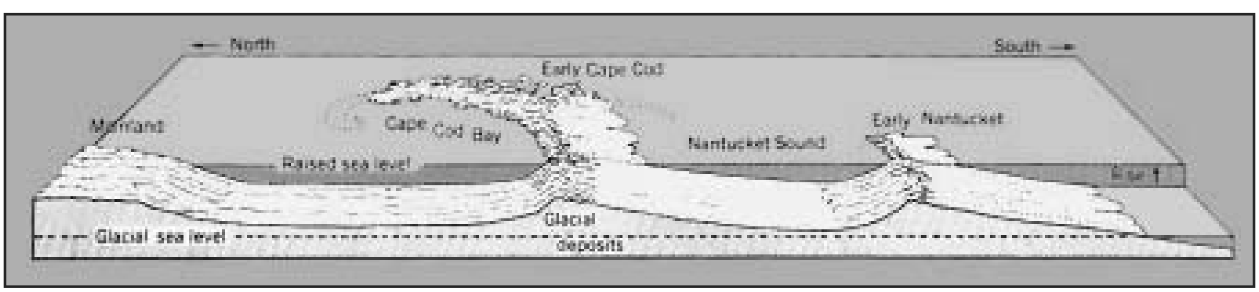

Figure 3-6. Cape and islands topography before and after inundation (after Strahler 1966).

Nantucket Sound and Sea Level Rise

The retreat, thinning, breakup, and final disappearance of the Laurentide ice sheet did not mark an end to the ice-driven morphological alterations of the New England land surface. Worldwide melting of the continental ice sheets led to the return of water to the ocean basins and a concomitant rise in global sea level. Initially, up until about 10,000 years ago, sea levels rose quickly at a rate of about 50 feet per 1,000 years. However, as glacial ice volumes decreased, the rate of sea level rise gradually slowed (Figure 3-7). On Cape Cod, the rate of sea-level rise between 6,000 years ago and 2,000 years ago was about 11 feet per 1,000 years. From 2,000 years ago, the rate of sea-level rise was about three feet per 1,000 years. Rates of worldwide sea-level rise have been determined using radiometric ages of submerged shoreline features. Local rates of sea-level rise have been determined through radiocarbon dating of salt-marsh peats, which are considered an accurate indicator of relative sea level (Redfield and Rubin 1962; Oldale 1992; OSI 2002).

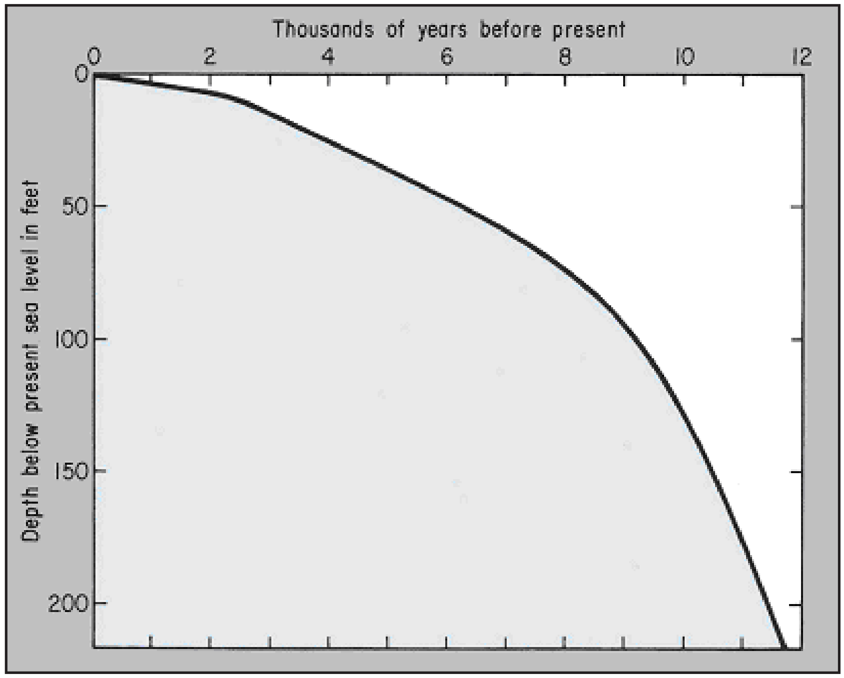

Figure 3-7. Sea level rise - 12,000 B.P. to present (after Oldale 1992).

In the Cape and islands region, this rise in sea level resulted in the inundation by Atlantic Ocean waters of Cape Cod and Buzzards bays, and Nantucket, Vineyard, and Long Island sounds. As relative sea levels rose, Martha's Vineyard and Nantucket became islands, and the lowland between the Sandwich terminal moraine at Cape Cod and the frontal moraines of Nantucket Island became Nantucket Sound. The lower topography of today's Nantucket Sound probably resulted from a unique combination of events, the first of which was subaerial erosion during a period of extremely low sea level in the late Tertiary, and erosion because of meltwaters from the later retreat of the Cape Cod Bay lobe (OSI 2002).

By about 6000 B.P., the rising sea inundated the lowlands that once occupied today's Vineyard and Nantucket sounds, and reached the Cape. The Cape's glacial drift headlands east of the present eastern shoreline were eroded as waves attacked the headlands to form marine scarps or sea cliffs. Eroded material was reworked and transported along the shore by wave-generated longshore drift and currents, and redeposited along the shore to form bay mouth bars, spits, and barrier islands across embayments (OSI 2002).

Sediments of Nantucket Sound

Surficial sedimentary deposits within the Nantucket Sound are Pleistocene and Holocene in origin. The texture of the glacial drift is coarse with sand-size particles most abundant and with little silt and clay (Hough 1940). Gravel and rock fragments are common within the moraines. The glacial drift surface is overlain in most places by freshwater, estuarine, and marine (mostly sand) deposits of Holocene age, although the glacial drift is exposed in many places on the sea floor within Nantucket Sound, especially in its northern and western portions (O'Hara and Oldale 1987). The tidal and wind-driven currents are the most important source of energy for sediment transport and sorting within Nantucket Sound. Sediments within the Sound range from muds and silts in the deeper regions, to sands, gravels, and boulders in shallower areas near-shore and near the eastern shoals of the sound.

Silt is found in the deeper, central regions of the sound generally below the 40-foot bathymetric contour, with fine sand along the north side near-shore depositional areas, with medium sand close to shore on the south side. Coarse sand is also associated with the north and northeast shoal areas of the upper sound. Coarse sand areas are swept by stronger currents, which remove finer-grained sediments (Moore 1963). Fields of sand waves have been observed and described in Nantucket Sound (OSI 2002).

In addition to providing a mechanism to alter basin sediments, the flooding of the basin allowed for erosion of shoreline deposits by wave action. To date, erosion of headlands and island shores has cut them back many meters. Overall, however, the change in the shoreline has been modest because of the abundant boulders in the glacial drift areas (Hough 1940). The subtidal topography of Nantucket Sound has undergone alterations as well, mainly smoothing resulting from erosion of shoals and increased deposition in hollows. However, like the beaches, the shoals (formed from the same materials) also form a coarse surface layer slowing their erosion. An example of this is the Nantucket Shoal, which is a conspicuous submerged sand and gravel shallow ridge extending southeastward from Nantucket Island (Limeburner and Beardsley 1982; OSI 2002).

Existing Environmental Conditions

A program of integrated geophysical/hydrographic survey and sediment sampling conducted in the offshore project area by OSI in June, July, August, and November of 2001 provided data for project engineers to assess and characterize seafloor and sub-seafloor conditions prior to the design, construction, and installation of the Cape Wind Energy Project's wind turbine array field and associated cable system. The primary objectives of the survey were to identify water depths, seafloor morphology and structural features (bedrock/till outcrops, silt, clay, sand, etc.), sub-seafloor stratigraphy, and any natural or anthropogenic obstructions on and below the seafloor. Five, east- to west-oriented lines spaced 5,236 feet apart, and 14 lines oriented north to south and spaced 2,743 feet apart were investigated within the WTG array field area. Three lines, spaced 500 feet apart, were surveyed along the centerline routes of the proposed 115 kV low voltage buried submarine cable system to Yarmouth and to Cotuit (OSI 2002). Geophysical data contained in the OSI report and geotechnical data provided by ESS were reviewed by PAL to identify potential shipwrecks and assess the current environmental conditions within the Cape Wind Energy Project's offshore study area.

WTG Array Field

Water depths within the WTG array field measured between 7.7 and 62.5 feet in depth. The shallowest depths were recorded along the southern leg of Horseshoe Shoal. The area of maximum depth is located in the eastern limit of the study area. A 60-foot deep basin-like bathymetric low exists within the east-central portion of the array field area between the northern and southern legs of Horseshoe Shoal. A 50-foot deep east to west trending channel feature was documented on the southern leg of the shoal.

The surface of the seafloor within the array field was observed to include areas that were flat and featureless, areas with pronounced sand wave features, and an irregular area in the western portion of the array field probably caused by patches of submerged aquatic vegetation. The sand waves are oriented generally north to south and range in height from 1 to 16 feet, with 4 to 5 feet being the average height. The largest sand waves were recorded within the aforementioned east to west trending channel. During the course of the survey, sands were observed to migrate with the ebb and flow of tidal currents between east and west. The WTG array field's shallow (i.e., 10 feet or less), subsurface stratigraphy consisted predominantly of fine- to medium-grain sands, with localized fractions of clay, silt, gravel and/or cobbles, and shell fragments.

Transmission Cables Route

The seafloor along the cable route to Yarmouth displayed minor irregularities and had a maximum depth of 40 feet. Three- to 5-foot tall sand waves are present in areas along the route. The upper 10 feet of the seafloor was determined to contain approximately 10 feet of unconsolidated sediments, ranging in size from clay to gravel with a fraction of shell fragments. Except for an acoustic basement outcrop, there are no notable geological features within this area.

CHAPTER FOUR

NATIVE AMERICAN CULTURAL CONTEXT

Archaeologists and anthropologists have documented almost 12,000 years of human settlement in the deglaciated terrestrial terrain of southern New England. Professional archaeologists commonly divide the Northeastern Native American record into three general temporal periods: PaleoIndian, Archaic, and Woodland. The latter two periods are further subdivided into Early, Middle, and Late categories with the Late Archaic and Early Woodland periods being separated by a distinct transitional period to which it is referred as the Terminal or Transitional Archaic. Each general period of the Native American archaeological record is distinguishable on the basis of material culture, specific land use patterns, and occasionally by social indicators (Table 4-1).

Following the retreat of thick glacial ice from the region, Cape Cod (part of the Northeast's physiographic Coastal Plain Province) and the then subaerially exposed Cape Wind Energy Project's offshore study area were probably populated by relatively small bands of migratory people collectively referred to as PaleoIndians. The timing of the initial population of the Eastern Seaboard by PaleoIndian peoples is presently debated by archaeologists with the discovery of apparent cultural strata and artifacts predating the PaleoIndian "Clovis Culture" or fluted point tradition at the Topper Site in South Carolina and the Cactus Hill Site in Virginia. Similarly, an averaged date of 15,960 radiocarbon years B.P. from reported cultural strata at the Meadowcroft Rock Shelter Site in Pennsylvania predates accepted Clovis dates in the Northeast by nearly 3,000 years (Adovasio 1993). Nevertheless, the earliest unequivocal evidence for the human occupation of the Northeast is associated with the Clovis Culture and dates to 11,120 ± 180 B.P. at the Vail Site in Maine (Gramly 1982). The presence of thick glacial ice in the Northeast until roughly 16,000 years B.P. makes any discussion of a pre-Clovis presence in the region largely academic.

The configuration of Cape Cod has changed significantly since the retreat of the glaciers. Sea levels, low during the glacial period, gradually increased following glacial retreat resulting in the inundation of former shorelines and increasing the levels of fresh water in the groundwater supply, as well as in the ponds and rivers. For at least part of the Native American period, shorelines were much farther offshore than they are today. It is likely that an array of site types and locations have been destroyed or obscured by the rising sea levels on both the northern and southern shores of Cape Cod. By about 4,500 years ago sea levels stabilized and by 3,500 years ago the majority of marshes and swamps on the Cape had formed (Goudie 1977:169).

Up until just a decade ago, early Native American artifacts and/or documented archaeological sites dating from the PaleoIndian and Early and Middle Archaic periods (ca. 12,000 to 5000 B.P.) along the Atlantic Coastal Plain were quite rare. This lack of archaeological data initially led researchers to conclude that unfavorable environmental conditions had resulted in an apparent depopulation of the

Table 4-1. Native American Cultural Chronology for Southern New England.

Period	Years	Identified Temporal Subdivisions[1]	Cultural Aspects
PaleoIndian	12,500–10,000 B.P.[2] (10,500–8000 B.C.)	• Eastern Clovis • Plano	Exploitation of migratory game animals by highly mobile bands of hunter-gatherers with a specialized lithic technology.
Early Archaic	10,000–7500 B.P. (8000–5500 B.C.)	• Bifurcate-Base Point Assemblages	Few sites are known, possibly because of problems with archaeological recognition. This period represents a transition from specialized hunting strategies to the beginnings of more generalized and adaptable hunting and gathering, due in part to changing environmental circumstances.
Middle Archaic	7500–5000 B.P. (5500–3000 B.C.)	• Neville • Stark • Merrimack • Otter Creek • Vosburg	Regular harvesting of anadramous fish and various plant resources is combined with generalized hunting. Major sites are located at falls and rapids along river drainages. Ground-stone technology first utilized. There is a reliance on local lithic materials for a variety of bifacial and unifacial tools.
Late Archaic	5000–3000 B.P. (3000–1000 B.C.)	• Brewerton • Squibnocket • Small Stemmed Point Assemblage	Intensive hunting and gathering were the rule in diverse environments. Evidence for regularized shellfish exploitation is first seen during this period. Abundant sites suggest increasing populations, with specialized adaptations to particular resource zones. Notable differences between coastal and interior assemblages are seen.
Transitional	3600–2500 B.P. (1600–500 B.C.)	• Atlantic • Watertown • Orient • Coburn	Same economy as the earlier periods, but there may have been groups migrating into New England, or local groups developing technologies strikingly different from those previously used. Trade in soapstone became important. Evidence for complex mortuary rituals is frequently encountered.
Early Woodland	3000–1600 B.P. (1000 B.C.–A.D. 300)	• Meadowood • Lagoon	A scarcity of sites suggests population decline. Pottery was first made. Little is known of social organization or economy, although evidence for complex mortuary rituals is present. Influences from the midwestern Adena culture are seen in some areas.
Middle Woodland	1650–1000 B.P. (A.D. 300–950)	• Fox Creek • Jack's Reef	Economy focused on coastal resources. Horticulture may have appeared late in the period. Hunting and gathering were still important. Population may have increased from the previous low in the Early Woodland. Extensive interaction between groups throughout the Northeast is seen in the widespread distribution of exotic lithics and other materials.
Late Woodland	1000–450 B.P. (A.D. 950–1500)	• Levanna	Horticulture was established in some areas. Coastal areas seem to be preferred. Large groups sometimes lived in fortified villages, and may have been organized in complicated political alliances. Some groups may still have relied solely on hunting and gathering.
ProtoHistoric and Contact	450–300 B.P. (A.D. 1500–1650)	• Algonquian	Groups such as the Wampanoag, Narragansett, and Nipmuck were settled in the area. Political, social, and economic organizations were relatively complex, and underwent rapid change during European colonization.

[1] Termed Phases or Complexes
[2] Before Present

Northeast at that time (Fitting 1968; Ritchie 1971). This hypothesis has been rejected in light of new archaeological and paleoenvironmental data to the contrary (Dincauze and Mulholland 1977; Robinson and Petersen 1989). While sites dating from the PaleoIndian, and Early and Middle Archaic periods remain comparatively rare relative to later Woodland Period sites along the Atlantic Coastal Plain, recent archaeological investigations on Cape Cod (Dunford 1999), in eastern Massachusetts (Cross 1999; Doucette and Cross 1998), in Connecticut (Forrest 1999; Jones 1999; Jones and Forrest 2000), and elsewhere (Carr 1996; Gardner 1987) have dramatically increased our existing knowledge about early Native American settlement patterns. These studies also bring into question current survey paradigms for locating sites from these periods in southern New England. Increasingly, evidence of lowered water levels and an emergent correlation between large wetlands and major water bodies and early Native American archaeological sites suggests that water and its associated food resources were a critical factor in site selection. Hypotheses are now proposed that assert that large Early and Middle Archaic Period archaeological sites in proximity to large lakes, rivers, and extensive wetlands with inlets and outlets flushing the system may have been more common on the Coastal Plain, but were submerged by rising sea level (McWeeny and Kellogg 2001).

Virtually every documented PaleoIndian and Early Archaic find reported on the Cape and islands lacks detailed contextual information. A single Neville-type projectile point recovered from the Davis Beach Site (19-BN-568), located east of Lewis Bay in Dennis, represents the only evidence for early Holocene occupation in proximity to the mainland portion of the study area. Similarly, Neville and Stark type projectile points have been found at the Felix Neck 4 Site in Edgartown. Known Middle Archaic sites on Nantucket have been discovered within the Nantucket outwash plains near freshwater ponds, creeks, wetland margins, and shoreline bluffs.

Coastal archaeological sites dating from the Late Archaic Period are more common and are documented on mainland locations, such as the Davis Beach Site (19-BN-568) in Dennis, the Snows Creek Drive Site (19-BN-531) in Barnstable, and the Maushop Site (19-BN-791) in Mashpee. Numerous sites are also reported from coastal and inland locations on nearby Nantucket and Martha's Vineyard islands. On Martha's Vineyard, the majority of the Late Archaic through Woodland Period archaeological sites is located along ponds and the shoreline, where fishing and shellfish collection would have taken place. For Nantucket, Late/Transitional Archaic period materials in the central outwash plains are commonly identified from isolated projectile finds. Documented Late Archaic sites include 19-DK-24, 19-DK-25, 19-DK-98, and 19-DK-117 on the Vineyard and the Herrecater Swamp Site, 19-NT-157, and 19-NT-99 on Nantucket. A propensity for Late Archaic sites to be located in coastal settings along with Martha's Vineyard and Nantucket's isolation from the mainland during this period bespeaks of a well-developed maritime economic subsistence base for the period. Most documented Late Archaic sites in the area are components of larger sites with longer-term habitation.

The Woodland Period that followed the Late Archaic in regional prehistory appears to have been a time of dynamic development for local indigenous peoples. The archaeological data suggests that throughout the period there was a gradual but distinct diversification of food sources, along with an increased reliance on shellfish, the refinement of pottery manufacturing, and eventually year-round settlement. The transformation from a foraging way of life toward a more sedentary existence associated with the introduction of plant domestication likely was related to the formation of stable coastal or estuarine environments that supported a varied, rich, and reliable subsistence base. This pattern is preserved along the mid-Cape in proximity to the study area with local collections being dominated by triangular Levanna-type projectile points. Woodland Period sites are similarly the most prevalent cultural components represented in the archaeological records on each of the islands with dozens of habitation, resource extraction and utilization, burial, and habitation sites being documented in immediate proximity to the islands' large salt ponds and estuaries.

Woodland Period archaeological sites are reported all along the mainland coastline and estuaries of Popponesset, Cotuit, East, North, Lewis, and Shoestring bays and Centerville Harbor. Reported Woodland Sites include the Maushop Site (19-BN-791) in Mashpee, the Davis Farm (19-BN-780), Snow Creek Drive (19-BN-531), Bay Street Landing (19-BN-775), Butler (19-BN-511), Birdsall (19-BN-676), and Dunbar Point (19-BN-577) sites in Barnstable, the horticultural Sandy's Point Site (19-BN-647) in Yarmouth, and the Davis Beach Site (19-BN-568) in Dennis (MHC Site Files). Long-term habitation with evidence for horticulture was also recently diagnosed at archaeological site 19-NT-50 on Nantucket and the Hornblower II Site on Martha's Vineyard. The Dunbar Point Site, diagnosed through the recovery of isolated projectile points, overlooks the study area to the southeast. Considering the known aspects of the Woodland settlement system, it is likely that most of the 29 archaeological sites with virtually no reported information in the MHC's archives other than "shell-heap" or mortuary are Woodland in origin, reflecting extensive exploitation and habitation of the southeastern coastal plain throughout the period.

PaleoIndian Period (12,500–10,000 B.P.)

The variability in shorelines and change in levels of fresh water have raised questions about what the Cape looked like and what resources were available when Native American groups first occupied this area. The known early Holocene (post-Ice Age) sites are nearly all interior or near-interior sites, although it is assumed that saltwater fishing was an important resource and that campsites were located along the coastline as it existed at that time. Projectile points diagnostic of the PaleoIndian Period have been found in riverine and kettle pond settings on the Cape (Davin 1989; Mahlstedt 1987). These projectile points have generally been Eden-like points that appear to associate the occupations of these sites with late PaleoIndian or Early Archaic Period occupations. These points are generally manufactured from stone materials that were available from local cobbles in the glacial drift in the moraines or along the beaches.

Early Archaic Period (10,000–8000 B.P.)

Diagnostic Early Archaic bifurcate-based projectile points have also been found along rivers in the mid-Cape area. On the outer Cape a few Early Archaic sites have been found in interior locations several miles from the current shoreline. Two reported finds are known in the Herring River/Harwich section of the mid-Cape (Bells Neck Road and Halls Field sites) and one bifurcate point was recovered from the outer Cape at Indian Rock (Mahlstedt 1987:4; Towle 1984:304).

In general, the known sites show that Cape Cod was occupied during the early Native American period and that freshwater locations were an important part of the land use patterns. However, known sites dating to these early periods are relatively scarce and components are relatively small compared to those identified for later periods. Archaeological research concerning both the PaleoIndian and Early

Archaic periods on the Cape needs to focus on understanding the resources that would have been exploited at this time. The effects of glaciation and deglaciation were significant factors in determining local environmental conditions. The most obvious was the much greater landmass that was present, because of the lower sea levels. Today, distance to the coast is no more than 10 miles at the widest point. Eight thousand years ago, the distances may have been appreciably greater. Then, the headwaters of the rivers were more than 30 miles from the coast. These rivers, which today are brackish, would have been sources of fresh water, as well as of fish and related plants, waterfowl, and other animals.

Middle Archaic Period (8000–5000 B.P.)

As has been well documented in other locations in southern New England, the number of known sites with diagnostic materials increases greatly in the Middle Archaic Period. Riverine settings continued to be a focus of exploitation during this temporal period. Diagnostic artifacts have been located both in situ and as surface collections in significantly greater numbers than those of the earlier periods. The locations of Middle Archaic sites strongly suggest a broad base subsistence pattern with a particular focus on anadromous fishing.

Middle Archaic depositions have been located adjacent to kettle ponds in both the inner and outer Cape, where rivers are not in close proximity to each other (Davin and Gallagher 1987; McManamon et al. 1984). For example, a Stark projectile point was found at the Round Swamp Site in Bourne (Davin and Gallagher 1987). On the outer Cape, there are only a few scattered indications of Middle Archaic utilization and these are primarily located around kettle hole ponds. The locations of these known sites indicate that freshwater and associated resources were important to Middle Archaic groups (McManamon et al. 1984).

The Bass and Herring rivers on the mid-Cape both contained significant Middle Archaic depositions. In particular, the Farham Collection contains 56 Middle Archaic projectile points, primarily from the Bells Neck Road I (West Harwich), Swan River (19-BN-31) (Dennis), and Blue Rock (19-BN-562) (Yarmouth) sites (Mahlstedt 1987). A concentration of Middle Archaic deposits has been identified in Dennis along the Bass River, including multicomponent sites such as Narrows River 2 (19-BN-761) and 4 (19-BN-763), Mayfair Narrows (19-BN-599), Bass River Lane (19-BN-566), and Nickerson/Bush (19-BN-563) (MHC site files). Middle Archaic stemmed biface and Stark points were also recovered from the Fox-4 and Fox-5 sites, adjacent to the Santuit River in Mashpee (Shaw and Savulis 1988:48, 57). The Kelly's Bay (19-BN-570) and Sea Street Beach (19-BN-586) sites along Dennis's southern shoreline also contained Middle Archaic deposits, indicating that both coastal and interior environments were utilized during this period in the mid-Cape area.

Late/Transitional Archaic Period (5000–3000 B.P.)

Land use patterns on the Cape during the Late Archaic Period are similar to the rest of southern New England. Small Stemmed projectile points, the most frequently found artifact on the mid- and inner Cape areas, have been recovered from a wide variety of environmental settings (Mahlstedt 1985). On the outer Cape, Small Stemmed points are second only to Late Woodland Levanna projectile points (McManamon 1984). The widespread prevalence of these projectile points has been attributed to several different causes including population growth and environmental stress. The latter explanation suggests that a dry spell occurred during the Late Archaic Period. Native American groups would have responded to this by using a wider range of exploitation areas in order not to deplete the existing resources. The majority of the evidence indicates that this style of projectile point was more functional than stylistic or representative of a certain time period or cultural group. Small Stemmed points have frequently been located with Woodland Period ceramics in radiocarbon-dated contexts (Halligan 2000). They appear to have been used from 4000–2000 B.P. and maybe even into the Late Woodland Period (1000–450 B.P.) (Herbster and Cherau 1999, 2001).

Transitional Archaic sites and artifacts are relatively well represented on riverine sites in the mid-Cape area. Artifact collections from the Bass River area show that Susquehanna Tradition projectile points are numerous (Mahlstedt 1987:62). Atlantic and Susquehanna Broad points occur in relatively high densities at the Blue Rock Site in Yarmouth. In comparison, the Herring River area contains a much lower density of Susquehanna artifacts and sites. The Coburn Phase of the Susquehanna Tradition has a relatively strong presence on the outer Cape, and this cultural tradition was first identified through avocational excavations at a cremation burial site in Orleans (Kremp 1961). In Dennis, sites along the Bass River indicate continued use of this waterway from the Middle to Late Archaic periods. Late Archaic deposits have been identified at a number of the same sites discussed above including Narrows 2 and 4, Mayfair Narrows, Bass River Lane, and Nickerson/Bush as well as at Dutch's Way (19-BN-565). Types of sites other than burials are relatively rare for the Coburn Phase, and as a result the Oak Ridge Site, a Coburn lithic manufacturing area, was particularly important (Loparto 1985:38). Transitional Archaic artifacts have also been found at the Spruce Swamp Site in Sandwich and at Hathaway Pond in Barnstable (Davin 1989; Davin and Gallagher 1987).

Early Woodland Period (3000–1600 B.P.)

The Early Woodland Period is generally not well understood or well defined in southern New England. As previously stated, basic questions as to which projectile points may or may not be diagnostic of this period have yet to be determined. As a result, it has been traditional to view the Early Woodland Period as a period of possible regional population decline, from which fewer sites are known. The earliest local manufacture and use of ceramics are attributed to this period. Only a few site locations containing evidence of probable Early Woodland activity have been identified on the inner and mid-Cape. These locations are primarily based on the presence of diagnostic Meadowood and Rossville projectile point types.

While definite Early Woodland Period sites are infrequent, archaeological deposits dating to this period have been located in all sections of the Cape. In Bourne, the Round Swamp Site contained a Meadowood point (Davin and Gallagher 1987). A slight concentration of Early Woodland Period activity has been identified for the Herring River area, based primarily on the recovery of diagnostic Rossville projectile points and pottery (Mahlstedt 1987:72). At least seven Early Woodland sites have been identified in the town of Harwich. Few Early Woodland components have been located on the outer Cape (McManamon 1984). Early Woodland components have been identified at several of the multicomponent Bass River sites (Narrows 2 and 4, and Nickerson/Bush) (MHC site files).

Middle Woodland Period (1650–1000 B.P.)

Middle Woodland sites and depositions are relatively numerous in southeastern Massachusetts, including Cape Cod. During the archaeological investigations of the Cape Cod National Seashore, a number of Middle Woodland components were discovered. One site along Nauset Marsh contained eight Jack's Reef points, as well as evidence of winter exploitation of shellfish (Borstel 1984:244). In the mid-Cape area, Middle Woodland sites have been identified along the Herring and Bass rivers, particularly at the Blue Rock Site in Yarmouth.

Sites from the mid- and outer Cape areas containing Early and Middle Woodland depositions do not indicate the degree of contact with extraregional groups evidenced at mainland sites in southern New England during this period. There is a general lack of "imported" finished goods (Adena-like points, elbow and tubular pipes made of clay and stone) and raw materials (Pennsylvania Jasper, New York cherts) at the Cape sites. The majority of the sites on the Cape indicate that a local procurement of stone for tool manufacture, retrievable from local beaches, river channels, and exposures in the drift, was the strategy followed throughout the Woodland, if not the entire Native American period. While long-distance contacts cannot be ruled out, it does appear that the insular nature of the Cape may have influenced how the Woodland (and probably Archaic) populations interacted with other peoples (MHC 1987).

Late Woodland Period (1000–450 B.P.)

Late Woodland Period sites, depositions, and artifacts dominate the archaeology of the outer Cape (McManamon 1984). Levanna projectile points are the single most numerous artifacts east of Harwich. Sites on the mid- and inner Cape areas also consistently contain Levanna projectile points, but not in the same densities as on the outer Cape. While artifacts are numerous, site locations are not as varied as those associated with earlier periods. On the outer Cape, shell middens located adjacent to protected embayments and estuaries are a dominant pattern. Shell middens are located next to both saltwater and freshwater on the inner and mid-Cape areas. The diversity of density of the materials within these middens indicate that these may be remnants of sedentary, relatively long-term occupations (McManamon 1984:409).

Archaeological Sensitivity for Native American Submerged Cultural Resources

Preliminary background research and a review of existing geophysical and geotechnical data provided information necessary to generally characterize the environmental conditions and physical integrity of marine sediments, and develop an inventory of reported shipwrecks within the Cape Wind Energy Project's offshore study area for the purpose of assessing its archaeological sensitivity. Archaeological sensitivity is defined as the likelihood for Native American and/or early Euro-American submerged cultural resources to be present.

The study of Native American land-use and settlement systems in the Northeast has benefited from cultural preservation movements supported by local and federal legislation. The resultant body of data has documented more than 10,000 years of human occupation in the region. However, recession of the glaciers, alterations of the landscape, successions in plant and animal communities, subsidence of the coastline because of rising sea levels, and the effects of the marine transgression on the formerly exposed paleolandscape complicate interpretation of the early archaeological record offshore. Furthermore, settlement system information that has been assembled is biased in favor of durable material types, such as stone artifacts, and toward sites that have resisted destruction and are on land. Consequently, the types of data presently available for interpretation provide only a partial and incomplete view of prehistoric Native American culture. Systematic identification, documentation, and data recovery of submerged prehistoric cultural resources can potentially supply various categories of information presently unavailable to researchers working in the Northeast. These classes of data would be extremely useful for refining or revising our current perception of the earlier periods of prehistoric human settlement and subsistence patterns.

The accumulation of data resulting from the extensive archaeological research conducted to date on land in the Cape and islands region indicate that certain types of environmental and topographical settings are strongly associated with the presence of prehistoric archaeological deposits. Archaeological research has repeatedly demonstrated that prehistoric peoples in North America and elsewhere sought the most productive areas within their landscape, especially those areas that offered diverse resources available on a seasonally consistent basis. Some of the richest habitats of diverse flora, fish, and wildlife are found near the junction of land and water, both fresh and salt. Riparian corridors consisting of rivers, streams, and estuaries, their beds, banks, and floodplains, along with the soils, plants, and animals that exist there are among the most productive biological systems in the world.

Stright (1990) and others (Crock 2003; Dencker 2003; McBride 2003; Merwin 2003; Robinson 2003; Robinson and Waller 2002) have provided discussions of ways to predict the location of inundated sites, including those on the North American continental shelf, as well as the methods of locating these sites. Generally, the prerequisite for site preservation on the continental shelf is site burial in terrestrial or low-energy marine sediments prior to the transgression of the ocean (Waters 1992). The site will be preserved if it remains below the depth of shore face erosion during and after the marine transgression process. The “fishing site model,” developed and tested with positive results by Danish researchers (Pedersen et al. 1997), asserts that submerged prehistoric site locations may be expected at resource-rich water/land interfaces in locales that were good for fishing with stationary nets or traps. Such locales include lands around river mouths, narrows within bays, and on projecting points of land and islands with shallow, evenly sloped shorelines that have not undergone substantial sediment reworking.

The possibility that submerged prehistoric sites may be present in the study area is supported by the density and diversity of known archaeological resources on the Cape and islands, and the fact that spot finds of prehistoric cultural material, as well as large prehistoric assemblages (e.g., the “Corcione” assemblage, Sandy Hook, New Jersey), in the offshore waters of the northeastern United States are documented (Lynch et al. 2002).

Although no submerged prehistoric archaeological sites are reported within the study area, published rates of local sea level rise indicate that much of the offshore project area may have been available for human occupation from about 12,500 to 7000 B.P., with progressively smaller portions of the area available thereafter up until about 1000 B.P. (Redfield and Rubin 1962; Oldale 1982, 1992). Based on available data, it is theoretically possible that prehistoric archaeological deposits with contextual integrity may be present within isolated portions of the study area in areas where natural soil strata are present.

Site types could include small, special-purpose activity areas, transportation corridors, semipermanent habitations, and burial sites as described in the Native American cultural context.

The development of predictive models for locating cultural resources onshore is somewhat applicable to submerged cultural resources located offshore, since any intact submerged prehistoric archaeological deposit offshore would be located in a former subaerially exposed terrestrial landscape. The criteria used in the prehistoric sensitivity model for the study area is essentially the same as that used on land, with some modifications to factor in the erosional effects of the marine transgression and post-submergence effects of waves and currents. The criteria used to assess the archaeological sensitivity of the study area are its physical condition, environmental characteristics, proximity to documented prehistoric cultural resources, detectable submerged intact buried paleosol geomorphic features that may correlate with known site locations on land, and regional prehistoric land use patterns.

Based on the application of these criteria to the data collected during the background research and the geophysical and geotechnical engineering surveys, the study area was characterized for expected archaeological sensitivity. A majority of the study area may be described as having low archaeological sensitivity for containing submerged prehistoric cultural resources. This assessment is based on the extensive disturbance of sediments that is apparent in both the geophysical and geotechnical survey data. A majority of the formerly exposed landscape within the study area was either destroyed, disturbed, or deeply buried by the marine transgression and subsequent modern wave and tidal current regimes.

One relatively small zone that may contain intact paleosols with potential for containing submerged prehistoric cultural resources was identified from the 2001 survey data within the study area. This area corresponds with evidence exhibited in sub-bottom profiler data and vibratory core specimens. Project vibratory cores collected in 2001 (VC01-G4 and VC01-G7) and a core specimen collected in the 1970s by U.S. Geological Service (USGS VC-4939), recovered from the margin of the basin-like feature described above on the eastern side of the WTG array field, all contain a distinctive, 1 to 3-foot thick, layer of sediments buried beneath 8 to 10 feet of overlying marine sediments. Organic materials (e.g., wood, peat, and charcoal) in vibratory core sample VC01-G4 are stratified and appeared to include a sequence of estuarine or lagoonal sediments overlying peat and what appears to be an organic-rich "A-horizon" soil with wood debris above an orange-brown apparent "B-horizon" of coarser-grained, oxidized subsoils. These subsoils overlay very lightly colored sands interpreted to be a glacial outwash deposit forming a "C-horizon" (Figure 4-1). The organic layer is also visible in the seismic sub-bottom profiler data as a discontinuous, reflective, non-conformable surface. Organic material recovered in USGS VC-4939 was determined in the 1970s through radiocarbon dating methods to have an age of 6470 ± 200 B.P. Calibration of this date using OxCal (ver. 3.5) computer software provided a date range of 7513 to 7233 CalBP with 88 percent probability (Figure 4-2).

All three cores were collected from the present 45 to 55-foot depth contour along the western margin of the basin-like bathymetric low forming the interior portion of Horseshoe Shoal. Reconstructed

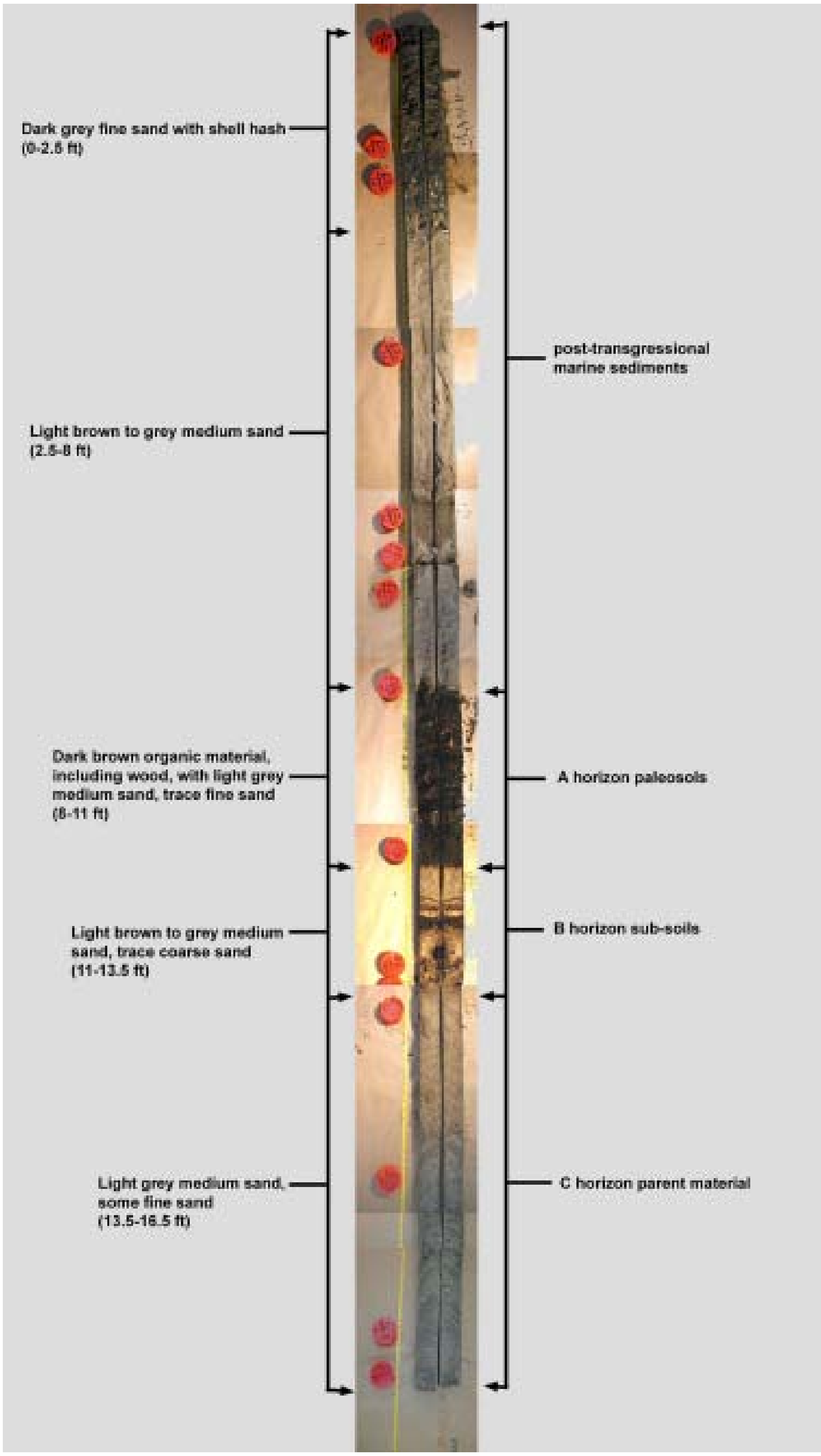

Figure 4-1. Photomosaic of 2001 project vibratory coring specimen VC01-G4 (individual images comprising mosaic courtesy of ESS).

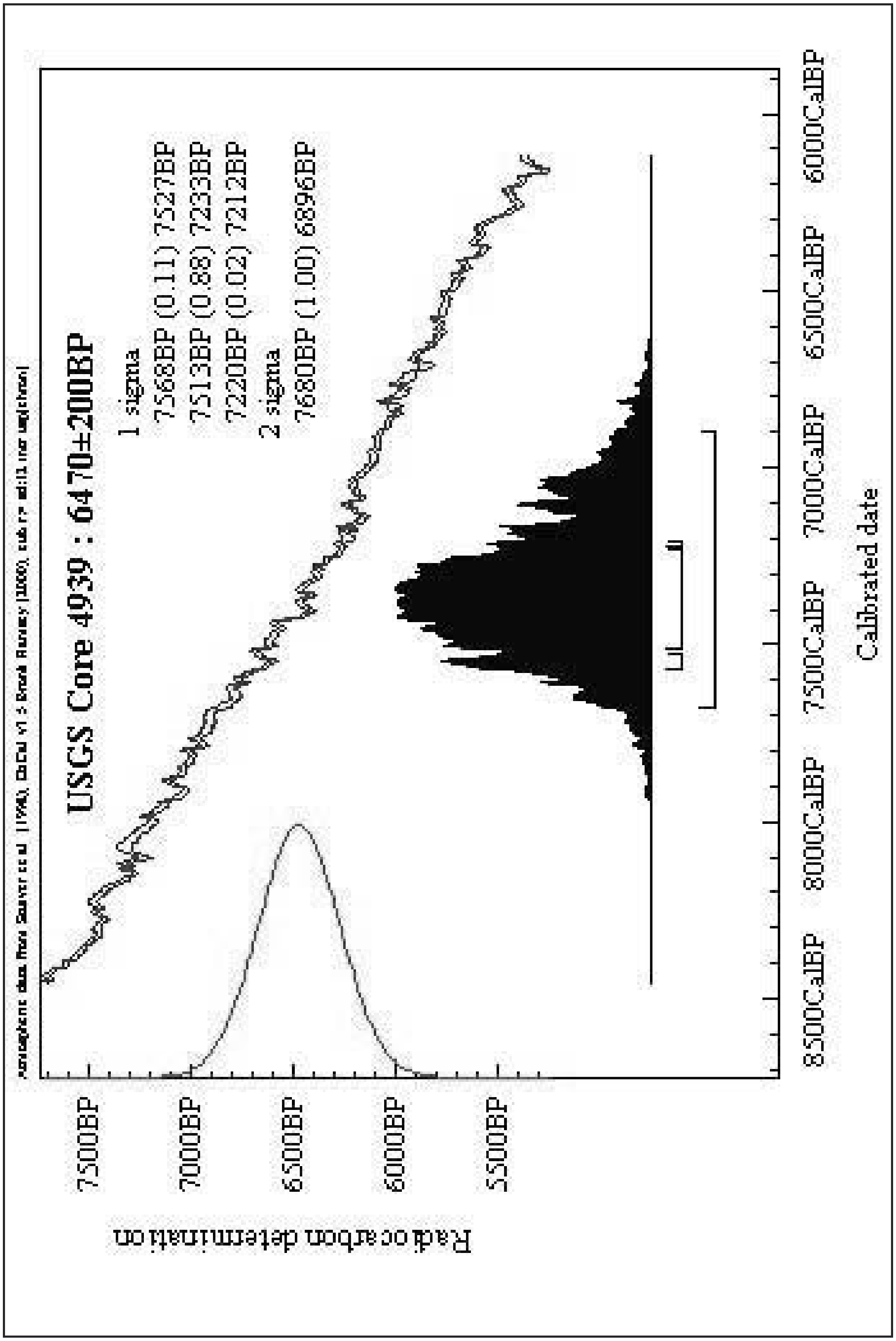

Figure 4-2. OxCal (ver. 3.5) calibrated C-14 date for USGS vibratory core specimen no. 4939.

projections of sea levels from 7250–3000 B.P. (Figures 4-3, 4-4, 4-5, 4-6, and 4-7) onto the study area's existing bathymetry suggest that the 45 to 55-foot depth contour from which the vibratory core samples were taken may have once been a subaerially exposed land surface, possibly located along the western margin of a large kettle pond, or a cluster of smaller kettle ponds, at circa 7250 B.P. The kettle pond or ponds were eventually transgressed by rising sea level circa 6000 B.P. to become a prominent embayment on the southeast end of a large, peninsula-like, topographic high encompassing today's Horseshoe Shoal. Resource-rich lakes and coastal embayments are known to have been attractive landscapes for ancient human habitation, and archaeological evidence exists in southern New England for coastal adaptation and regular harvesting of anadromous fish by the Middle Archaic Period (7500–5000 B.P.).

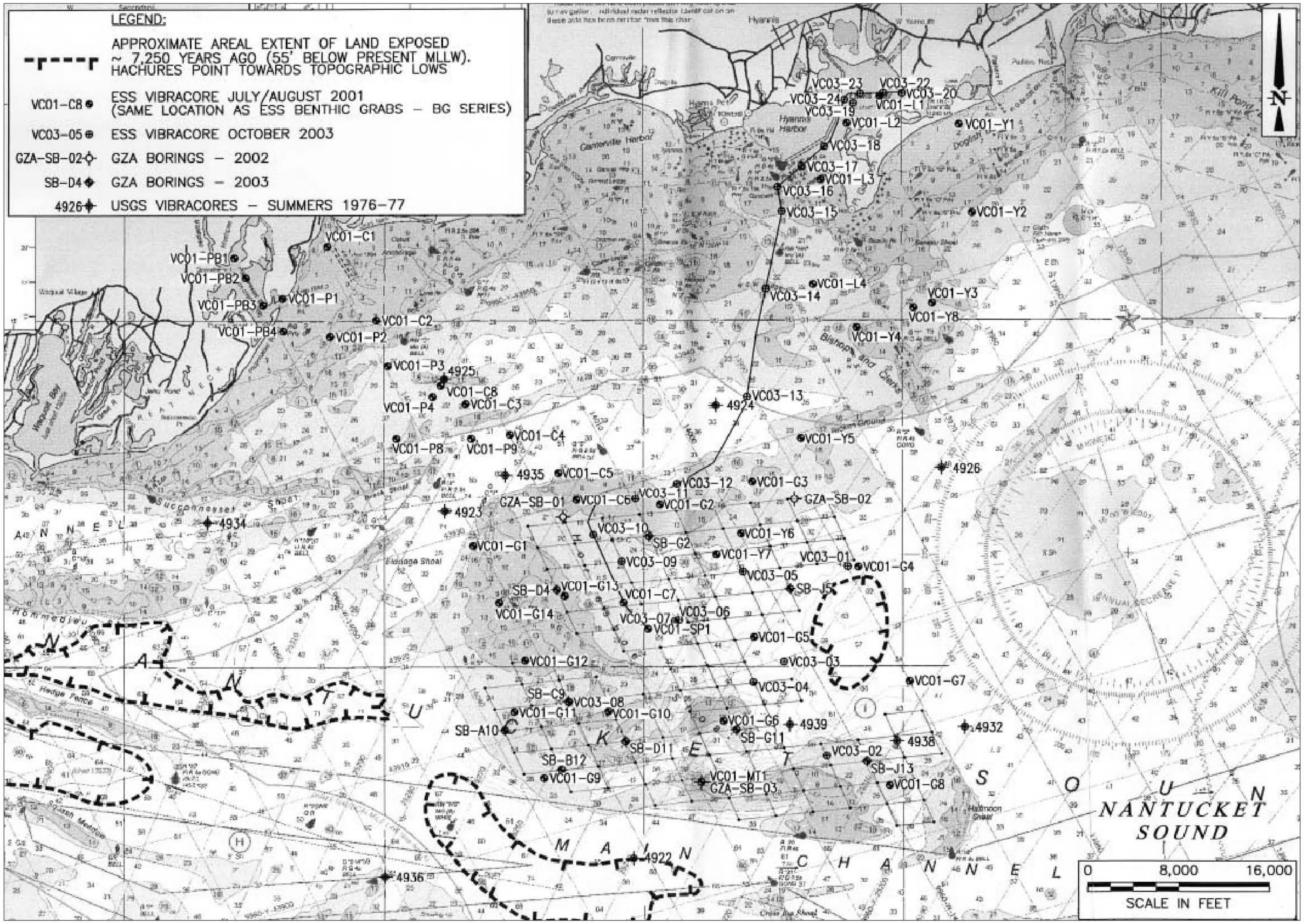

Figure 4-3. Projected subaerially exposed paleolandsurface circa 7250 B.P. (sea level 55 feet below present Mean Low Low Water [MLLW]) based on application of Uchupi et al. (1996) sea level rise model to charted bathymetry (image courtesy of ESS).

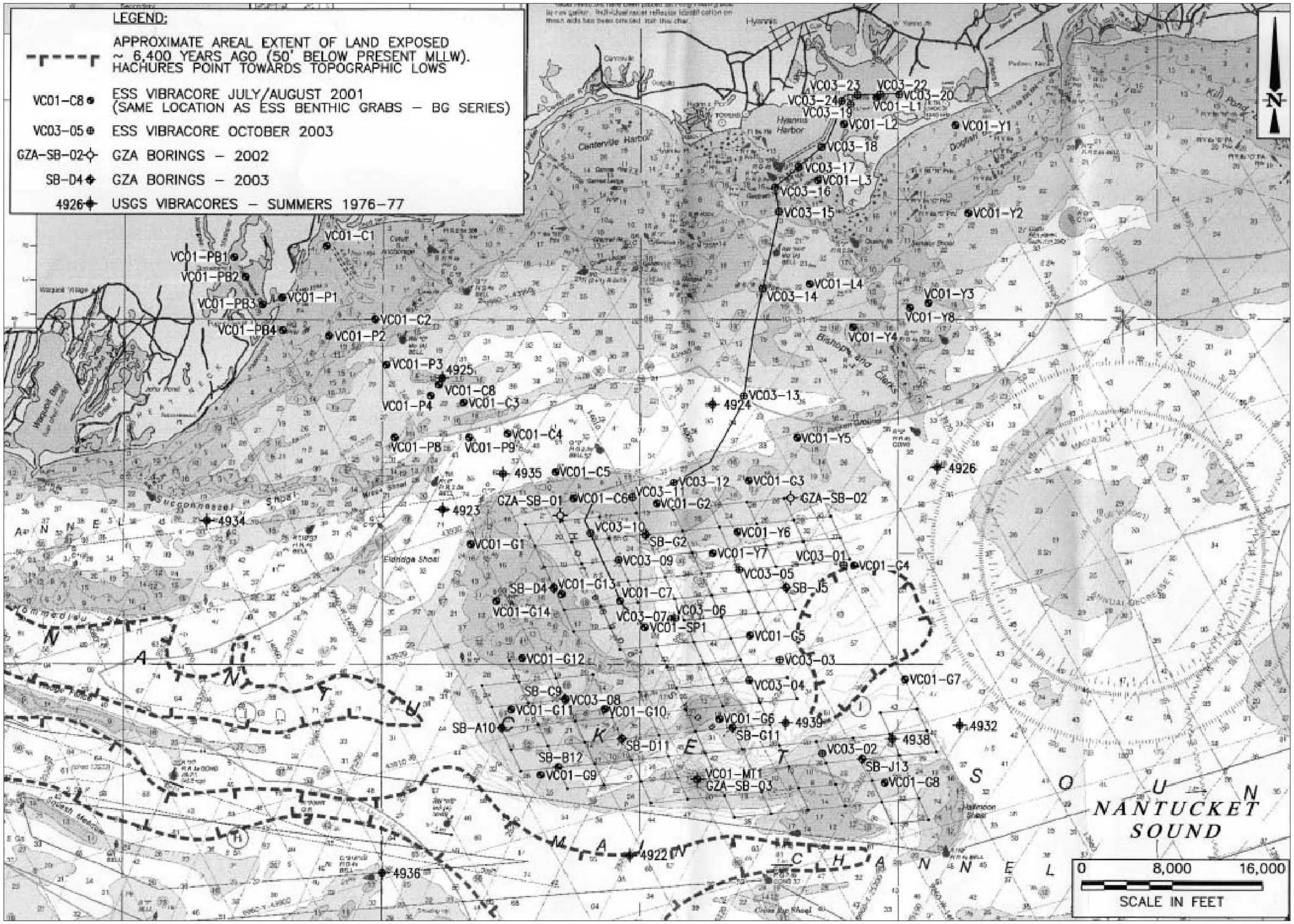

Figure 4-4. Projected subaerially exposed paleolandsurface circa 6400 B.P. (sea level 50 feet below present Mean Low Low Water [MLLW]) based on application of Uchupi et al. (1996) sea level rise model to charted bathymetry (image courtesy of ESS).

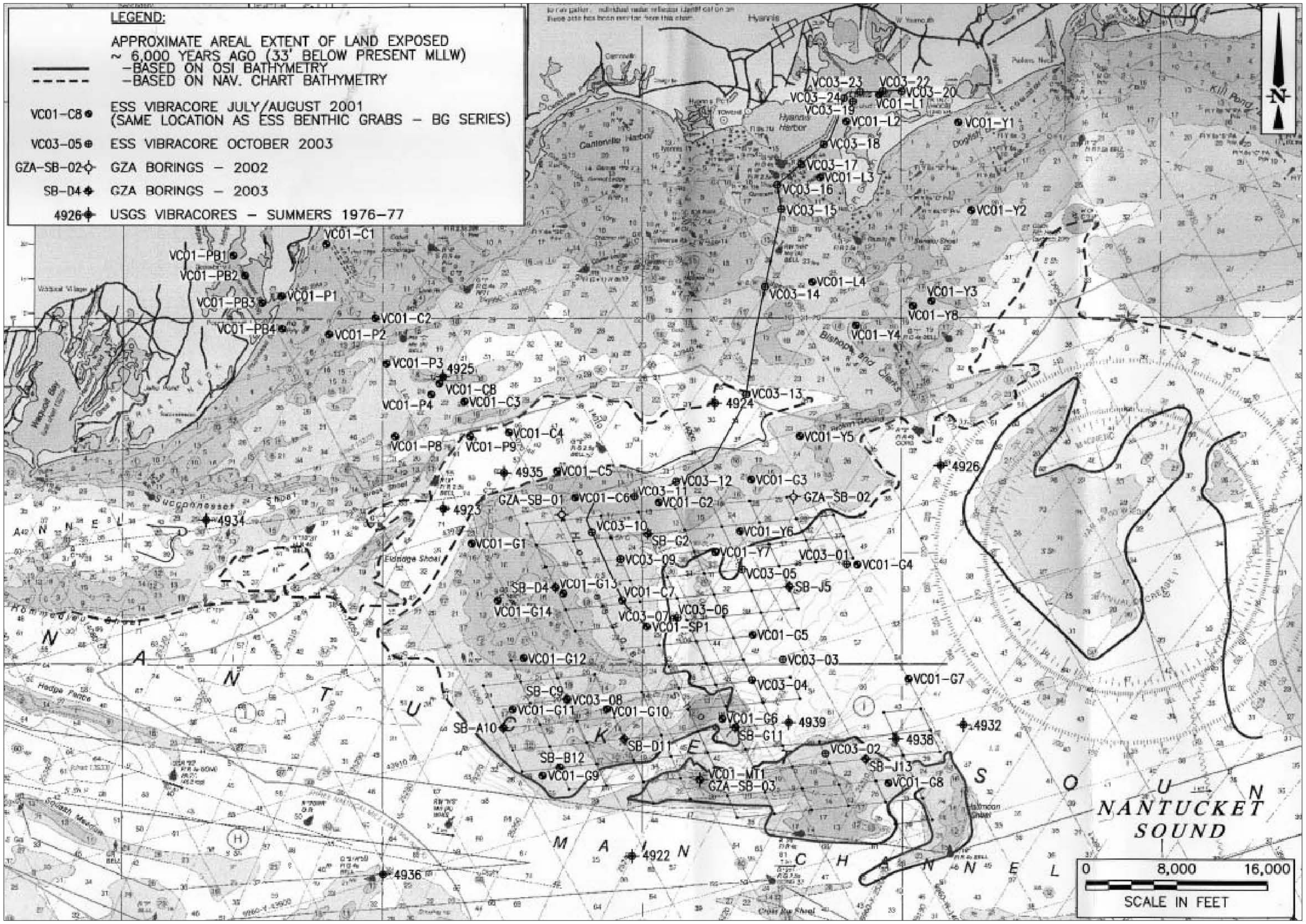

Figure 4-5. Projected subaerially exposed paleolandsurface circa 6000 B.P. (sea level 33 feet below present MLLW) based on application of Uchupi et al. (1996) sea level rise model to charted bathymetry (image courtesy of ESS).

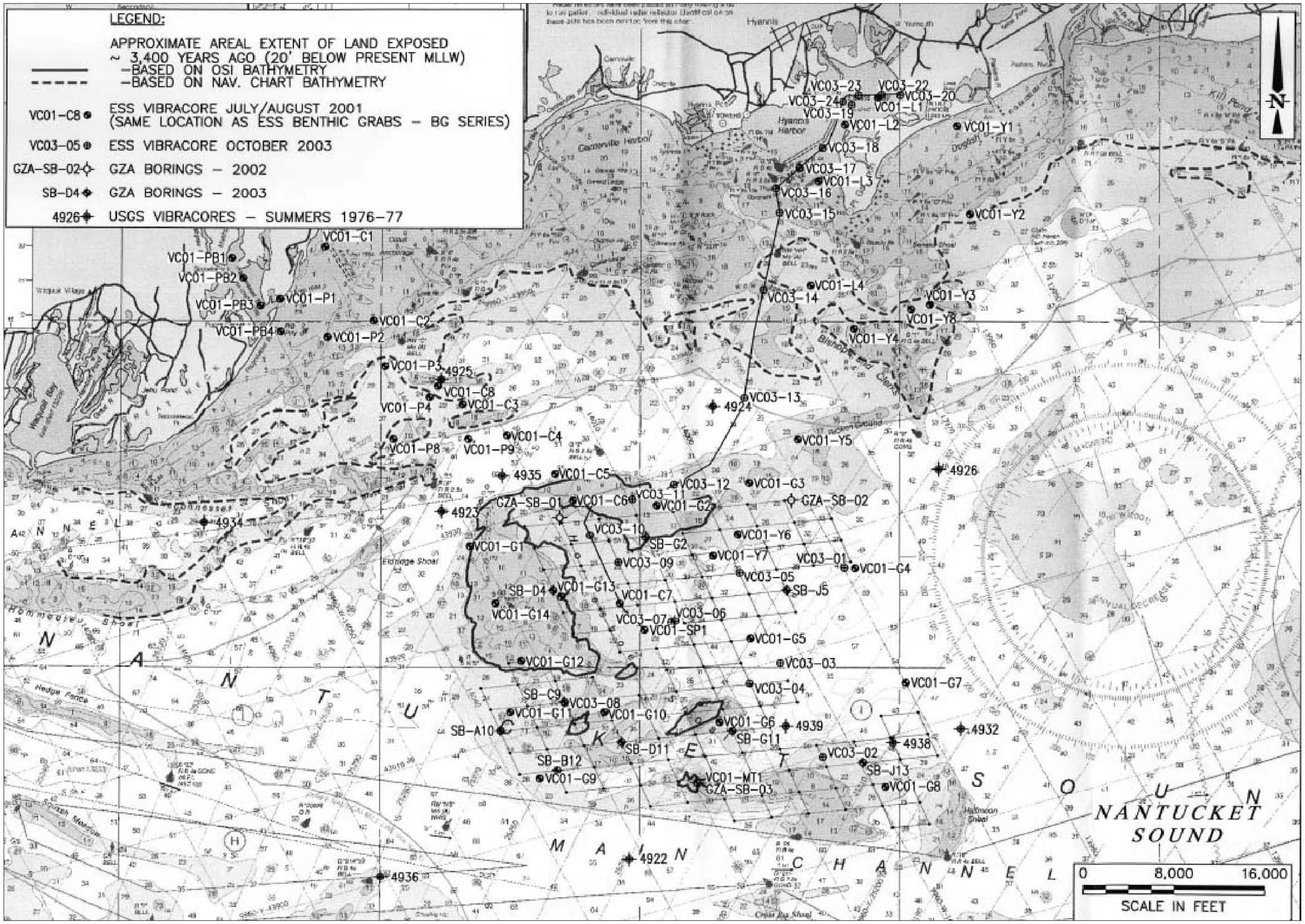

Figure 4-6. Projected subaerially exposed paleolandsurface circa 3400 B.P. (sea level 20 feet below present MLLW) based on application of Oldale (2001) and Redfield and Rubin (1962) sea level rise model to charted bathymetry (image courtesy of ESS).

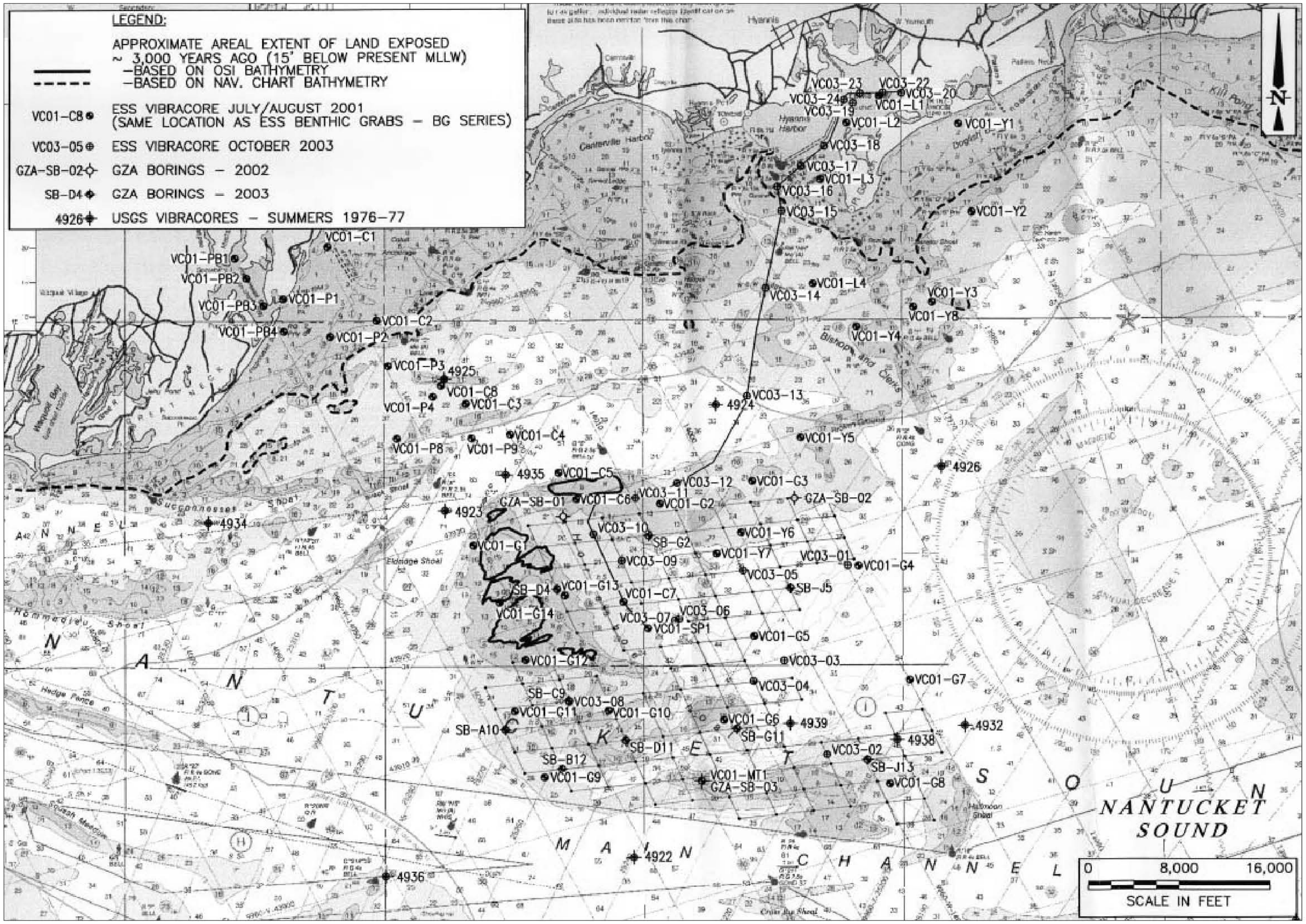

Figure 4-7. Projected subaerially exposed paleolandsurface circa 3000 B.P. (sea level 15 feet below present MLLW) based on application of Oldale (2001) and Redfield and Rubin (1962) sea level rise model to charted bathymetry (image courtesy of ESS).

CHAPTER FIVE

EURO-AMERICAN CULTURAL CONTEXT

Contact and Plantation Period (1500–1675)

The initial incursion of Europeans into eastern Massachusetts prior to 1620 was followed by the expansion of fishing, exploration, and limited trade in the region. The first Europeans to arrive in the area found Native American villages established along major river drainages that were interconnected via land by extensive trail systems (Figure 5-1). Some of the earliest contact between aboriginal peoples and Europeans took place in the name of exploration (Calloway 1991). For example, Bartholomew Gosnold landed off of Cape Ann in 1602, Samuel de Champlain explored the coast in 1604, and Henry Hudson touched at Cape Cod in 1609 (Weeden 1890:8). Before these formal expeditions, fishermen and trappers had frequented the area in search of fish and animal pelts for markets in Europe. France, Spain, and Portugal were the nations with major fishing fleets in the northwest Atlantic, including Nantucket Sound, during the early sixteenth century (Holmes et al. 1998). In 1618, eight vessels departed London and Plymouth to fish the Massachusetts coast, eventually carrying large quantities of fish and oil to Portugal and Spain (Weeden 1890:10). By the late sixteenth century, trade in fur between fishermen and Native Americans was common (Muir 2000:25).

Following initial local success in fishing and trapping, permanent European settlements were established in the region. The majority of settlement north of Nantucket Sound was clustered near Barnstable, which was settled in 1637. Edgartown was settled in 1641. Nantucket was purchased by a partnership of ten investors in 1659, and officially became part of Massachusetts in 1692 (MHC 1987:77). On Nantucket there were approximately two to three thousand native residents at the time of European contact, many of whom were engaged in fishing and collecting shellfish. The immigration of Europeans and their endemic diseases to North America caused a precipitous and disastrous decline in the Native American population. Regional estimates indicate that between 80 and 90 percent of the native population was killed off through disease, with some individual Native American groups suffering even higher mortality rates. Prior to European contact, an estimated 120,000 Native Americans inhabited the region. A century later, that number had plummeted to just 16,000 (Muir 2000). At contact with Europeans the native population of Martha's Vineyard was between 1,500 and 3,000, and the native population of Nantucket was approximately 2,400 (MHC 1987:61). By 1640, approximately 35,000 Europeans were estimated to reside in Massachusetts.

The death of such a large portion of the native population left many prepared fields vacant, facilitating the development of European agriculture. During this period, agriculture was the primary economic base for the region. Corn, wheat, and livestock were raised on both sides of Nantucket Sound (MHC 1984a, 1984b). Industrialization during this period was limited to smithy and gristmill operations.

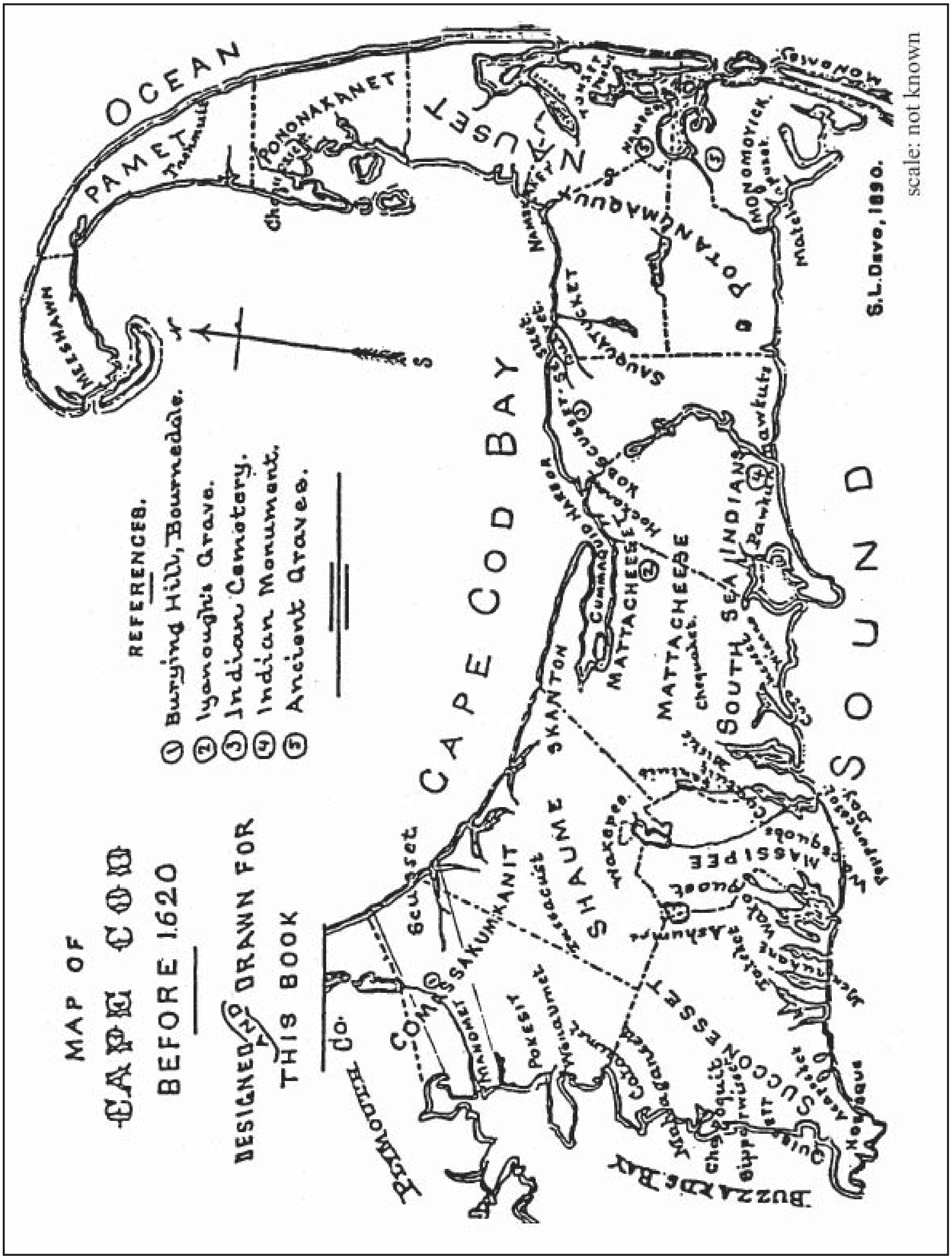

Figure 5-1. "Map of Cape Cod Before 1620" (Deyo 1890).

Nantucket Sound was not highly traveled by Europeans during much of this period. On the mainland, settlement tended to be on the north side of Cape Cod, which provided easier access to Boston across Cape Cod Bay. With the settlement of Nantucket there was an increase in the number of vessels in Nantucket Sound because the island's residents had to import the majority of their goods. During this period, the main port and center of settlement on Nantucket was Cappamet Harbor. While the major occupation of Nantucket's residents was agriculture, the islanders were also involved in whaling (as early as 1640) and cod fishing (as early as 1672) (Bauer 1988:230; MHC 1984b).

Although Nantucket Sound was not heavily traveled during this period, both oceangoing vessels and small fishing and coastal traders occupied its waters. The oceangoing vessels of this period consisted primarily of ships, barks, and pinks, while the most common coastal and riverine watercraft were pinnaces, shallops, ketches, and sloops (Lawson 1895:111–115). All of the coastal and oceanic vessels of the period were of wooden construction, fabricated from hand-cut planks and timbers, and iron-, copper alloy-, and treenail-fastened. Unfortunately, the copper alloy fasteners and treenails used throughout the historic period have few specifically datable attributes. Sheet lead and copper were also used in ship construction during this period for protective hull sheathing (Kemp 1976:205). Larger vessels of the period tended to be carvel-built, while the clinker or lapstrake construction technique was the more common planking scheme of the smaller, coastal craft. Ballast carried on-board ships of the period was generally of stone, although vessels inbound from Europe were occasionally ballasted in brick for resale in the colonies. Because of the threat of piracy, transoceanic vessels were typically armed, though usually only lightly, with a few guns that fired shot of four to six pounds. By today's standards, the oceanic vessels of the period were small; a 300-ton vessel was considered large and vessels of the period seldom exceeded 100 feet in length (Kemp 1976). Most oceanic vessels measured 60 feet or less. Because capacity rather than speed was of principal import to the merchants of the day, transoceanic ships of the period tended to be broad of beam, with a length-to-breadth ratio of around 3:1. Coastal vessels were generally smaller (in the 30- to 40-foot range) (Bauer 1988:31), and had only a quarterdeck if decked at all.

Common ceramics of the period, which are useful for dating wreck sites, included majolica, early tin-glaze earthenware, and Rhenish and Bellarmine stoneware. Kaolin clay smoking pipe stem bores tended to be widest (7/64 to 9/64 of an inch) during this period. Glass bottles of the period are "free-blown," and, therefore, lack pontil scars and mold marks. Cannon of this period are a mixture of cast copper alloy and banded wrought iron, with cast iron appearing toward the end of the period. Shot of the period was a mixture of varieties, including stone and cast iron. Cast iron became the predominant shot material by the 1540s.

Colonial Period (1675–1775)

During the Colonial Period, the Euro-American population of the region continued to expand through immigration and natural growth, which led to expanded settlement and the establishment of additional towns throughout the area. Hyannis was settled in ca. 1690, Centerville 1690, Hyannis Port 1696, and Osterville in the early 1700s (MHC 1984a, 1984b). The lands for these settlements were purchased from the Mattacheesett and South Sea Indian Tribes. Both tribes were subgroups of the Wampanoag Indian Tribe (Mair 2000).

The physical and material expression of this Euro-American expansion was apparent in the continuation of earlier social and economic patterns that originated from the previous period (MHC 1984a). For example, roads were expanded and improved (though many roads of the period remained nearly impassable after a heavy rain). The best roads were those in the more developed coastal areas, while roads leading to the west were not well maintained and tended to be more dangerous (Weeden 1890:408). By 1665, the Cape's County Road extended across the northern portion of Barnstable. On the islands, most transportation routes continued to be based on native paths, although the first Euro-American roads were built on Martha's Vineyard around 1642 (MHC 1987:67). Expansion of the area's road system led to an increasingly extensive network of inns that were developed during this period to service travelers. The first express rider service in the area began in 1721.

A dichotomy between rural and urban life emerged during this period as well. The interior hinterlands continued to support themselves through agricultural and raw material harvesting, while in the urban centers along the coast, especially in Boston, New England's largest city, industrial and commercial pursuits developed. Because of the dominance of Boston, the northern half of Barnstable continued to be the preeminent commercial and urban center nearest the project area. The southern half of the town remained sparsely populated and primarily agrarian. Nantucket followed a similar pattern, as the commerce of its inhabitants increasingly focused on sheep and livestock production and maritime pursuits. The economy of Martha's Vineyard, and Edgartown in particular, focused also on agriculture and maritime trade. Wind-powered gristmills were established on the island in 1750 (MHC 1984c).

Farms of the period tended to be primarily subsistence- and family-oriented operations, with most farms producing just enough to sustain their residents and provide a small market crop that could be used to procure other necessary goods and improvements for the homestead. The production and sale of small home industry products, such as wool and/or hides were common sources of income. The extractive industries of the region involved a number of resources, among the most notable of which were wood, stone, and iron. Much of the agricultural, extractive, craft, and industrial pursuits were driven by the labor of indentured servants and slaves. Use of slave labor initiated during the previous period expanded during colonial times. African and Native American slaves were forced to serve in most occupations, including that of a seaman (Bolster 1997). Commercial trade prospered during this period as well. After the Peace of Utrecht (1713) ended the War of Spanish Succession and gave England dominance, the seas became a relatively safe place for merchant vessels, and trade flourished (Weeden 1890:552). The primary trade network that engaged most Massachusetts merchants during the period was the infamous "Triangle Trade," in which sugar and molasses, rum, and slaves were transported between Africa, the Caribbean Islands, and the North American colonies. Export of natural resources, such as pelts and lumber remained major sources of wealth as well (MHC 1984b).

While Euro-American colonists worked to develop the infrastructure and network of an independent nation at this time, the continent remained colonial property divided among England, Spain, and France. Following the same rationale applied by modern core nations to those of the periphery, England viewed their colonies as a source of raw materials that could be processed in England and sold back to the colonies as a finished product for the profit of English merchants. In exchange, the colonies were provided with established trade networks, financial support, and military protection. With the removal of France to Canada at the end of the French and Indian War (1689–1763), the incentive of military protection was effectively removed from the Massachusetts region. Similarly, the establishment of a native-born merchant class reduced the need for England's assistance. However, in an attempt to maintain control over the financial fortunes of their colonies, the British passed a series of new laws that included the Townshend Act (1767) and the Stamp Act (1770), which were aimed at restricting the economic growth of the colonies. The Boston Massacre (1770), the burning of *Gaspee* (1772), and the Boston Tea Party (1773) were colonial revolts against the effects of these acts leading up to the April 19, 1775 running battle of Lexington and Concord and the beginning of the American Revolution.

Because of its sparse population and focus on agriculture, the mid-Cape's south shore adjacent to the project area was not heavily involved in maritime trades during this period. Nantucket, conversely, was beginning to develop fishing and commerce traditions. The region's cod fishing industry expanded, and Nantucket's whaling industry began during this period.

Prior to 1725, cod fishing crews were composed of primarily Native Americans. Native Americans remained heavily involved in both cod fishing and whaling throughout the period (Little 1992). Cod fishers lived in camps along the coast, some of which later became permanent towns (e.g., Siasconset). Whaling on Nantucket began with the taking of drift whales. The native inhabitants of Nantucket had been harvesting drift whales since before 1668, and as they sold off their lands they retained the rights to any drift whales that might wash up on their former property (Little and Andrews 1982). Europeans also engaged in drift whaling. Eventually whaling crews began to pursue whales at sea. Whaling crews sailed out of Smith Point, Hummock Pond, Weweder, and Siasconset. Throughout the period the whaling industry continued to expand, and by 1775 Nantucket had more whaling vessels than any other colonial whaling port. Commercial trade also expanded during this period. The increase in population and wealth that whaling brought gave rise to merchant and trade classes. In 1715, Nantucket had six deep-water vessels. By 1730, this number had risen to 25, and then to 150 in 1775.

Cape Cod, Nantucket, and Martha's Vineyard were connected to Plymouth, Salem, Boston, Providence, and New York by water transportation routes (MHC 1987:67). It was also during this period that the commercial and population center of the islands' shifted from Cappamet Harbor on Nantucket to Great Harbor on Martha's Vineyard after a 1722 storm closed the former. The requisite shift between harbors may have resulted in a change in trade routes to the mainland (MHC 1984b).

The major classes of maritime occupations in eastern Massachusetts during this period were commerce, fishing, whaling, the slave trade, and privateering/piracy. The increased differentiation of maritime trades led to a corresponding need for more specialized vessel types. The schooner appeared in Boston in 1716 (Bauer 1988:31). The sloop surpassed the pinnace, shallop, and ketch, and the brigantine replaced the bark (Goldenberg 1976:39). However, the general methods of ship construction remained largely the same. Hull timbers and planking were hand-cut or sawn, fasteners were fashioned from hand-wrought iron, copper alloy, or wood (treenails), and ballast generally consisted of stone. The practice of carrying brick in ballast from Europe for resale in the colonies reached its peak during this period. Similarly, English colliers were known to carry scrap iron as ballast (Robinson et al. 2001:130).

Besides the changes in rigging and mast placement that occurred during the transition to schooners and sloops, coastal and riverine vessels otherwise changed little during this period. They continued to be built 30 to 40 feet long and 10 to 15 feet wide, and were lightly, or heavily timbered depending on their intended purpose. Fishing and coastal boats were of this class, with displacements that ranged between

25 and 40 tons (Weeden 1890:372). While most vessels did not exceed 300 tons, increasingly larger vessels began to be produced as trade improved, such as the 400-ton *Sea Nymph* and 600-ton *Thomas and Elizabeth*, both of which were launched at Taunton in 1710 (Goldenberg 1976:38). However, there was not a drastic increase in the sizes of most vessels during this period. Larger vessels were proportionately more expensive to build, harder to fill to capacity with cargo, and represented a more significant risk for investors if the ship was lost. Consequently, the dimensions of most large vessels of this period were still generally no more than 120 feet long with a 40-foot beam.

This period saw the widespread expansion of the slave trade and was the golden age of pirates/privateers (Cordingly 1995:XVII). Both of these occupations required medium-sized, maneuverable, fast sailing vessels. Vessels used in these trades tended to be less than 100 feet in length, with slavers covering the upper portion of the range and privateers the middle portion. To improve performance and increase hull speed, these vessels tended to have increased length-to-breadth ratios, with vessel breadth usually restricted to less than one-third that of the hull's length. Pirate vessels were also sometimes surprisingly small, as short as 30 feet in length, but all tended to be heavily armed. Pirate vessels carried a substantial number of cannon, both of the cast iron and cast copper alloy type, and smaller rail-mounted guns. Many of these vessels were originally built as merchant vessels, and, in many cases, were structurally similar.

As whaling became more prevalent, ships were either built specifically for the industry, or were converted from medium-sized merchantmen. Vessels employed as whalers had to be large enough to sustain a sizable crew for a year at sea and capacious enough to contain the rendered whale products. Consequently, many of them tended to be 60 to 80 feet long. The most identifiable feature of a whaling ship built after circa 1720 was the substantial brick hearth located amidships for rendering the whale blubber. These onboard try-works permitted whalers to extend their cruising limits to the coast of Brazil and the Arctic Ocean (Morison 1979:20).

A number of artifacts are useful for dating vessels of this period. Ceramics of the era include imported tin-glaze earthenware, and white salt-glazed, English brown, Westerwald, and scratch-blue stoneware. The 4-6/64-inch mean pipe stem bore of the period is narrower than that of the previous period, and glass bottles include those that were free-blown and those that were molded. Cannon shot was almost entirely made from cast iron.

Federal Period (1775–1830)

The Federal Period in the region is characterized by economic growth and population expansion and the emergence of the Cape's south shore, particularly the Hyannis area, as a growing population and commercial center. The period began with the Revolutionary War, which effectively disrupted many of the region's traditional trades until well after the Treaty of Paris (1783) was signed and relative peace was restored. Maritime trades, such as commerce and whaling, were almost destroyed by British predation and raids. Agricultural pursuits saw some decline as men joined the Continental Army. However, others made substantial money by supplying the Colonial Army with goods and food (Weeden 1890:821). Some farmers stayed at the plow and supplied the troops and local economy. While there was substantial rebuilding after the war, the commercial diversity of Massachusetts allowed the region's economy to rebound quickly.

Immigrant laborers from Europe and freedmen found work in the region's growing industrial centers. In 1776, the populations of Barnstable, Edgartown, and Nantucket reached 2,300, 1,020, and 4,412, respectively (MHC 1987:84). Villages began to develop around rural mills and furnaces. It was during this period that the rural economy began to shift from agriculture to industry. As competition along the eastern seaboard became more pronounced and industry became more prevalent, many young men left the fields for the factories. One of the major causes for the proliferation of industrial facilities, especially mills, was the improvement of waterpower technology and the development of new mill privileges (Muir 2000). While Barnstable and Nantucket continued to focus much of their land on agriculture, there was an increase in the number of mills operating in the region during this period (MHC 1984a, 1984b).

Numerous important improvements to the fledgling nation's transportation infrastructure also came during this period. New roads were developed and increased effort was invested in their maintenance. Numerous canals were dug, including the Erie Canal (completed 1825), which linked the deep-water port of New York with the fertile lands and abundant resources of the Great Lakes, and steamships were introduced and began to see widespread use.

During the last decades of the eighteenth century, Yankee merchants opened trade with the Orient, a region that had always attracted Europeans for its wealth and exotic goods (Weeden 1890:820). In addition to China, Americans found a number of willing markets for their raw materials and finished goods after the war. However, the Embargo Act (1807), the War of 1812 (1812 to 1815), and the Great Panic of 1819 all caused depressions in the economy. These disruptions caused hardships in the short-term, but encouraged merchants to be more self-reliant and seek out alternative trade opportunities that eventually produced economic growth (Adams and Jenkins 1995).

Maritime commerce and shipbuilding in the region continued to expand during the Federal Period. Without the ships of English merchants to transport goods to market, American merchants were forced to hire or build their own fleets to carry their wares. Furthermore, ships were needed to protect the coast and America's maritime trade routes. The American Revolution greatly disrupted the maritime trades of the region. Towns like Gloucester, Beverly, New Bedford, and Nantucket had developed into major fishing and whaling ports prior to the war. With the inception of hostilities and the predation of British warships on American vessels, these ports suffered a major decline. Nearly every vessel in Nantucket's whaling and commercial fleet was destroyed during the war. Out of 200 vessels in Nantucket and Dartmouth, only four or five survived the war (Morison 1979:31).

In an effort to offset their losses, many of the fishermen and merchants of the region re-rigged and armed their sailing vessels and turned to privateering. The effectiveness of these vessels as privateers is questionable, because most fishing vessels of the time were slow and unwieldy (Morison 1979:31). Nantucket had a substantial Quaker population who opposed war on moral grounds, and had an even larger mercantile population that was hesitant to break off relations with England for financial reasons. The Nantucket merchants were continually caught between the requirements of the Congress and General Court and the danger of being caught by British ships while sailing under Colonial permits. Given these dangers, many Nantucket merchants attempted to import goods to the island at night using long, narrow, lightly built vessels. These vessels were built for speed, but under full sail they were often swamped drowning the entire crew (Starbuck 1924). It was during this period that the American seagoing navy was founded.

Commerce rebounded during the intervening years between the Revolutionary War and the War of 1812. Nantucket became the nation's most important whaling port by 1804. The War of 1812 led to another recession in whaling (Bauer 1988). Following the wars, commerce and fishing again flowered in the Cape and islands region. The region's commercial focus shifted from agriculture to maritime trades, particularly cod fishing, and the southern shore of Barnstable began to take precedent over the north. By 1830, Hyannis had developed into a major port and replaced Barnstable Village as the largest population center in the area.

The growth of Hyannis was accompanied by navigational improvements to its harbor. The Point Gammon Light was built in 1815, and the breakwater was built in 1826. The Hyannis breakwater is one of the oldest breakwaters in the nation. Boatyards, salt works, ship chandlers, and other maritime trades also developed in and around Hyannis during this period (MHC 1984a). Nantucket also saw an expansion of its whaling and maritime commerce trades during this period. By 1789 Nantucket had at least 36 vessels pursuing both right and sperm whales (Morison 1979). That same year saw the construction of the first lighthouse on the island. Prior to that time, the increased marine traffic around the island had led to a number of shipwrecks on unrecorded hazards (e.g., sand bars, rock outcrops) (Holmes et al. 1998). There were at least five wharves, in addition to warehouses, ship chandlers, whale oil processing plants, approximately 20 candle making factories, 10 ropewalks, and other whaling and trade related industries. By this time, much of the island had been denuded and a large portion of the population was involved in trades other than agriculture. The islanders consequently had to import much of their own supplies, which made maritime commerce a natural choice for a number of the inhabitants.

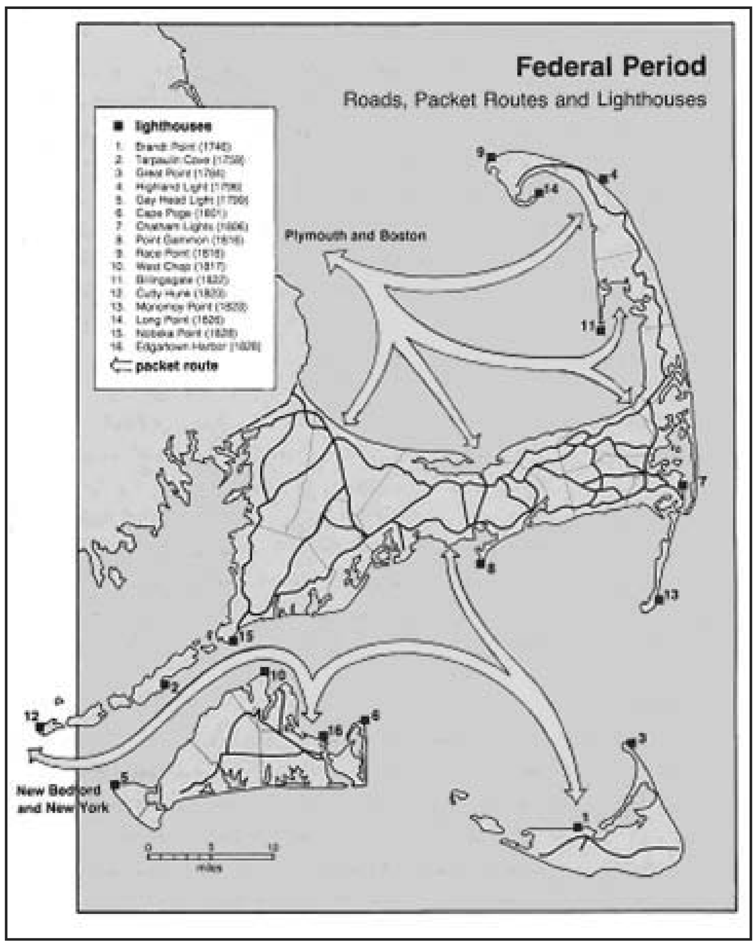

Figure 5-2. Federal Period roads, packet routes, and lighthouses (after MHC 1987).

During this period, Nantucket's shipping network stretched to North Carolina, and internationally to England and the Falkland Islands (Bauer 1988:239). In 1828, the first steamer ran between Nantucket and New Bedford, and packet ships shuttled between most of the coastal towns (Adams and Jenkins 1995; MHC 1984b; Morison 1979). Coastal packet vessels traveled throughout the Nantucket Sound, taking goods between Nantucket, Barnstable, Edgartown, New Bedford, and New York (MHC 1987) (Figure 5-2). Trans-Atlantic packets also began traveling regularly to and from Europe, and the Sound was part of the primary shipping corridor through the area.

Edgartown became a port of entry in 1789 and served as the county seat for Martha's Vineyard making it an important commercial center. Whaling and fishing were the major sources of local revenue during this period (MHC 1984c).

Besides giving rise to the American Navy, the wars of this period produced significant changes in ship design. The danger of being seized during wartime caused ship owners to place a higher premium on speed over cargo capacity, although this requirement was slightly relaxed after the War of 1812. This was also a time of experimentation with steam engines. John Fitch introduced commercial steam navigation on the Delaware River in 1790 (Gould 2000). In 1825, the first iron-hulled, steam-powered vessel, *Cordus*, was launched. However, neither of these innovations saw widespread use in the Massachusetts area until well into the next period.

While America's largest ships were being built in New York and Philadelphia, and the Chesapeake's builders were becoming known for their fast designs, vessels constructed in Massachusetts' shipyards retained the more traditional designs, characterized by their broad beams, usually not less than a quarter of the vessel's length, and "bluff," full bows of the "cod's head" variety (Morison 1979). Prior to 1830, it was still uncommon to see large vessels under construction in the Boston yards. This absence of larger vessels may have been a result of a commonly held notion at that time that 500 tons was the upper limit of safe ship size, and that any larger vessel would split in a heavy sea (Morison 1979:97). Consequently, most ships of the period were under 300 tons, with lengths that ranged from approximately 90 to 125 feet. The whaling vessels of this period were constructed with full bows and square sterns, with displacements that ranged from 200 to 300 tons (Morison 1979). Large vessels built in other regions, such as the Baltimore Clipper, a vessel type whose origin dates to the American Revolution, were relatively narrow as compared to the Massachusetts-built vessels of the period. Smaller, coastal vessels were not significantly changed during this period. Whaling continued to expand and coastal trade continued to employ a large number of sloops and schooners.

Both small and large vessels of this period were built almost exclusively of wood, with the remainder being of iron. Timbers and planks used in ship construction were both pit-sawn and hand-hewn, though toward the end of the period, the water-powered sash-saw came into use. Sash-saws leave a ragged saw mark along the cut face of the timber every one-half to 1-inch (Visser 1997:26). Fasteners used during this period continued to include those manufactured from copper alloy, iron, and wood, with copper used for many of the larger, harder to replace fasteners (e.g., keel fasteners). Hand-wrought nails were replaced by cut nails by around 1790 in terrestrial contexts. However, given the larger sizes and special shapes needed for many of the timbers used in ship construction, hand-wrought spikes may have survived slightly longer in maritime uses. Copper sheathing began to see widespread use during this period. The idea of sheathing the hull of a vessel below the waterline dates from at least 2000 B.P., and was used in the British Navy as early as 1761. Universal application of hull sheathing dates from about 1780. The 1783 replacement of iron with copper-alloy fasteners in British naval ship construction lead to the general use of copper sheathing, especially for vessels bound for warmer southern waters (Kemp 1976; Throckmorton 1969). It is likely that commercial vessels adopted copper sheathing earlier than naval vessels.

Items found on the wreck site of a vessel dating from this period might include wrought iron, forge-welded anchors of the "Old Admiralty" design (Robinson et al. 2001). Cannon and shot would have been made from cast iron. Creamware and pearlware, most with hand-painted or transfer printed decorations, predominate the ceramic assemblages of this period. Generally datable pipe-stem bores reach their smallest size (4/64 of an inch), and the first tin cans (post-1819) appear during this time. After 1810, three-piece mold glass bottles begin to appear as well. Ballast during this period continues to be predominantly stone, although "pigs" of iron were also used to a lesser extent.

Early Industrial Period (1830–1870)

Many of the trends begun in the previous era continued to accelerate during the Early Industrial Period, as the continued maritime prosperity of the previous decades led to significant growth and expansion of towns along the Cape's southern shore adjacent to the Cape Wind Energy Project study area. A southward shift in the economic focus of the mid-Cape area to Nantucket Sound after 1850 resulted in the area's south shore becoming the dominant focus in the region.

The development of the region's transportation infrastructure (roads, canals, railroads, steamships) continued to expand, primarily in the form of railroads, which proliferated after circa 1835 (MHC 1981; Tindall 1984). The Cape Cod Railroad, which began construction in 1848 and reached Hyannis in 1854, solidified the port's position as the region's most populous center (MHC 1984a). The expanded network of roads and railroads effectively opened up the interior of the country to mass settlement. Coastal commerce and travel, however, continued to depend heavily on waterborne transportation.

Large-scale agriculture in New England began its final decline during this period. The removal of native populations from the Midwest in the 1830s, the success of the Erie Canal, and the expansion of the nation's railroads provided an opportunity for emigration from the overcrowded rural lands of the East by permitting settlement of the Old Northwest. Railroads also provided the most efficient means of transport for the produce of the large midwestern farms to the East Coast. Massachusetts' farmers found it hard to compete with the prices of the midwestern mass-produced crops. Consequently, much of the remaining rural population turned to mills and industrial centers for their livelihoods. Some farmers also began to engage in cranberry agriculture during this period.

The influx of European immigrants into the region, primarily Irish driven across the ocean by the potato famine (1845–1846), filled the labor needs of area mills and factories. Many of the region's Portuguese immigrants also became deeply involved in the local fishing industries. By 1870, the population of Barnstable had reached 4,793, and the Vineyard and Nantucket's populations had reached 1,516 and 4,123, respectively (MHC 1987).

Trade continued to be a source of income for the region, as was fishing, although commercial fishing, especially whaling, saw a decline during this period as production and use of petroleum began to surpass that of whale oil. Efforts to expand commerce with Europe and the Orient, as well as the allure of the west fueled by the "Gold Rush," provided ample opportunities for continued expansion of maritime trade.

While cod fishing continued to be a major industry during this period, especially out of the Cape Cod ports, whaling peaked in the 1840s and then collapsed during the 1850s. In 1835 a Nantucket whaler took the first right whale off the northwest coast of America, opening a new fishing ground for whalers and ushering in a brief period of prosperity. However, Nantucket was beginning to lose its dominance over the industry.

New Bedford first became a rival to Nantucket in the 1820s. By 1823, the New Bedford fleet outnumbered Nantucket's. The reason for this change in market dominance was primarily related to the size of the ports. As the whale population declined, vessels had to go farther from port to hunt. These longer cruises required larger vessels. Nantucket lacked the capital to dredge the bar that blocked its harbor so it was difficult for large ships to enter, causing them to take their catch elsewhere (Bauer 1988). Other causes for the decline of the Nantucket whaling fleet include the drop in the price of whale oil in 1842, the 1846 fire, and the 1849 Gold Rush. One quarter of Nantucket's voting population left the island over a nine-month period during 1849 (Morison 1979:333).

The decline of whaling in Nantucket was a harbinger for the entire industry, which was pushed nearly out of existence by the end of the period because of the introduction of petroleum oil. In 1839, Nantucket's whaling industry made it the third most important commercial center in Massachusetts. In 1855, Nantucket had 44 whaling ships, a substantial decrease from the more than 100 vessels involved in whaling a few decades earlier. By 1865 that number had fallen to seven. The last whaling ship out of Nantucket, *Oak*, cleared the port in 1869 (Newell 2001). Despite this decline, 69 percent of the region's population was engaged in navigation or maritime commerce in 1870 (MHC 1987). Large-scale shipbuilding was discontinued on the island after 1840, because of the prohibitively high costs associated with importing the necessary raw materials (MHC 1984b). While the role of whaling in the Nantucket maritime economy had diminished, the industry continued to be a major economic force in the economy of Edgartown, on Martha's Vineyard. For example, the Edgartown-based, Dr. Daniel Fisher's oil and candle works were claimed to be the largest in the world (MHC 1984c).

Changes in and expansion of the national economy and the rapid progression of new technological developments have led scholars to describe this period as the time that "the Industrial Revolution went to sea" (Gould 2000). While the tonnage of steam-driven vessels did not surpass that of sail-powered ships until the 1880s (Gould 2000), steel and steam began to assert their dominance and the "golden age" of the large wooden sailing vessel had arrived. In Massachusetts, steam navigation was almost non-existent in maritime commerce until after the Civil War (Morison 1979). Although ships driven by the wind cost less to build and operate, they could not maintain as regular a schedule as a vessel powered by steam.

With the proliferation of railroads, a modern concept of time developed during this period that made wind power an undesirable source of power for the transportation of cargo. Similarly, with long-range trade reaching the Orient, it became desirable to build ships that were both larger and faster. During the Early Industrial Period, from about 1846 to 1859, wooden "clipper" ships briefly filled this need. Representative of the vessel class was the clipper ship, *Flying Cloud*, which measured 229 feet on deck and had a breath of 41 feet. As the period progressed, iron-hulled vessels became increasingly common. Another product of the increased industrialization and technology of this period was more advanced underwater salvage techniques. During this period, marine salvage became increasingly common.

It was during this era that New York began to usurp Boston in its maritime commercial dominance, which possibly caused a shift in shipping patterns throughout Nantucket Sound (MHC 1981). As the period progressed, more vessels from the north passed around Cape Cod (or later through the Cape Cod Canal), either went through Nantucket Sound or passed south of Nantucket on their way to New York City. Alternatively, ships coming from points south of New York City stopped there instead of traveling further north through the Sound to Boston.

Sailing ships of this period, both those of wood and iron, tended to be longer and narrower, and were faster sailors than any of the wind-powered ships of earlier generations. Wooden cargo vessels of the first portion of the period were generally less than 150 feet long, with a beam that was less than one-quarter of their length (Morison 1979). As with their predecessors, most of these vessels were carvel planked with stone or, in some cases, iron ballast and copper sheathing. Because the whaling industry went into decline prior to the wholesale introduction of steel hulls, the vast majority of whaling vessels were of wooden construction. The last surviving example of a New England whaler, *Charles W. Morgan*, was built in New Bedford in 1841. The whaler is representative of other whaling vessels of the period and measures 113 feet overall with a beam of 26 feet. Most whaling vessels strongly resembled the merchant ships of the age, although they were fitted with a large rendering hearth in the center of the main deck.

Steam engines were found on both wooden and iron vessels from this period. Early wooden steamships had hull designs very similar to those of sailing ships, but had wider decks amidships to accommodate the paddlewheels extending from both sides of the vessel. Side-paddlewheel steamers were the predominant steamship type in the area's coastal waters throughout the period, although screw-propelled vessels became increasingly common elsewhere after their introduction in the United States during the early 1840s (Bauer 1988:100; Robinson 1999).

Small-scale coastal trade continued to be economically important in the area during this period, and sloops and schooners saw use as both coastal traders and fishing vessels. Coastal commerce was also shared with the area's railroads and larger, steam-driven vessels. Coastal fishing vessels of the era, like those of most of the preceding and subsequent periods, continued to be built with comparatively low freeboard, which permitted the haul to be brought onboard more easily.

In terms of identifiable shipbuilding technologies of the period, most vessels still carried stone and iron ballast (Kemp 1976). Copper spikes continued to be used for attaching sheathing, copper bolts were commonly used to attach some types of timbers, and hand-wrought spikes were used for special purposes, although the primary, lighter fasteners were cut nails (Visser 1997). The circular saw replaced the sash saw in most mills between 1850 and 1870. Circular saw cuts are identifiable by the familiar arc-shaped scars they leave in cut wooden surfaces (Visser 1997). During the transition from wood- to iron-built vessels in the middle nineteenth century, a large number of composite-construction ships were built. These vessels were fabricated from iron frames sheathed in wooden planking (Kemp 1976:191). The steel- and iron-hulled vessels of this period were constructed of plates that were bolted or riveted in place and did not greatly exceed the dimensions of the clipper ships. Wooden ships, however, continued to far outnumber iron vessels during this period, which did not become prevalent until the subsequent period.

In terms of datable artifacts associated with the wrecks of this period, the most common forms of ceramic wares used at the time included pearlware (especially early in the period), white earthenware, yellow ware, and domestic stoneware. Decoration on ceramic wares was dominated by those applied through the transfer printing process. Rubber products began to be used widely after about 1839. Glass bottle manufacture underwent a number of changes during this period. By 1840, two-piece bottle molds began replacing the three-piece variety, and "snap-case" bottle manufacture, which leaves no pontil scar, became prevalent after 1857. Lettered panel bottles began being produced in 1867.

Late Industrial Period (1870–1915)

The Late Industrial Period on the Cape and islands is one of adjustment on regional and local scales with the decline of the maritime economy and the general loss of population in the region. Fishing and shipping activities became more centralized, rail connections were extended, and the area started to develop as a resort destination. The mid-Cape's South Shore remained the primary commercial focus in the region.

The years prior to World War I bore witness to a number of major technological developments, including the widespread use of steam, electrification, and gas lighting. These advances resulted not only in more comforts at home, but also in improved industrial production. While some industry was present along the margins of Nantucket Sound, the area largely reverted to agriculture during this period. This transition was caused by the collapse of the shipping and whaling industry and the resultant decrease in local populations (MHC 1984a, 1984b, 1984c).

Transportation routes in the region expanded during this period. By 1890 every town on Cape Cod, except Mashpee, had local train connections. Rail service was also introduced on Martha's Vineyard and Nantucket during this period. The Cape Cod Canal opened in 1914. In 1915, the population of Barnstable numbered 4,995, the population of Nantucket was 3,166, and the population of Edgartown was 1,276 (MHC 1987:129–134).

Coastal Massachusetts began to see the development of vacation and resort industries aimed at individuals wealthy enough to vacation. This transformation was aided by the Cape Cod Railroad, and later, the automobile. In 1872, steamboat ferry service began between Nantucket and Woods Hole, effectively opening the island as a vacation destination. At approximately the same time, Hyannis, Hyannis Port, Edgartown, and surrounding towns experienced increased development related to the tourist trade. Despite the shift in the economy, commercial fishing and maritime trades remained a major source of employment in the area. Cod fishing continued off of Cape Cod, and in 1881, commercial scalloping commenced in the waters around Nantucket (MHC 1984a, 1984b, 1984c).

Following the Civil War, most large-scale shipbuilding in the country had shifted to iron and steel construction. The success of the "ironclads" during the Civil War, and the increasing absence of suitable lumber were among the principal causes for the transition to metal shipbuilding. At the beginning of World War I, there were only 14 major metal hull shipbuilding yards in the United States; a result of the huge amount of capital needed to build iron- and steel-hulled vessels. Consequently, their construction was limited to major firms. Wooden shipbuilding also persisted during this period, primarily in medium and small vessels (Bauer 1988). Iron- and steel-hulled vessels did not push wooden ships out of the market until World War II. Metal-hulled ships of this period tended to be 260 feet or less in length with beams of 40 feet or less (Bass 1988; Gould 2000). Hulls were constructed of riveted metal plates secured over metal frames. Trim-control was provided by ballast tanks, which took on and expelled water as needed, bilge keels, or through stone, iron, or concrete ballast stowed in the hold. Sail continued to be used into the twentieth century (Bass 1988), but an increasing number of vessels were powered by steam-driven propellers. Most of the vessels of this period, both sail- and steam-powered, were constructed differently as the period progressed because of the development of naval architecture as a science.

Besides oceangoing vessels, a number of smaller commercial vessels traveled up and down the East Coast and through the Nantucket Sound. Large three- to seven-masted schooners, with displacements ranging from 500 to 900 tons, were used to transport inexpensive bulk cargoes of coal and ice to Boston, New York, and other ports. Some of these vessels passed through the sound. Additionally, lime mined from Penobscot Bay, near the towns of Thomaston and Rockland, was transported to Boston, New York and Europe in schooners of various sizes. Most of these working schooners did not see the end of the period, especially the colliers, as they were eventually replaced by iron-hulled, steam-powered, bulk carriers.

Many of the small vessels of this period were workboats, such as catboats, which were used by small-scale commercial fishing operations. Other workboats used in the area were the pound-net scow, beach skiff, and V-bottomed garvey (Chapelle 1951). As time progressed and the tourist industry flourished, the hull forms of many of these small workboats were adapted for use as recreational vessels. Most of these vessels were of wooden construction with copper alloy or iron fasteners (wire nails were common after 1900), and did not exceed 30 or 40 feet in length. Many were also open hulled, while others were decked with a bow cabin. Ballast for many of these vessels, especially the pleasure craft that seldom altered their load, was provided by iron or lead affixed to the keel (Kemp 1976:55). In addition to the increased production of small recreational craft, large steam-powered passenger liners began to see common use both in ocean and coastal service.

This era also witnessed the expanded use of barges. Like canal boats of previous periods, barges do not supply their own propulsion. While oxen could be used to tow a canal boat, widespread use of barges on the ocean along the coast was precluded until the adoption of steam power. Generally, barges are heavily timbered, or iron/steel-hulled rectangular-shaped craft, with square sides, blunt ends, and flat-bottoms that were used for hauling bulky, heavy loads. They can have either an open hull with decking only around the sides for carrying items such as trash or coal, or a full deck designed for carrying items such as building supplies. Barges can also be modified to carry construction equipment, such as a derrick (Basnight 1996:23; Kane 2001). The size and morphology of barges depends entirely on the tasks for which they were intended. Barges of the period were used on the ocean, but generally only along the coast or in protected harbor waters. Transits over the rougher seas of the open ocean usually fell to the schooners (Bauer 1988:270).

All of these vessel types were used in Nantucket Sound during this period. Steamships made runs to Nantucket, cod and scallop fishing boats worked the sound, and pleasure boats related to the tourist industry also sailed in the area. Cargo vessels transporting goods to New York, Boston, and other ports were also present in the sound, especially prior to 1914. After the Cape Cod Canal was opened on July

29, 1914, much of the commercial traffic bypassed the sound by traveling through the canal (Farson 1993). The Cape Cod Canal was built to shorten the water route between Boston and New York by 135 miles. The canal also made travel safer by eliminating the dangers of rounding the Cape. An average of two vessels per week were lost off Cape Cod prior to the construction of the canal.

A number of diagnostic artifacts are associated with vessels of this period. Modern, stockless anchors began to see use at this time. High-fired white earthenware, yellow ware, and domestic stoneware dominate the ceramic assemblages of the period. Developments in glass bottle manufacture accelerated during this period. The semi-automatic bottling machine became prevalent after 1881, only to be replaced by the fully automatic machine after 1903. The Hutchinson stopper was developed post-1872, the canning jar closure after 1875, and the crown bottle cap after 1892. The double seamed tin can is introduced in 1904.

Modern Period (1915–present)

During the Modern Period, the dominance of the mid-Cape locus of settlement and activity established during the early twentieth century continued, with increased residential development, resort growth, and automobile-oriented commercial expansion focused in the mid-Cape area. Proliferation of the automobile and major transportation thoroughfares during this period made it possible for companies to be situated away from the dense population centers. Many of the service and professional companies located themselves in proximity to major roads. The ease of automobile travel increased the desertion of the urban core for the suburbs, and led to a gradual decline of the urban core. Many of these people settled on traditionally agricultural lands of the Cape and islands (Adams and Jenkins 1995). This influx of people increased local populations. In 1940, Barnstable had 8,333 residents, while Nantucket and Edgartown had 3,401 and 1,370, respectively.

Improved transportation also aided agriculture. After the decline of previous periods, agriculture had stabilized at a reduced, but still important, level. The rural economy was bolstered by market gardens and truck farming, which shipped their produce to the suburban centers. Much of the region continued to rely on the recreation industry for its economic base. The Edgartown Yacht Club came to the harbor in 1927 and since 1950 resort development has played an important role in restructuring the town (MHC 1984c). Airports were built in Barnstable and on both Nantucket and Martha's Vineyard during this period (MHC 1987:148).

This period saw the near total disappearance of large sailing wooden vessels. The few that remain are generally training and museum ships. Instead, large vessels of this period were primarily those built of iron and steel, and were assembled initially with rivets, and later with arc-welded seams (Bauer 1988:295). Propulsion for these large vessels was initially in the form of reciprocating steam engines, but by World War II, diesel and steam turbines had nearly replaced the older style engines. During the middle part of the century, turbo-electric and diesel-electric engines were installed in large vessels with varying degrees of success (Bauer 1988:293). This period saw the proliferation of specific vessel shapes, sizes, and rigging to fit the intended use of the ship. Merchant vessels became very niche-oriented. Based on the silhouette of the hull, the position of the superstructure, and the type of cargo-handling equipment, the different types of large merchant vessels can be easily identified (Basnight 1996). Ballast for most of these vessels consisted of seawater flooded into ballast tanks.

Small vessels underwent a number of developments during this period. Steel hulls became prevalent in small commercial vessel construction during the second half of the twentieth century. Hulls fabricated from fiberglass became increasingly common during the past few decades. By the late twentieth century 90 percent of dinghies, yachts, and small craft up to 75 feet in length were made of fiberglass (Kemp 1976:300). In 1886, the first naphtha-powered motor-launches appeared along the East Coast. Shortly after the turn of the century, the naptha-burning launches were replaced by those powered by gasoline-combustion engines. Diesel engines became available on the civilian market during the 1920s, but their use did not become widespread until after World War II. Gasoline and diesel engines were used to power wooden, fiberglass, and steel commercial and recreational craft. Sail persisted in small recreational vessels, and is generally used in conjunction with a wood or fiberglass hull and sometimes supported by a gasoline engine. Until the 1920s, barges continued to be constructed of heavy timbers (Kane 2001). However, by the end of World War II, steel- hulled barges began to become more common. Other working boats of this period are distinctive as well. Many of the region's fishing boats are recognizable by their low freeboard and open transoms; however, finer distinctions can be made based on the shape of the hull and the type of superstructure (Basnight 1996). Ballast tanks or a ballast keel, depending on the use of the vessel, are employed on many smaller vessels to adjust the trim.

The twentieth century saw new safety regulations applied to the sea. Drastically improved navigational aides and the presence of radios combined with radio-dispatched tugs to call for help made it easier for mariners to stay out of or get out of harms way. With the addition of more reliable power sources to keep vessels off of rocks, the mortality rate at sea dropped significantly during this period.

A number of different artifacts are associated with this period. Modern stockless anchor predominate during this era. Similarly, hard white earthenware, stoneware, porcelains, and melamine (post World War II) dominate the ceramic assemblages. All bottles of this period are "full automatic," machine-made, and use of purple manganese glass predominated in the first portion of the era. The aluminum can was introduced in 1935 with the pull-tab opening in 1962. Plastic products were introduced to the mass market in circa 1900 and since then have become widespread.

Archaeological Sensitivity for Euro-American Submerged Cultural Resources

A list of shipwrecks obtained from MBUAR, the Northern Shipwreck Database, and AWOIS indicates that there are 45 vessels reported lost within and in proximity to study area (Appendix B). Dates for the reported wrecks included in these databases range from that of the sloop *Platina* lost off Half Moon Shoal in 1841 to the US Navy oil-screw *P. C. 1203* lost off of Horseshoe Shoal in 1963. The breakdown of reported vessel losses per century is as follows:

- 1600s: 0 vessels reported lost
- 1700s: 0 vessels reported lost
- 1800s: 19 vessels reported lost
- 1900s: 7 vessels reported lost
- No date: 19 vessels reported lost

The temporal distribution of reported shipwrecks exhibits a correlation with the post-1850 expansion of settlement and commercial activity on the mid-Cape's southern shore. Other vessel casualties from the earlier periods undoubtedly occurred in the area, but either went unreported, or have been referred to only obliquely, without any locational information, in the available literature. Detailed information regarding the size and construction of the majority of the vessels recorded lost in Nantucket Sound is poor. However, losses of both steel- and wooden-hulled vessels ranging in size from 78 tons (*Colleen*) to 1,962 tons (*Governor Powers*) are reported. Among the recorded types of vessels lost in Nantucket Sound (e.g., barges, motor boats, oil-screws, schooners, ships, and sloops), the formerly ubiquitous schooner is the most commonly reported vessel type.

Besides those vessel casualties that occurred while underway, others would have sunk at their moorings near shore, been intentionally scuttled, or were simply abandoned in shallow water. It is likely that some of the area's shipwrecks were salvaged after wrecking. Wrecks of this nature are more likely to be present in the shallower, near-shore portion of the study area.

Although useful for characterizing the geomorphology of the study area and assessing its potential for containing submerged *prehistoric* cultural resources, the results of the preliminary geophysical and geotechnical surveys conducted for the project in 2001 were less useful for identifying discrete targets that could be attributed to submerged historic cultural resources (e.g., shipwrecks). Such targets, especially those associated with the wrecks of older, wooden-hulled vessels, are typically represented by subtle acoustic anomalies and/or patterned distributions of complex magnetic anomalies that are distinguishable only in geophysical data collected at a relatively close (e.g., 50 feet) survey track line interval.

No evidence of a shipwreck was apparent in the preliminary 2001 geophysical or geotechnical data. However, given the extremely wide track line interval employed during the geophysical survey, the absence of evidence of shipwrecks in the study area is considered to be a function of the survey data's limitations for locating such wrecks, rather than an indicator of low archaeological sensitivity for submerged historic cultural resources.

The long history of extensive Euro-American maritime activity in the area, the treacherous nature of the waters in and around Horseshoe Shoal, and the number of reported wrecks within and in the vicinity of the study area leads PAL to conclude that the entire offshore study area has the potential to contain submerged historic cultural resources (e.g., shipwrecks).

CHAPTER SIX

RESULTS

The 2003 marine archaeological reconnaissance survey resulted in the collection of documentary and field data that were used to predict the locations and types of ancient Native American and Euro-American submerged cultural resources that could be expected within the offshore portion of the proposed Cape Wind Energy Project's area of potential project impacts. This chapter presents the results of this research and field survey tasks. Recommendations for the scope of additional archaeological investigations and the future treatment and management of archaeological sites and sensitive areas within the offshore portion of the proposed Cape Wind Energy Project impacts area are presented in the subsequent chapter.

Ancient Native American Submerged Cultural Resources

Any ancient Native American archaeological sites preserved within the eastern portion of the WTG array field identified as potentially sensitive would most likely be temporally affiliated with the PaleoIndian through Middle Archaic periods (12,500–5000 B.P.), based on current estimates about the rate of sea level rise and the inundation of Nantucket Sound (described in Chapter Two of this report). Examples of archaeological sites from these periods recorded in terrestrial contexts throughout southern New England and on the nearby Cape and islands indicate that the region was occupied during these early prehistoric periods; however, a review of the cultural resources inventory of the MHC and MBUAR revealed that there are no submerged ancient Native American sites from any period documented offshore within Nantucket Sound and the Cape Wind Energy Project's offshore study area. This absence of documented sites may be seen more as a function of the negligible amount of ancient Native American underwater archaeological research that has been conducted thus far in Nantucket Sound, rather than a conclusive indicator of the potential for such sites to exist.

Understanding pre- and post-inundation environmental conditions, particularly the effects of glaciation/deglaciation and sea level rise and the resources that would have been available for exploitation during this time is essential to predicting the ancient Native American archaeological sensitivity of the offshore study area. During the time of initial postglacial colonization and settlement in the Northeast, glacial lake basins were widely distributed across the recently deglaciated New England landscape. Recent palynological studies indicate that the spruce and jack pine-dominant tundra and boreal vegetation that prevailed in the offshore study area during the PaleoIndian Period (12,500–10,000 B.P.) was replaced as the postglacial climate became increasingly warmer and drier during the Early and Middle Archaic periods (10,000–5000 B.P.) by vegetation dominated by coastal heath lands of grasses and sedge, thickets of bayberry and related species, and forests of pitch pine, white pine, birch, and oak. A period of climatic cooling that began after about 5500 B.P., and the continuously rising sea level, probably stunted and salt-pruned vegetation. Salt-sensitive species most likely grew only in lower topographically protected areas and some species disappeared altogether (Dunwiddie 1989a, 1989b).

Documented PaleoIndian materials collected in southern New England suggest a focus on postglacial freshwater wetlands, glacial lakes, and riverine settings for PaleoIndian settlement and/or exploitation (Robinson and Waller 2002). Recent terrestrial archaeological investigations on the Cape (Dunford 1999), in eastern Massachusetts (Cross 1999; Doucette and Cross 1998), in Connecticut (Forrest 1999; Jones and Forrest 2000; Jones 1999), and elsewhere (Carr 1996; Gardner 1987) have provided evidence suggesting water and its associated food resources were a critical factor in site selection. Present hypotheses assert that large Early and Middle Archaic Period archaeological sites in proximity to large lakes, rivers, and extensive wetlands with inlets and outlets flushing the system may have been common in a Coastal Plain environment, such as that which was submerged by rising sea levels in Nantucket Sound (McWeeny and Kellogg 2001). Projectile points diagnostic of the PaleoIndian and Archaic periods have been found in riverine and kettle pond settings on the Cape (Davin 1989; Mahlstedt 1987), and, generally speaking, the known sites on the Cape confirm the hypothesis that fresh water locations were an important factor in the land use patterns of these periods. Given these current interpretations of prehistoric land use patterns, any contextually intact paleolandforms associated with wetlands, lakes, and riverine settings would be considered to have high archaeological sensitivity.

Geophysical and geotechnical field survey data collected in 2003 provided additional evidence of extensive disturbance of the sea floor's sediments that occurred during and after the postglacial marine transgression. These observations confirmed PAL's initial assessment that a majority of the offshore study area had low archaeological sensitivity for containing contextually intact prehistoric cultural deposits. However, the additional geotechnical survey recommended for the relatively small zone identified as potentially sensitive on the eastern side of the WTG array field area confirmed that the origin of the organic deposits observed in several previously recovered vibratory coring samples were terrestrial in nature and contextually intact. Furthermore, these paleosol deposits, described below, are interpreted as having derived from proximally related deciduous forest, freshwater wetlands, and lake settings with high archaeological sensitivity.

Analyses of a composited sample of the 2001 vibratory core specimen VC01-G4 (full core was not retained), and nine vibratory core specimens (VC03-01 to -09) recovered in 2003 from the eastern side of the WTG array field where acoustic reflectors within 12 feet of the sea floor's surface were visible in the sub-bottom profiler data (Figure 6-1, Back Pocket), provided evidence that enabled the identification of three areas where contextually intact buried paleosols are present, and one area corresponding with the edge of a bathymetric low with oxidized coarse sediments indicative of a freshwater "seep." (King 2003) (Appendices C and D). Based upon macro- and microscopic analyses of the plant materials they contained, the paleosols are interpreted to represent a deciduous forest floor, fresh water wetlands, and a shallow fresh water pond, all of which are located along the western margin of the basin-like bathymetric low on the east side of the WTG array field hypothesized to have been a large kettle pond at circa 7250 B.P. (see Figure 4-3).

VC01-G4 was recovered in approximately 47 feet of water in 2001 and described previously in PAL's archaeological sensitivity assessment report (Robinson et al. 2003). The composited sample taken from the core contained organic materials from the distinctive organic horizon 8 to 10 feet below the sea floor (visible in Figure 4-1) interpreted initially as paleosols (Robinson et al. 2003). Examination of a sub-sample of the composited specimen revealed that the organic horizon consisted of charcoal and carbonized plant fragments, very abundant plant debris (wood fragments, leaf fragments, and root fragments), plant seeds (*Potamogeton sp*. [Pondweed], *Typha sp*. [Cattail], *Carex sp*. [Sedge], and *Cyperus sp*. [Flatsedge]), one small fish scale, and one insect head tentatively identified as that of an ant (King 2003; John King, personal communication 2003). The presence of such materials and the core's stratigraphic profile are interpreted to indicate that the core was recovered from a wetland area (probably fresh water) on the northern margin of the large freshwater basin.

Vibratory core sample VC03-04, recovered in 2003 from approximately 52 feet of water, contained an organic-rich dark brown clay paleosol layer 10.25 to 10.4 feet below the sea floor with a strong sulfur odor, which is indicative of sulfate-reducing anaerobic conditions. The sample's organic-rich paleosol deposit had abundant plant debris, very abundant wood fragments, abundant sub-angular to rounded mineral grains (primarily quartz), some leaf and root fragments, some charcoal, and some seeds (i.e., *Potamogeton sp*. [Pondweed], *Najas sp.* [Naiad], and a *Betula* [Birch] cone scale) (King 2003). The observed assemblage of seeds indicates deposition in a quiet, shallow, freshwater pond (King 2003), or swamp on the southwestern margin of the large freshwater basin.

Vibratory core sample VC03-05, also collected in 2003, was recovered in approximately 33 feet of water and contained an organic-rich, dark brown, clay paleosol layer with a strong sulfur odor as well (Figure 6-2). This paleosol layer was buried less deeply under marine sediments than the organic paleosol layers in both VC01-G4 and VC03-04, and lies just 5 to 6.5 feet below the surface of the sea floor. Examination of VC03-05's paleosol horizon revealed that it was stratigraphically differentiated into three distinct intervals, the undisturbed lower two of which were sampled and examined for plant macrofossils.

The first paleosol sample analyzed from VC03-05 was taken from the interval at 5.45 feet below the sea floor, adjacent to a large piece of wood that was removed and frozen in preparation for subjecting a portion of it to accelerated mass spectrometric (AMS) radiocarbon dating. The preliminary results of this dating effort indicate a radiocardiocarbon date of 5490 B.P. for the wood. This sample was found to consist almost exclusively of wood debris, with some root material, mineral grains (primarily quartz), and charcoal observed as well. Some of the wood that was bisected in the process of splitting the cores, although soft and waterlogged, was extremely well preserved and appeared light and natural in its interior color. This preservation of an organic material, such as wood, is typical for depositional contexts that are aqueous and anaerobic in nature. The exterior of the wood fragments, and most of the other wood fragments present in the organic horizon, were relatively dark in color. Shortly after their exposure to atmospheric oxygen, the well-preserved wood oxidized and became very dark. No seeds were observed in this sampled portion of the organic layer.

The second sample examined from VC03-05 was obtained from the lowermost interval of the core's organic paleosol layer, 5.6 to 5.7 feet below the sea floor, and was significantly different from the sample taken at the 5.45-foot level. Wood fragments were still found to be abundant, but the fragments were weathered and darkly colored. Root fragments and fine pieces of charcoal were very abundant, and mineral grains (primarily quartz) were common. One carbonized seed from the shrub *Myrica sp*. (Bayberry) was observed in the sample.

Materials found in both samples taken from VC03-05's organic horizon are indicative of contextually intact forest soils. The analyzed sample from 5.45 feet below the sea floor is best interpreted as the

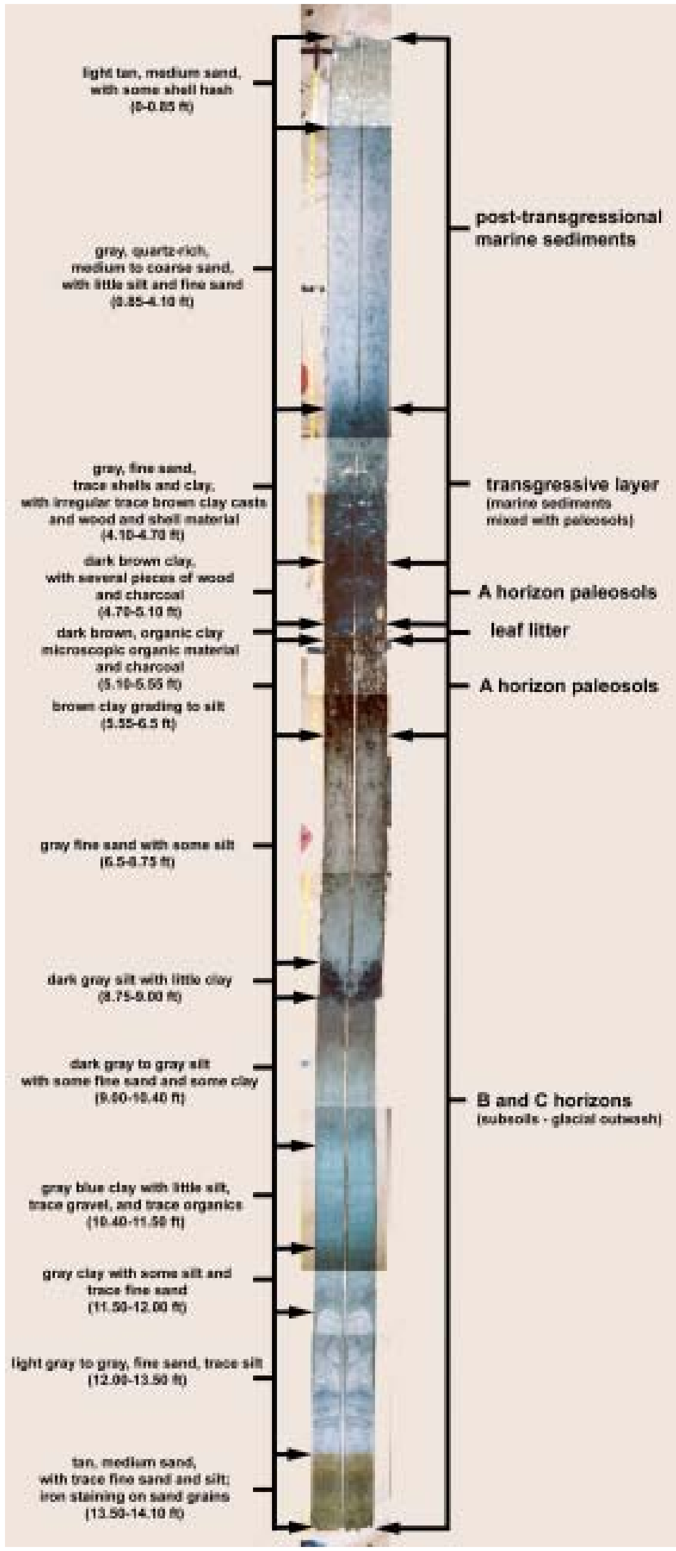

Figure 6-2. Photomosaic of 2003 project vibratory coring specimen VC03-05 containing organic layer interpreted to be a contextually intact, archaeologically sensitive, deciduous forest floor containing wood with a radiocarbon date of 5490 B.P.

litter layer or A° horizon, whereas the sample from 5.6 to 5.7 feet below the sea floor is best interpreted as the base of intact A horizon soil. The presence of charcoal is indicative of fire, but whether or not the fire was anthropogenic in origin is impossible to determine from the limited data available.

Preliminary results of the AMS dating effort indicate that the organic horizon has a radiocarbon date of 5490 B.P. (John King, personal communication 2004). This date corresponds closely with the projected location of the 6000 B.P. shoreline as it is depicted in Figures 4-5 and 6-1 of this report. The deposit's date also appears to support PAL's current interpretation that the intact paleosols in VC03-05 derive from a forested upland area that would have been inundated later than the lower, fresh water wetland and shallow pond deposits encountered in vibratory core specimens VC01-G4, VC03-04, and USGS 4939, all of which are located in significantly deeper water and buried beneath twice as much marine sediment.

Vibratory core VC03-03, recovered from approximately 51 feet of water within the southwest quadrant of the large basin consisted almost entirely of a deposit of homogenous, well-sorted, dark reddish brown, fine to medium, iron-stained sands that extended from 2 to 10.8 feet (the limit of the core) below the surface of the sea floor. The well-sorted, oxidized nature of the sands is indicative of the percolation of acidic groundwater via discharge or seepage (King 2003). The presence of this type of a deposit supports the current hypothesis that the basin was once a large fresh water body, possibly a kettle pond.

Euro-American Submerged Cultural Resources

Preliminary review of geophysical survey data as it was acquired in the field during the initial 2003 field study deployment in June and July recorded 430 different anomalies (103 side-scan sonar, 129 magnetic, and 198 CHIRP sub-bottom profiler anomalies). Review of geophysical data collected in September 2003 during the second field deployment, conducted to survey the near-shore portion of the transmission cable's route into Hyannis Harbor (completed without PAL staff on board), recorded an additional six side-scan sonar anomalies, 25 magnetic anomalies, and an unquantified number of CHIRP sub-bottom profiler reflectors. Together, the final number of anomalies recorded during the survey was 461 (109 side-scan sonar, 154 magnetic, and 198-plus CHIRP sub-bottom profiler anomalies).

Of the 430 anomalies inventoried during the June-July 2003 field deployment, all but 29 (6.7 percent) of them were determined to have a source that was non-cultural in nature or was interpreted as isolated debris, and, therefore, were eliminated from further consideration. Survey data was post-processed and additional analyses completed for the remaining 29 anomalies, as well as for the anomalies detected during the September 2003 survey work.

Post-Processed Geophysical Data Analyses Results

Analyses of the post-processed data associated both with the 29 anomalies of interest initially inventoried following the June-July 2003 survey and the data collected during the shallow water survey of September 2003 produced three targets with moderate probability of representing submerged Euro-American cultural resources. The locations of the 2003 surveyed track lines and the anomalies comprising the three targets (PAL Targets 03-01 to 03-03) are plotted in Figure 6-3 (Back Pocket), included as a fold-out

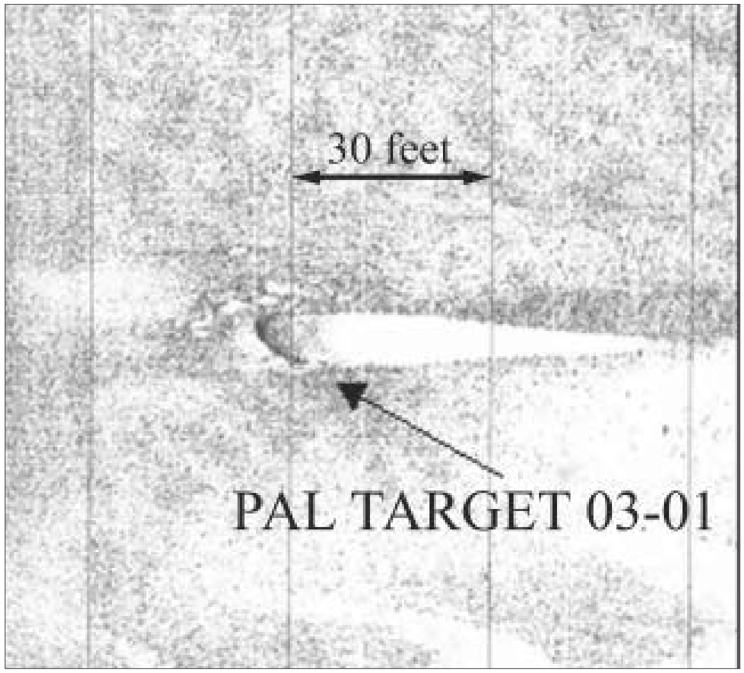

Figure 6-4. Side-scan sonar image of PAL Target 03-01 (image courtesy of OSI).

map at the back of the report. Descriptions of the three targets are presented below and in a tabular format in Appendix E, also at the end of the report.

PAL Target 03-01. PAL Target 03-01, located within the ESP portion of the project survey area, consists of a side-scan sonar anomaly designated by OSI as SS-36 (Figure 6-4) that was visible on four adjacent survey track lines as a large, crescent-shaped feature surrounded by unidentifiable debris or rocks (OSI 2003) and a cluster of five magnetic anomalies (PAL Anomalies 23, 24, 25, 26, and 27) distributed across five adjacent track lines (Figure 6-5). The largest of these associated magnetic anomalies (PAL

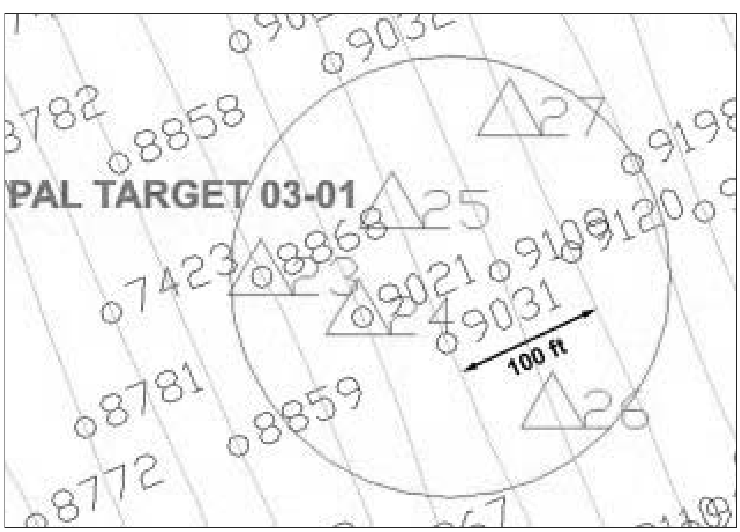

Figure 6-5. Distribution of magnetic anomalies associated with PAL Target 03-01.

Anomaly 26) has a dipolar signature measuring slightly greater than 100 gammas in intensity and a duration of approximately 200 feet.

PAL Target 03-02. PAL Target 03-02 is located near the planned position of WTG D5 and consists of three anomalies (PAL Anomalies 6, 10, and 11) that include magnetic, side-scan sonar, and CHIRP sub-bottom profiler anomalies. The anomalies are distributed across two adjacent survey track lines (Figure 6-6). The largest magnetic anomaly associated with the target has a negative monopolar signature with an intensity of 50 gammas and a duration of 30 feet. The acoustic anomalies associated with the target consist of three linear side-scan sonar anomalies approximately 10 feet in length and a 3-foot high anomalous positive elevation point in the sub-bottom data.

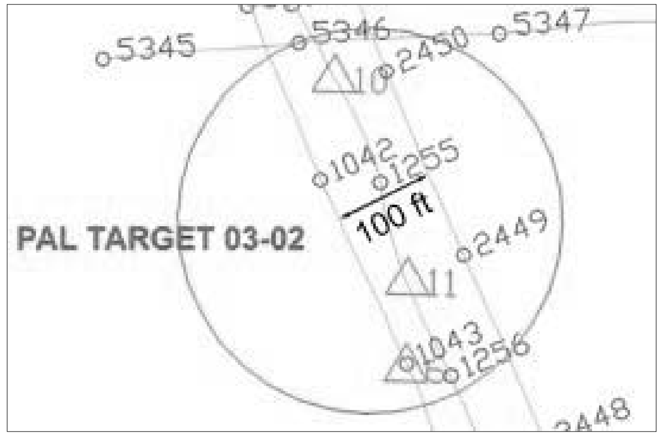

Figure 6-6. Distribution of magnetic anomalies associated with PAL Target 03-02.

PAL Target 03-03. PAL Target 03-03, located near the planned location of WTG D4, is composed of PAL Anomalies 5, 8, and 14, which include magnetic, side-scan sonar, and CHIRP sub-bottom profiler anomalies spread across three adjacent surveyed track lines (i.e., the centerline and both offsets) (Figure 6-7). The largest magnetic anomaly associated with the target has a 25-gamma positive monopolar signature of 80 feet in duration. The target's magnetic anomalies are associated with an approximately 5-foot high anomalous positive elevation point in the sub-bottom record and several 10- to 30-foot long linear side-scan sonar anomalies.

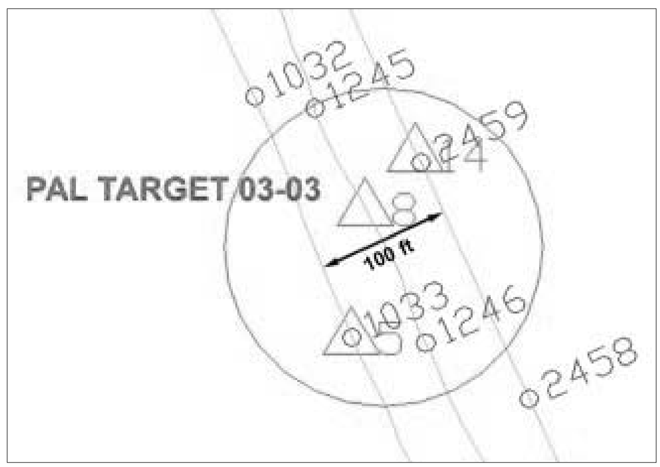

Figure 6-7. Distribution of magnetic anomalies associated with PAL Target 03-03.

CHAPTER SEVEN

SUMMARY AND RECOMMENDATIONS

Summary

Archival research, fieldwork, and predictive modeling completed as part of this marine archaeological reconnaissance survey indicate a variable potential for both submerged ancient Native American and Euro-American resources within the offshore Cape Wind Energy Project study area. Archival research collected additional documentation about the presence of Native American populations in the surrounding Cape and islands region over time spanning the prehistoric period through early historic periods. Archival research also documented regional Euro-American populations and maritime activities from the time of colonization to the present century. The proposed offshore project area contains no recorded prehistoric or historic period sites; however, previous efforts to date to locate ancient Native American sites in Nantucket Sound have been negligible and 45 vessel casualties in the general vicinity are reported.

Geophysical survey of the project study area conducted in 2003 recorded more than 450 anomalies from which three remote sensing targets with moderate potential to represent historic period submerged cultural resources were inventoried, described, and located (see Figures 6-3 to 6-7). In addition to these individual targets, geophysical and geotechnical surveys carried out in 2001 and 2003 resulted in the identification of areas of moderate and high archaeological sensitivity for containing prehistoric period archaeological deposits (see Figure 6-1). These areas correspond with the locations of heretofore undiscovered deposits of contextually intact paleosols 8 to 10 miles offshore representing wetland and upland terrestrial settings available for human occupation that were undisturbed by the destructive effects of the Holocene marine transgression. Currently available radiocarbon dates and estimates of local sea level rise indicate that submerged prehistoric archaeological deposits within these paleosols all would range in date from about 7500 to 5500 B.P. and derive from the Early or Middle Archaic ancient native cultures. Land use patterns during these periods observed in the terrestrial context of the Cape and islands reveal a strong correlation between high sensitivity and the margins of wetlands and other settings proximal to fresh and salt water resources. For this reason, ancient Native American submerged cultural resources could be present within these highly sensitive areas.

Recommendations

The marine archaeological reconnaissance survey provided an overview of the environmental and human history of the Cape Wind Energy Project offshore study area within the context of local and regional research themes, and identified remote sensing targets with moderate potential to be submerged Euro-American cultural resources. The marine archaeological reconnaissance survey also identified areas of high archaeological sensitivity where submerged ancient Native American cultural resources could be present below the surface of the sea floor. Based on the results of this reconnaissance investigation, the following is recommended:

Submerged Ancient Native American Cultural Resources

The proposed locations of six WTGs (G3, G4, H9, I4, I5, and L4) and seven portions of the WTG-interconnect cable grid (between WTGs F7-G7, F9-G9, G2-G3, G3-G4, G4-G5, G9-H9, and I4-I5) should be redesigned as necessary to avoid construction activities where sub-bottom profiler reflectors were identified within the current project APE, buried less than 12 feet below seafloor, in the vicinity of the identified paleosol deposits on the eastern edge of the offshore study area (see Figure 6-1). If avoidance of these archaeologically sensitive and potentially sensitive areas is not possible, then the following is recommended:

- conduct geotechnical survey (vibratory coring) of previously untested sub-bottom profiler reflectors within the area of high archaeological sensitivity, the project's area of potential impacts, and less than 12 feet below the sea floor's surface to determine the presence/absence of archaeologically sensitive paleosols;

- analyze paleosols in vibratory coring specimens (including those in VC03-04 and VC03-05) to determine the presence/absence of ancient Native American cultural materials; and

- conduct intensive marine archaeological survey, consisting of systematic subsurface testing using a methodology developed in consultation with the USACE and SHPO (i.e., MHC and MBUAR), of the archaeologically sensitive areas with paleosols to determine the presence/ absence of ancient Native American archaeological deposits.

Submerged Euro-American Cultural Resources

Proposed construction of WTGs and the WTG and WTG-ESP interconnect cables should be redesigned as necessary to avoid construction activities at the locations of PAL Targets 03-01, 03-02, and 03-03 maintaining a minimum buffer of 100 feet in all directions around the detectable limits of each target. If avoidance of the potentially archaeologically sensitive targets is not possible, then the following is recommended:

- conduct intensive marine archaeological survey, consisting of visual inspection and limited subsurface probing and testing by archaeological divers, of Targets 03-01, 03-02, and 03-03 to determine the source of each target and preliminarily evaluate its potential historic significance as necessary.

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Appendix A

PROJECT CORRESPONDENCE

ESS Group, Inc.

888 Worcester Street, Suite 240
Wellesley, Massachusetts 02482
p 781.431.0500
f 781.431.7434

MEMORANDUM

TO: Karen Kirk Adams, USACE

DATE: 5-28-03

FROM: Terry Orr, ESS Group, Inc.

SUBJECT: Cape Wind Project

Scope of Proposed Marine Archaeological Reconnaissance Survey

PROJECT NO.: E159-4.9

COPY TO: Craig Olmsted, CWA

David Robinson and Deborah Cox, PAL

A marine archaeologist at Public Archaeology Laboratory, Inc. (PAL) has completed review of the preliminary geophysical and geological (46 vibracores and 3 borings) information collected in 2001 within the proposed Wind Park site on Horseshoe Shoal and nearshore Project Areas, as part of a marine archaeological sensitivity assessment. PAL concluded that the majority of the offshore study area has a low probability for containing submerged prehistoric archaeological resources. No evidence of shipwrecks was apparent in the preliminary geophysical or geotechnical data recorded in 2001, although the track line interval employed was not sufficiently spaced to rule out all potential targets. Since 2001, the turbine array has been reduced from 170 proposed turbines to 130, and the layout has been revised. PAL has recommended the following geophysical and geological scope of work for a marine archaeological reconnaissance survey within the revised direct Area of Potential Effect (APE) of the Wind Park and the 115 kV transmission line into the Yarmouth landfall on Lewis Bay, to identify potentially significant submerged cultural resources. The survey was designed to encompass the expected APEs of both construction and operational activities. The duration of the geophysical survey is estimated for 3.5 weeks, and is planned to commence in June 2003. The geological program will be conducted following review of the geophysical data. Your timely review and comment on the following geophysical program scope is appreciated.

At the location of each Wind Turbine Generator (WTG), intersecting geophysical tracklines will be run using the Full Instrumentation Suite (FIS), on centerlines shown on the attached figure. The FIS will include high resolution side-scan sonar, marine magnetometer, single-beam digital depth sounder, Chirp type subbottom profiling for the shallow subsurface and Boomer type subbottom profiling equipment for the deep subsurface. Each North-South centerline will be offset 50 feet on either side with a trackline using the Reduced Instrumentation Suite (RIS), resulting in 3 North-South survey tracklines. The RIS will consist of the FIS instrumentation, minus the Boomer type subbottom profiler. Use of the Chirp only will assist in meeting the objective of identifying the presence or absence of any potentially significant submerged cultural resources, which are relatively shallow. The deep Boomer is needed over the WTG locations only for geotechnical purposes. Intersecting tracklines using the RIS suite are shown on the attached figure.

The ESP Survey Area, where a large number of inner array cables converge, will be surveyed using a gridded approach to achieve 100 per cent coverage at 50-foot trackline spacing. Most lines will be RIS; FIS will be used over the ESP structure itself. Inner array cable routes and the 115 kV interconnection cable route to Yarmouth will be investigated using RIS instrumentation in two survey lines, offset 25 feet and parallel to the route centerline. The 115 kV route has been re-routed slightly to the west of the previously proposed route, to avoid several reported shipwrecks on Bishops and Clerks Shoals.

The geophysical survey firm (Ocean Survey Inc.) and the marine archaeologist (PAL) will review the side-scan sonar and magnetometer anomalies to identify targets that may be potential cultural resources.

Also as recommended by PAL, additional vibratory coring will be conducted in a limited area to maximum depths of 15 feet below sea bottom. The purpose of the additional coring is to determine the origin (i.e. terrestrial or marine) and delimit the extent of an organic deposit identified in three previously-collected vibracores at depths between 8 to 10 feet below seabottom in the easternmost portion of the Wind Park Project Area. Up to 8 vibracores are planned, and will be inspected and logged to determine whether the organic zone could be a potential paleosol, or inundated former land surface, capable of supporting past human activities.

A marine reconnaissance survey report will be prepared by PAL, which will include background information, cultural contexts and findings of the geophysical and geological survey program. The report will be submitted to USACE, MHC and MBUAR for review.

Due to weather related restrictions, we would like to commence this field work as soon as possible, and we look forward to your comments.

The Commonwealth of Massachusetts
William Francis Galvin, Secretary of the Commonwealth
Massachusetts Historical Commission

June 10, 2003

Christine A. Godfrey
Chief, Regulatory Division
US Army Corps of Engineers
696 Virginia Road
Concord, MA 01742-2751

ATTN.: Karen Kirk Adams

RE: Cape Wind Energy Project, Yarmouth, MA. MHC #RC.29785. COE #199902477.

Dear Ms. Godfrey:

Staff of the Massachusetts Historical Commission have reviewed the memorandum prepared by ESS Group Inc., "Scope of Proposed Marine Archaeological Survey," dated May 28, 2003 and received by the MHC on June 4, 2003. The memorandum appears to be an abbreviated summary of a research design and methodology. It is not possible to review and comment on the proposed research design and methodology from this abbreviated memorandum.

Please submit to the MHC and to the Massachusetts Board of Underwater Archaeological Resources the archaeological research design and methodology prepared by the Principal Investigator at the PAL.

These comments are offered to assist in compliance with Section 106 of the National Historic Preservation Act of 1966 as amended (36 CFR 800) and the Secretary of Interior's Standards and Guidelines for Archeology and Historic Preservation (48 Fed. Reg. 190 (1983)). Please contact me if you have any questions.

Sincerely,

Edward L. Bell
Senior Archaeologist
Massachusetts Historical Commission

xc:
Kathleen Atwood, USACOE
Terry Orr, ESS Group Inc.
Victor Mastone, MBUAR
Deborah Cox, PAL

220 Morrissey Boulevard, Boston, Massachusetts 02125
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ESS Group, Inc.

Engineers
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June 19, 2003

Karen Kirk Adams
Regulatory Division
US Army Corps of Engineers
696 Virginia Road
Concord, Massachusetts 01742-2751

Re: Marine Archaeological Sensitivity Assessment Report
Cape Wind Energy Project
MHC #RC.29785; COE #199902477

Dear Ms. Adams:

Enclosed are two copies of the Marine Archaeological Sensitivity Assessment: Cape Wind Energy Project report prepared by Public Archaeology Laboratory, Inc. (PAL). The report is also provided to the distribution list below, in response to a request from Edward L. Bell at the Massachusetts Historical Commission for the proposed research and design methodology in support of the proposed scope for the marine archaeological reconnaissance survey. The scope was previously provided to you by memorandum dated May 28, 2003, and was developed in coordination with PAL's marine Principal Investigator for the Project, based upon recommendations in their report.

Please contact me if you have any questions at (781) 489-1110 or sfaldetta@essgroup.com.

Sincerely,

ESS GROUP, INC.

Sarah K. Faldetta

Sarah K. Faldetta, CPG
Senior Environmental Scientist

Copy with report enclosed:

Edward L. Bell, Massachusetts Historical Commission
Victor Mastone, Massachusetts Board of Underwater Archaeological Resources

The Commonwealth of Massachusetts
William Francis Galvin, Secretary of the Commonwealth
Massachusetts Historical Commission

July 10, 2003

Christine A. Godfrey
Chief, Regulatory Division
US Army Corps of Engineers
696 Virginia Road
Concord, MA 01742-2751

ATTN.: Karen Kirk Adams

RE: Cape Wind Energy Project, Yarmouth, MA. MHC #RC.29785. COE #199902477.

Dear Ms. Godfrey:

Staff of the Massachusetts Historical Commission have reviewed the report prepared by the PAL, *Marine Archaeological Sensitivity Assessment, Cape Wind Energy Project, Nantucket Sound, Massachusetts*, and received by the MHC on June 23, 2003. MHC has reviewed and taken into account the thoughtful comments of the Massachusetts Board of Underwater Archaeological Resources (BUAR) concerning the proposed identification effort.

MHC reviewed the results of the background research and analysis prepared by the PAL, and considered the PAL's recommendations with the summary memorandum prepared by ESS Group Inc., "Scope of Proposed Marine Archaeological Survey," dated May 28, 2003 and received by the MHC on June 4, 2003.

The proposed methods for the remote sensing survey appear to be adequate to meet the goals and purpose of the archaeological survey, provided however that the survey evaluates all the anticipated project-related impact areas. The BUAR noted in particular that the anchor spreads of the construction vessels should be considered along with all other project-related impacts. MHC looks forward to reviewing the results of the investigation along with the Corps' evaluation of the results of the identification effort.

These comments are offered to assist in compliance with Section 106 of the National Historic Preservation Act of 1966 as amended (36 CFR 800) and the Secretary of Interior's Standards and Guidelines for Archeology and Historic Preservation (48 Fed. Reg. 190 (1983)). Please contact Edward L. Bell of my staff if you have any questions.

Sincerely,

Brona Simon

Brona Simon
State Archaeologist
Deputy State Historic Preservation Officer
Massachusetts Historical Commission

xc:
Kathleen Atwood, USACOE
Terry Orr, ESS Group Inc.
Victor Mastone, MBUAR
Deborah Cox, PAL

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The Commonwealth of Massachusetts
Executive Office of Environmental Affairs
251 Causeway Street, Suite 900
Boston, Massachusetts 02114-2119
Rec'd 7/14/03

BOARD OF
UNDERWATER
ARCHAEOLOGICAL
RESOURCES

Tel. (617) 626-1000
Fax (617) 626-1181
http://www.magnet.state.ma.us/envir

July 10, 2003

Karen Kirk Adams
Regulatory Division
US Army Corps of Engineers
696 Virginia Road
Concord, MA 01742-2751

RE: Marine Archaeological Sensitivity Assessment
Cape Wind Energy Project
MHC # RC.29785; COE # 199902477; PAL # 1485

Dear Ms. Adams:

The staff of the Massachusetts Board of Underwater Archaeological Resources has completed its review of the technical report entitled *Marine Archaeological Sensitivity Assessment, Cape Wind Energy Project* and offers the following comments on the report's findings and recommendations pursuant to 36 CFR 800.4 (a) (3) and 800.4 (b) (1).

Concerning the potential of the study area to contain submerged prehistoric cultural resources, the Board concurs with the report's assessment that the majority of the area exhibits a low archaeological sensitivity due to the extensive disturbance of sediments by the marine transgression and subsequent modern wave and tidal energy. As the exception to this assessment appears to be that portion of the study area described in the report as the "basin-like feature" on the eastern side of the proposed wind turbine generators (WTG) array field, the Board supports the recommendation of additional geophysical survey of this area and requests that this area be delineated on a nautical chart and submitted for inclusion in the Board's records.

In recognition of the long history of maritime activity in Nantucket Sound, the numerous reported wrecks in the proposed project area and degree of danger to vessel traffic that has historically been associated with Horseshoe Shoal, the Board concurs with the report's assessment that the entire offshore study area exhibits potential to yield submerged historic cultural resources (shipwrecks). Therefore, the Board supports the recommendation that a marine archaeological remote sensing survey be conducted to determine the presence or absence of potentially significant submerged historic cultural resources. Such a survey should include the use of a side scan sonar, a marine magnetometer, a sub-bottom profiler, DGPS and recording fathometer. The Board also concurs with the report's recommendation that survey track line spacing for those portions of the proposed project area in which construction will generate sub-surface impacts be no greater than fifty (50) feet. The Board requests that, in addition to those areas "where installation of the submarine electrical transmission cables, WTGs, and the ESP are proposed", the areas of anticipated impact be further defined to include the anchor spreads for vessels that will be utilized in the construction process.

The Board appreciates the opportunity to comment on this report and looks forward to reviewing the scope of work for future archaeological study relative to the proposed project.

Should you have any questions regarding the content of this letter, please do not hesitate to contact me at the address above, by telephone at (617) 626-1141 or by email at victor.mastone@state.ma.us.

Sincerely;

Victor T. Mastone
Director

VTM/dwt

Cc: Brona Simon, Massachusetts Historical Commission
Sarah K Faldetta, ESS Group, Inc.
Deborah Cox, PAL, Inc.

Appendix B

REPORTED SHIPWRECKS WITHIN AND IN THE VICINITY OF THE CAPE WIND ENERGY PROJECT OFFSHORE STUDY AREA

ID #	Vessel Name	Vessel Type	Hull Material	Year Built	Year Lost	Notes	Reference
1	*P.C. 1203*	Oil-screw	Steel	Unknown	1963	Owned by US Navy	MBUAR; AWOIS; Northern Shipwreck Database
2	*Angela*	Schooner	Unknown	Unknown	1858	App. 1.25 miles west/northwest of Cross Rip	MBUAR
3	*Benjamin Gartside*	Schooner	Unknown	Unknown	1889	App. 2.5 miles northwest of Handkerchief Shoal	MBUAR
4	*Benjamin H. Hold*	Schooner	Wood	Unknown	1853		Northern Shipwreck Database
5	*Charles S. Simmons*	Schooner	Unknown	Unknown	1856		Northern Shipwreck Database
6	*Charles Smith*	Schooner	Unknown	Unknown	1856		Northern Shipwreck Database
7	*Charm*	Schooner	Wood	Unknown	1852		Northern Shipwreck Database
8	*Cheryl Ray*	Unknown	Unknown	Unknown	Unknown		MBUAR; AWOIS; Northern Shipwreck Database
9	*Colchis*	Ship	Wood	Unknown	1849	Salvaged	Northern Shipwreck Database
10	*Colleen*	Oil-screw	Unknown	1925	1932	Burned	Northern Shipwreck Database
11	*Constance*	Motorboat	Unknown	Unknown	1949		Northern Shipwreck Database
12	*Edward E. Briry*	Schooner	Wood	1896	1917		Northern Shipwreck Database
13	*Elect*	Schooner	Wood	Unknown	1858		Northern Shipwreck Database
14	*Forest City*	Schooner	Wood	Unknown	1888	Derelict	Northern Shipwreck Database
15	*G.M. Porter*	Schooner	Unknown	1871	1914		Northern Shipwreck Database
16	*George W. Elzey, Jr.*	Schooner	Unknown	Unknown	1932	Near Cross Rip Lightship	MBUAR; Northern Shipwreck Database
17	*Governor Powers*	Schooner	Wood	1905	1918	Collided with SS *San Jose*	MBUAR; Northern Shipwreck Database
18	*Helen Thompson*	Schooner	Unknown	Unknown	1891		MBUAR; Northern Shipwreck Database
19	*Isaac Rich*	Schooner	Unknown	Unknown	1856		Northern Shipwreck Database
20	*Jennie French Potter*	Schooner	Unknown	1899	1909		MBUAR; Northern Shipwreck Database

ID #	Vessel Name	Vessel Type	Hull Material	Year Built	Year Lost	Notes	Reference
21	*John Paul*	Schooner	Wood	1891	1914		MBUAR; Northern Shipwreck Database
22	*Mary F. Cushman*	Schooner	Unknown	1872	1918		Northern Shipwreck Database
23	*Mary Farrow*	Schooner	Unknown	Unknown	1911		Northern Shipwreck Database
24	*Palow*	Schooner	Wood	Unknown	1844		MBUAR; Northern Shipwreck Database
25	*Panope*	Schooner	Wood	1881	1888		Northern Shipwreck Database
26	*Pelican*	Unknown	Unknown	Unknown	Unknown		MBUAR; Northern Shipwreck Database
27	*Pelon*	Schooner	Wood	Unknown	1844		Northern Shipwreck Database
28	*Platina*	Sloop	Wood	Unknown	1841		Northern Shipwreck Database
29	*Seneca*	Unknown	Unknown	Unknown	Unknown		MBUAR; AWOIS; Northern Shipwreck Database
30	*Susan*	Schooner	Wood	Unknown	1852		Northern Shipwreck Database
31	Unknown	Unknown	Unknown	Unknown	Unknown		Northern Shipwreck Database
32	Unknown	Unknown	Unknown	Unknown	Unknown		Northern Shipwreck Database
33	Unknown	Barge	Unknown	Unknown	20th c	Appears on chart	MBUAR; Northern Shipwreck Database
34	Unknown	Unknown	Unknown	Unknown	Unknown		Northern Shipwreck Database
35	Unknown	Unknown	Unknown	Unknown	Unknown	Appears on chart	Northern Shipwreck Database
36	Unknown	Unknown	Unknown	Unknown	Unknown	Appears on chart	AWOIS
37	Unknown	Unknown	Unknown	Unknown	Unknown		AWOIS
38	Unknown	Unknown	Unknown	Unknown	Unknown		Northern Shipwreck Database
39	Unknown	Unknown	Unknown	Unknown	Unknown	Possibly the same as 41	MBUAR; AWOIS
40	Unknown	Unknown	Unknown	Unknown	Unknown	Possibly the same as 40	Northern Shipwreck Database
41	Unknown	Unknown	Unknown	Unknown	Unknown	On Dogfish Bar near mouth of Parkers River	MBUAR

ID #	Vessel Name	Vessel Type	Hull Material	Year Built	Year Lost	Notes	Reference
42	Unknown	Unknown	Unknown	Unknown	Unknown	On Bishop & Clerks Ledge app. 2 miles south of Point Gammon	MBUAR
43	Unknown	Packet	Wood	Unknown	1819	Partial loss, made port	Northern Shipwreck Database
44	Unknown	Barge	Wood	Unknown	Unknown	Appears on chart	AWOIS
45	Unknown	Unknown	Unknown	Unknown	Unknown	Appears on chart	MBUAR; AWOIS

Locational data omitted from publicly distributed copies.

Appendix C

2003 CORE LOGS

ESS Group, Inc.

Engineers
Scientists
Consultants

888 Worcester Street
Suite 240
Wellesley
Massachusetts
02482
p 781.431.0500
f 781.431.7434

Client: Cape Wind Associates
Site: Nantucket Sound
Date: 10/14/03
Drilling Company: Ocean Surveys, Inc
Drilling Method: Vibracore
Sampling Method: 3.5" diam. plastic core sleeve
ESS Job No.: E159-002.2

Core ID : VC03-01
Location: Northing: 215392
Easting: 1696814
Recovery/Penetration (ft.): 9.5/11 (refusal)
Seas: 1-2 ft
Depth to Sediment (ft.): -48.1' MLLW
ESS Observer: JHB/SF

Depth below sea floor (ft.)	USCS Designation (field observations)	Sediment Log	Field Observations: Materials Description	Sample No.	Geotechnical Laboratory Data: ASTM Group Symbol (ASTM D 422)	Liquid Limit (ASTM D 4318)	Plastic Limit (ASTM D 4318)	Moisture Content (ASTM D 2216)	Organic Matter (ASTM D 2974)
0	SM		Gray to dark gray, fine SAND, little silt. Shell hash increasing with depth, abundant coarse shell hash (1.8-2.0')	N/A	N/A	N/A	N/A	N/A	N/A
2	SW		Gray, medium SAND, little fine sand and silt						
4	SP		Dark gray, coarse SAND						
			Tan to gray, massive, medium SAND						
			Gray, coarse SAND						
8	SW		Brownish gray, medium SAND, some silt and fine sand increasing with depth						
9	SM		Brown, fine SAND, some silt, iron staining on grains						
			End of Exploration: -9.5'						

Depth scale: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15

LEGEND:
ND: not detected
N/A: not applicable
bgs: below ground surface
NM: not measured
NP: non-plastic

SAMPLE TYPES:
D: drive
W: washed
ST: shelby tube
A: auger
HA: hand auger
C: cored

PROPORTIONS USED:
Trace: <10%
Little: 10-20%
Some: 20-35%
And: 35-50%

NOTES:

DRAFT

ESS Group, Inc.

Engineers
Scientists
Consultants

888 Worcester Street
Suite 240
Wellesley
Massachusetts
02482
p 781.431.0500
f 781.431.7434

Client: Cape Wind Associates
Site: Horseshoe Shoal
Date: 10/19/03
Drilling Company: Ocean Surveys, Inc
Drilling Method: Vibracore
Sampling Method: 3.5" diam. plastic core sleeve
ESS Job No.: E159-002.2

Core ID : **VC03-02**
Location: Northing: 174345 Easting: 1702186
Recovery/Penetration (ft.): 9.6/14.6
Seas: <1 ft
Depth to Sediment (ft.): -27.2' MLLW
ESS Observer: PRW/SF

Depth below sea floor (ft.)	USCS Designation (field observations)	Sediment Log	Field Observations – Materials Description	Sample No.	ASTM Group Symbol (ASTM D 422)	Liquid Limit (ASTM D 4318)	Plastic Limit (ASTM D 4318)	Moisture Content (ASTM D 2216)	Organic Matter (ASTM D 2974)
0–1	SP		Tan, medium SAND, little fine sand. Shell layer (1-1.3')	N/A	N/A	N/A	N/A	N/A	N/A
1–5.5	SW		Gray, coarse SAND, some medium sand, trace fine sand and silt. Shell layers (3.7-4.0' and 4.4-4.6')						
5.5–9.6			Gray, medium SAND, some fine sand. Thin beds (0.5-1" thick) of coarse sand and shell hash throughout, every 4-6". Bed of coarse sand and shell hash (8.2-8.6')						
9.6–15			End of Exploration: 9.6'						

LEGEND:
ND: not detected
N/A: not applicable
bgs: below ground surface
NM: not measured
NP: non-plastic

SAMPLE TYPES:
D: drive
W: washed
ST: shelby tube
A: auger
HA: hand auger
C: cored

PROPORTIONS USED:
Trace: <10%
Little: 10-20%
Some: 20-35%
And: 35-50%

NOTES:

DRAFT

ESS Group, Inc.

Engineers
Scientists
Consultants

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p 781.431.0500
f 781.431.7434

Client: Cape Wind Associates
Site: Horseshoe Shoal
Date: 10/14/03
Drilling Company: Ocean Surveys, Inc
Drilling Method: Vibracore
Sampling Method: 3.5" diam. plastic core sleeve
ESS Job No.: E159-002.2

Core ID : **VC03-03**
Location: Northing: 182636 Easting: 1698435
Recovery/Penetration (ft.): 10.8/13.3
Seas: <1 ft
Depth to Sediment (ft.): -51.1' MLLW
ESS Observer: JHB/SF

Depth below sea floor (ft.)	USCS Designation (field observations)	Sediment Log	Field Observations: Materials Description	Sample No.	Geotechnical Laboratory Data: ASTM Group Symbol (ASTM D 422)	Liquid Limit (ASTM D 4318)	Plastic Limit (ASTM D 4318)	Moisture Content (ASTM D 2216)	Organic Matter (ASTM D 2974)
0–2	SM		Gray, medium SAND, some shell hash, little silt and coarse sand	N/A	N/A	N/A	N/A	N/A	N/A
2–5.3	SP		Dark reddish brown, medium SAND, iron staining on grains						
5.3–5.9	SP		Dark reddish brown, fine SAND, iron staining on grains						
5.9–7.7	SW		Dark reddish brown, medium SAND, some fine sand, trace silt						
7.7–10.8	SM		Dark reddish brown, medium SAND, some fine sand, trace silt, interbedded with dark brown laminae (~0.5" thick) of fine sand and silt. Small charcoal piece at 9.3' in silt layer.						
10.8–15			End of exploration: -10.8'						

LEGEND:
ND: not detected
N/A: not applicable
bgs: below ground surface
NM: not measured
NP: non-plastic

SAMPLE TYPES:
D: drive
W: washed
ST: shelby tube
A: auger
HA: hand auger
C: cored

PROPORTIONS USED:
Trace: <10%
Little: 10-20%
Some: 20-35%
And: 35-50%

NOTES:
Core sent to URI.

DRAFT

ESS Group, Inc.

Engineers
Scientists
Consultants

888 Worcester Street
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Client: Cape Wind Associates
Site: Horseshoe Shoal
Date: 10/19/03
Drilling Company: Ocean Surveys, Inc
Drilling Method: Vibracore
Sampling Method: 3.5" diam. plastic core sleeve
ESS Job No.: E159-002.2

Core ID : VC03-04

Location: Northing: 180822 Easting: 1695733
Recovery/Penetration (ft.): 13.3/15
Seas: <1 ft
Depth to Sediment (ft.): -52.2' MLLW
ESS Observer: PRW/SF

Depth below sea floor (ft.)	USCS Designation (field observations)	Sediment Log	Field Observations – Materials Description	Sample No.	ASTM Group Symbol (ASTM D 422)	Liquid Limit (ASTM D 4318)	Plastic Limit (ASTM D 4318)	Moisture Content (ASTM D 2216)	Organic Matter (ASTM D 2974)
0–2.2	SM		Gray, fine SAND, little silt, trace shell hash	N/A	N/A	N/A	N/A	N/A	N/A
2.2–4.3	OL		Gray SILT, some shell hash, little fine sand						
4.3–4.8			Gray SILT and SHELL HASH, some clay						
4.8–5.9			Gray SILT, some clay nodules						
5.9–7.8			Gray to brown SILT, some gray clay in irregular mottles (1" diameter)						
7.8–9.6	SM		Gray, fine SAND, some silt, little medium sand						
9.6–10.9	OL		Dark brown CLAY, little silt. Wood chips (10.3-10.4). Gradational contact with overlying sand unit. Small mottles in top 1.5" of clay.						
10.9–11.5	ML		Gray SILT, trace sand and clay. Clay (11-11.1)						
11.5–12.4	OH		Dark gray CLAY, trace silt						
12.4–13.0	ML		Dark gray to gray SILT and CLAY						
13.0–13.3	OH		Dark gray SILT, little clay, trace fine sand, trace organic material						
			Dark gray CLAY, trace silt						
			End of Exploration: 13.3'						

LEGEND:
ND: not detected
N/A: not applicable
bgs: below ground surface
NM: not measured
NP: non-plastic

SAMPLE TYPES:
D: drive
W: washed
ST: shelby tube
A: auger
HA: hand auger
C: cored

PROPORTIONS USED:
Trace: <10%
Little: 10-20%
Some: 20-35%
And: 35-50%

NOTES:
Core sent to URI. Core has sulfuric odor.

DRAFT

ESS Group, Inc.

Engineers
Scientists
Consultants

888 Worcester Street
Suite 240
Wellesley
Massachusetts
02482
p 781.431.0500
f 781.431.7434

Client: Cape Wind Associates
Site: Horseshoe Shoal
Date: 10/19/03
Drilling Company: Ocean Surveys, Inc
Drilling Method: Vibracore
Sampling Method: 3.5" diam. plastic core sleeve
ESS Job No.: E159-002.2

Core ID : VC03-05
Location: Northing: 190551 Easting: 1694844
Recovery/Penetration (ft.): 14.1/15
Seas: <1 ft
Depth to Sediment (ft.): -33.5' MLLW
ESS Observer: PRW/SF

Depth below sea floor (ft.)	USCS Designation (field observations)	Sediment Log	Field Observations: Materials Description	Sample No.	Geotechnical Laboratory Data: ASTM Group Symbol (ASTM D 422)	Liquid Limit (ASTM D 4318)	Plastic Limit (ASTM D 4318)	Moisture Content (ASTM D 2216)	Organic Matter (ASTM D 2974)
0	SW		Light tan, medium SAND, some shell hash increasing with depth	N/A	N/A	N/A	N/A	N/A	N/A
1	SP		Gray, quartz-rich, medium to coarse SAND, little silt and fine sand						
4	SP		Gray, fine SAND, trace shells and clay, containing some irregular trace brown clay clasts and wood and shell material						
5	OH		Dark brown CLAY, several pieces of wood (some 1-2" diameter) and charcoal						
			Dark brown, organic CLAY, strong sulfur odor, microscopic organic material, charcoal present.						
	SM		Brown CLAY grading to SILT at 6.0'						
			Gray, fine SAND, some silt						
			Dark gray SILT, little clay						
9	ML		Dark gray to gray SILT, some fine sand, some clay						
	CH		Gray blue CLAY, little silt, trace gravel, trace organics						
	CL		Gray CLAY, some silt, trace fine sand						
12	SP		Light gray to gray, fine SAND, trace silt						
			Tan, medium SAND, trace fine sand and silt. Iron staining on sand grains.						
14			End of Exploration: 14.1'						
15									

LEGEND:
ND: not detected
N/A: not applicable
bgs: below ground surface
NM: not measured
NP: non-plastic

SAMPLE TYPES:
D: drive
W: washed
ST: shelby tube
A: auger
HA: hand auger
C: cored

PROPORTIONS USED:
Trace: <10%
Little: 10-20%
Some: 20-35%
And: 35-50%

NOTES:
Core sent to URI. Core has sulfuric odor.

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Client: Cape Wind Associates
Site: Horseshoe Shoal
Date: 10/14/03
Drilling Company: Ocean Surveys, Inc
Drilling Method: Vibracore
Sampling Method: 3.5" diam. plastic core sleeve
ESS Job No.: E159-002.2

Core ID: VC03-06
Location: Northing: 186260 Easting: 1689204
Recovery/Penetration (ft.): 8.1/7.7
Seas: 1-2 ft
Depth to Sediment (ft.): -36.6' MLLW
ESS Observer: JHB/SF

Depth below sea floor (ft.)	USCS Designation (field observations)	Sediment Log	Field Observations: Materials Description	Sample No.	ASTM Group Symbol (ASTM D 422)	Liquid Limit (ASTM D 4318)	Plastic Limit (ASTM D 4318)	Moisture Content (ASTM D 2216)	Organic Matter (ASTM D 2974)
0	SP		Light gray medium SAND, trace fine sand and silt	N/A	N/A	N/A	N/A	N/A	N/A
1	SM		Light tan, medium SAND, some fine sand, little silt. Trace shells at top increasing with depth. Layer of shell hash (1.4-1.6)						
2			Dark gray, medium SAND, little fine sand and silt.						
			Light gray, coarse SAND, little fine to medium sand and silt						
3			Light gray, medium SAND, little fine sand and silt						
4									
5									
6			Light gray, medium SAND, little interbedded fine sand and silt						
7									
8			End of Exploration: 8.1'						
9									
10									
11									
12									
13									
14									
15									

LEGEND:
ND: not detected
N/A: not applicable
bgs: below ground surface
NM: not measured
NP: non-plastic

SAMPLE TYPES:
D: drive
W: washed
ST: shelby tube
A: auger
HA: hand auger
C: cored

PROPORTIONS USED:
Trace: <10%
Little: 10-20%
Some: 20-35%
And: 35-50%

NOTES:

DRAFT

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Client: Cape Wind Associates
Site: Horseshoe Shoal
Date: 10/14/03
Drilling Company: Ocean Surveys, Inc
Drilling Method: Vibracore
Sampling Method: 3.5" diam. plastic core sleeve
ESS Job No.: E159-002.2

Core ID : VC03-07
Location: Northing: 186152
Easting: 1888823
Recovery/Penetration (ft.): 6.5/7.8
Seas: 1-2 ft
Depth to Sediment (ft.): -34.6' MLLW
ESS Observer: JHB/SF

Depth below sea floor (ft.)	USCS Designation (field observations)	Sediment Log	Field Observations: Materials Description	Sample No.	Geotechnical Laboratory Data: ASTM Group Symbol (ASTM D 422)	Liquid Limit (ASTM D 4318)	Plastic Limit (ASTM D 4318)	Moisture Content (ASTM D 2216)	Organic Matter (ASTM D 2974)
0	SP		Tan, medium SAND, little fine sand, trace silt	N/A	N/A	N/A	N/A	N/A	N/A
1	SW		Light tan, coarse SAND, some medium sand, little gravel, trace silt. Shell hash layer (0.7-0.9)						
2			Light tan (grading to tan below 2.6'), medium SAND, trace fine and coarse sand						
3–4			Gray, medium SAND, little fine sand, trace silt, coarse sand and gravel. Two cobbles at base (1 diorite, 1 weathered basalt)						
5–6	ML		Gray SILT, some fine sand						
7			End of Exploration: 6.5'						
8									
9									
10									
11									
12									
13									
14									
15									

LEGEND:
ND: not detected
N/A: not applicable
bgs: below ground surface
NM: not measured
NP: non-plastic

SAMPLE TYPES:
D: drive
W: washed
ST: shelby tube
A: auger
HA: hand auger
C: cored

PROPORTIONS USED:
Trace: <10%
Little: 10-20%
Some: 20-35%
And: 35-50%

NOTES:

DRAFT

Appendix D

URI GSO 2003 VIBRATORY CORE ANALYSES REPORT

The University of Rhode Island Graduate School of Oceanography
Narragansett Bay Campus, Narragansett, RI 02882-1197

Sarah K. Faldetta, CPG
ESS Group, Inc.
888 Worcester Street, Suite 240
Wellesley, MA 02482

13 November 2003

Re: Cape Wind findings

Dear Sarah,

I have completed the attached report for the Cape Wind cores and the single sample. The seed analysis indicates that the organic sediments were deposited in terrestrial environments. Diatom analysis of the aquatic sediments would refine the determination of the salinity of the environment. It is clear that the aquatic environments are low energy and shallow. Possibilities include freshwater pond, headwaters of an estuary, and relatively closed coastal pond. It was a pleasure working with you on this project.

Sincerely,

John W. King

John W. King
Professor of Oceanography

Report on organic layers observed in vibracores obtained for the Cape Wind Project

by John King, Professor of Oceanography

Introduction

A suite of new vibracores and a sample from an existing vibracore obtained as part of the Cape Wind project were examined for ESS, Group, Inc on October 23, 2003. Organic rich intervals in these cores were examined for plant macrofossils (e.g. seeds, leaves, wood). Seeds of aquatic plants are particularly useful for identifying depositional environments because they can often be identified to genus, and because they are heavy and are not transported for long distances. Therefore, seeds from aquatic plants are assumed to be deposited by taxa that lived at or near the sampling site (Brush and Hilgartner, 2000).

Methods

Samples of approximately 5 cm^3 in volume were seived through two nested seives. The primary seive had a 1mm mesh and the secondary seive had a 0.5 mm mesh size. Both size fractions were examined and picked using a Nikon SMZ-U micropaleontologial microscope. Seeds were identified using Martin and Barkley (1961).

Results

Sample ESS-0146254-01: This composited sample was obtained from an organic-rich interval identified in a vibracore obtained and described prior to 10/23/03. The 1.0 mm or larger fraction contained occasional shell fragments, abundant subangular to rounded mineral grains (primarily quartz), common charcoal and carbonized plant fragments, very abundant plant debris including wood fragments, leaf fragments, and root fragments, common plant seeds, 1 fish scale, and 1 insect head. The 0.5mm to 1.0mm fraction contained abundant subangular to rounded mineral grains (primarily quartz), very abundant plant debris (similar to the >1.0mm fraction), common charcoal, and carbonized plant fragments. No seeds were found in this fraction.

Seeds from > 1.0 mm fraction

Number	Name	Common Name
1	*Potamogeton sp.*	Pondweed
3	*Typha sp.*	Cattail
1	*Carex sp.*	Sedge
1	*Cyperus sp.*	Flatsedge

Sample VC03-04-10.25-10.4 feet bsf: This sample was obtained from an organic-rich dark brown clay that had abundant plant debris. The coarse fraction (>1.0mm) contained very abundant wood fragments, abundant subangular to rounded mineral grains (primarily quartz), some leaf and root fragments, some charcoal and some aquatic seeds. The finer fraction >0.5mm and <1.0mm was similar in composition, but contained no seeds.

Seeds from > 1.0 mm fraction

Number	Name	Common Name
7	*Potamogeton sp.*	Pondweed
1	*Najas sp.*	Naiad
1	*Betula* cone scale	Birch

VC03-05: Two samples were obtained from this core. The first was obtained adjacent to a large piece of wood located in the dark brown clay layer at 5.45 feet bsf. The second sample was obtained from the dark brown organic clay with a strong sulfide odor at 5.6-5.7 feet bsf.

Both the coarse and fine fractions of the sample obtained from 5.45 feet bsf consist almost exclusively of wood debris. Some root material was observed, and mineral grains (primarily quartz) were present, but rare. Some of the wood was relatively fresh (light colored), whereas most was weathered (dark colored). Charcoal was common in both size fractions. No seeds were observed.

The sample obtained from 5.6-5.7 feet bsf was significantly different from that obtained at 5.45 feet bsf. Wood fragments were still abundant but the fragments were weathered (dark colored). Root material was very abundant in both fractions and mineral grains (primarily quartz) were common in both fractions. Root hairs were very abundant in the fine fraction. Charcoal was very abundant, particularly in the fine fraction. One carbonized seed from a forest shrub, *Myrica sp.,* was observed in the coarse fraction of this sample.

Discussion

The assemblage of seeds found in the sample obtained from VC-03-04 and from sample ESS-0146254-01 indicate that they were deposited in quiet, shallow aquatic environments (Gray, 1970; Brush and Hilgartner, 2000). The salinity of the aquatic environment cannot be determined unequivocally, but a fresh water environment is the most likely possibility. Diatom analysis would be necessary to refine the salinity interpretation.

The samples analyzed from VC03-05 are indicative of a preserved forest soil. The sample from 5.45 feet bsf is best interpreted as the litter layer, whereas the sample from 5.6-7 feet bsf is best interpreted as the bottom of the A horizon.

Conclusions

The organic deposits analyzed in this study are interpreted as being deposited in terrestrial environments. The environments are interpreted as shallow aquatic (probably freshwater) and forest floor.

References

Martin, A. C., and W. Barkley, 1973. Seed Identification Manual. Regents of the University of California, 221 pp.

Brush, G. S., and W. B. Hilgartner, 2000. Paleoecology of submerged macrophytes in the Upper Chesapeake Bay. Ecological Monography, 70(4), pp. 645-667.

Fernald, M. L., 1970. Gray's Manual of Botany, Eight Edition. D. Van Nostrand Company, 1632 pp.

Appendix E

PAL TARGETS

PAL MARINE ARCHAEOLOGICAL RECONNAISSANCE SURVEY - UNDERWATER TARGETS

PAL Target #	PAL Anomaly #	Run	Line	Event	Date	Mag Type/Size	SSS?	CSBP?	Depth	Comments
1	23	177	165	8868	5-Jul-03	-10/200	y	n	32	20-foot long sss anomaly on starboard channel - 100 feet from centerline
1	24	179	166	9021	6-Jul-03	-12/175	y	n	31	sss anomaly on port channel - 60 feet from centerline
1	25	180	167	9031-9032	6-Jul-03	-62/175	y	n	33	sss anomaly on starboard channel - 35 feet from centerline
1	26	181	168	9109-9110	6-Jul-03	100+d/200	y	n	28	25-foot long sss anomaly on starboard channel - 30 to 50 feet from centerline
1	27	182	169	9120-9121	6-Jul-03	20d/75	y	n	33	
2	6	24	30	1043	20-Jun-03	25cd/30	y	y	20	sss anomaly on centerline associated with 3-foot high anomalous positive elevation point on sss
2	10	27	31	1254-1255	21-Jun-03	-50/30	y		20	
2	11	27	31	1255-1256	21-Jun-03	-20/30	y		20	(2) 10-foot long sss anomalies
3	5	24	30	1033	20-Jun-03	-15/30	y	n	19	(2) 10 to 25-foot long sss anomalies
3	8	27	31	1245-1246	21-Jun-03	25/80	y	y	20	sss anomaly on centerline associated with 5-foot positive elevation point on csbp and fathometer
3	14	44	32	2459	21-Jun-03		y	n	18	30-foot long sss anomaly on port channel associated with magnetic anomalies

Locational data omitted from publicly distributed copies

Figure 6-1. Location of sub-bottom acoustic reflectors and geotechnical sampling conducted in the potentially sensitive area associated with the basin-like bathymetric low on the eastern edge of the WTG array field, Cape Wind Energy Project offshore study area. – Locational Data Omitted From Publicly Distributed Copies.

Figure 6-3. Lcoations of 2003 geophysical survey track lines and PAL target locations. – Locational Data Omitted From Publicly Distributed Copies.