# Supplemental Report

Cape Wind Energy Project
Nantucket Sound, Massachusetts
*Supplemental Marine Archaeological Reconnaissance Survey of Revised Layout Offshore Project Area*

**PAL NO. 1485.06**

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## Introduction

This supplemental report presents the methods, results, and recommendations from a supplemental marine archaeological reconnaissance survey of the revised layout of the offshore portion of Cape Wind Associates, LLC's (Cape Wind's) proposed wind energy generation facility (the project) in Nantucket Sound, Massachusetts. The survey was performed in June, July, and November 2005 in collaboration with ESS Group, Inc. (ESS), Ocean Surveys, Inc. (OSI), and the University of Rhode Island's Graduate School of Oceanography (URI-GSO). Revisions to the proposed offshore layout involve the relocation or elimination of wind turbine generators (WTG) (i.e., WTG's D4, D5, G3, G4, H9, I4, I5 and L4) and their interconnecting cable routes (i.e., between WTG's F7-G7, F9-G9, G2-G3, G3-G4, G4-G5, G9-H9, and I4-I5 ), in part to avoid project impacts to archaeologically sensitive targets and confirmed and potential paleosol areas identified during the 2003 marine archaeological reconnaissance survey of the offshore project impact area (Robinson et al. 2004).

## Methods

Geophysical survey methods and instrumentation employed in 2005 were essentially the same as those used during the 2003 marine archaeological reconnaissance survey, and included the following:

| Equipment | Function |
|---|---|
| Trimble 4000 Global Positioning System (GPS) with Trimble Pro-Beacon differential receiver | Satellite positioning system that tracks up to nine satellites at a time, and applies position correction factors relayed to it from a US Coast Guard reference station. The differential corrections are received via radio transmission by a Trimble Pro-Beacon receiver interfaced to the Trimble 4000 unit. The system outputs position fixes at a rate of 1 per second to an onboard navigation and data logging computer running *Hypack Max* navigation software package. Positioning accuracy using this system |

| Equipment | Function |
|---|---|
| | configuration is reported at ± 3 feet, and is typically less. |
| Coastal Oceanographic's *Hypack Max* navigation software | Sophisticated navigation software runs on a notebook computer to provide real time track line control, digital data logging, and many survey utility functions; this package allows the simultaneous acquisition of data from multiple survey systems. Correlates all survey data by vessel position and time ensuring proper positioning of geophysical sensors. |
| Innerspace Model 448 digital depth sounder | Microprocessor controlled, high resolution, survey-grade depth sounder that operates at a frequency of 200 kHz, providing precise water depth measurements in both digital and graphic formats. |
| DataSonics SIS-1500 digital side-scan sonar system | Side-scan sonar that transmits and receives swept frequency bandwidth signals from transducers mounted on an underwater towfish that is towed by the survey vessel. The output from the side-scan sonar is essentially analogous to a high angle, oblique acoustic "photograph" providing detailed representations of bottom features and characteristics. |
| Geometrics Model G-882 cesium vapor marine magnetometer | Marine magnetometer designed to detect ferrous metal objects buried beneath or lying on the seabed. The magnetometer, which acquires information about the ambient magnetic field strength by measuring the variation in cesium electron energy level states, is towed aft of the survey vessel. As the sensor passes near objects containing ferrous metal a fluctuation/disturbance in the earth's magnetic field is detected. This fluctuation is measured in gammas and is proportional to the amount of ferrous components in the sensed object. |
| OSI 300 joule "Boomer" sub-bottom profiling system | Sub-bottom profiler that generates a high-energy acoustic pulse in the water column in the range of 0.5 to 5 kHz. The signal generated by the system propagates downward to the seabed where it is partially reflected at the water-sediment interface. The balance of this signal continues into the bottom and is partially reflected at each successive sub-bottom interface. Generates a profile view of seismic reflectors below the bottom that is then velocity corrected and interpreted to develop a geologic cross section under the track line surveyed. |
| EdgeTech GeoStar full spectrum "CHIRP" sub-bottom profiler | High-resolution sub-bottom profiler that uses wide band Frequency Modulation (FM) pulses to detect and measure the depth to reflecting horizons in the shallow subsurface. The GeoStar system operates in the 2 to 16 kHz frequency range. The system provides better near surface resolution than the lower frequency, higher energy boomer profiling system, but typically will not penetrate to the deeper sub-bottom reflectors that the boomer system is capable of reaching. |

Horizontal positioning control was maintained during the survey through the use of a differential global positioning system (DGPS), which typically provided horizontal

positions accurate to within 3 feet (ft) (1 meter [m]). The navigation system's accuracy was confirmed on a daily basis by locating and comparing the GPS antenna's position with a known control point. All reported survey data positions were projected in feet, referencing the Massachusetts State Plane coordinate system - Island Zone (2002), and the North American Datum of 1983 (NAD 83).

Vertical positioning control was maintained by referencing the fathometer and sub-bottom profiler data to the mean lower low water (MLLW) datum using the Hyannis Port predicted tide data obtained from the National Oceanic and Atmospheric Administration (NOAA).

Geophysical survey data were acquired along a series of parallel survey track lines spaced 50 ft (15 m) apart. Three parallel survey lines, effectively covering an approximately 150-ft- (46-m-) wide corridor, were run along the northwest-southeast-oriented WTG array interconnect cable routes encompassing the WTG node locations. Two parallel survey lines spaced 50 ft (15 m) apart and offset 25 ft (8 m) from the centerline of the remaining WTG interconnect cable routes provided approximately 100 ft (31 m) of survey coverage along each route.

The full suite of geophysical instrumentation was operated on every survey track line, with the exception of the "boomer" seismic reflection system, which was run separately because of acoustic interference. The boomer was only run on the center survey lines that passed directly over the newly proposed wind turbine locations. Side-scan sonar data were recorded at a 165-ft (50-m) range (i.e., a 330-ft [100-m] swath width per line) to provide overlapping coverage of each survey track line. The vertical display range of the CHIRP sub-bottom profiler data extended to a depth of approximately 45 ft (14 m) below the sea floor's surface.

Geophysical survey data sets were monitored by the project archaeologist simultaneously as they were recorded along survey lines. Information regarding each anomaly's approximate location (relative to recorded run and event), type (e.g., magnetic, side-scan sonar, and sub-bottom profiler), and signature characteristics was documented. Magnetic anomalies with amplitudes of 10 gammas or more were inventoried by PAL, while those less than 10 gammas in intensity were not.

Upon completion of the survey, data were post-processed by OSI. The PAL archaeologist reviewed and correlated these post-processed data with the field observations to produce a final inventory of anomalies and plots of the locations of survey track lines and anomalies for review. Sub-bottom profiles recorded during the survey were reviewed in conjunction with the results of the 2003 marine archaeological reconnaissance survey to preliminarily interpret and characterize the nature of the reflectors visible in the data. Sub-bottom reflectors interpreted to have potential to be paleosols were subjected to geotechnical survey (i.e., vibratory coring). Core specimens were split and visually examined by the

project archaeologist and a qualified marine geologist/limnologist for evidence of contextually intact, stratified paleosol deposits.

**Results and Recommendations**

The overall results of this supplemental survey are comparable to those of the 2003 marine archaeological investigation. A relatively low density of small side-scan sonar and small magnetometer anomalies and several sub-bottom reflectors with moderate potential for being buried paleosols were detected. In total, the supplemental survey produced 31 magnetic anomalies with amplitudes ranging from 10 to 95 gammas and 15 side-scan sonar anomalies ranging from 0.4 to 5.6 ft (12 centimeters [cm] to 1.7 m) wide and 3.9 to 85.4 ft (1.3 to 26 m) long. In addition, three sub-bottom profiler reflectors of interest corresponding to the locations of vibratory cores VC05-05, VC05-06, and VC05-07 were also identified (Tables 1A and 1B; Figure 1 [**redacted – contains location information about potentially significant cultural resources**]).

Analysis and interpretation of the post-processed and plotted survey data in conjunction with field observations indicates that none of the magnetic or side-scan sonar anomalies possess characteristics associated with contact or post-contact period archaeological deposits (i.e., shipwrecks). Instead, these anomalies are interpreted from the available data to originate from sources that are either geological in nature or are isolated modern debris.

Three areas in approximately 13 to 45 ft (4 to 14 m) of water (i.e., one on the western flank and two on the eastern flank of Horseshoe Shoal) contained sub-bottom profiler reflectors 3 to 6 ft (1 to 2 m) below the surface of the seafloor. All three reflectors were subjected to geotechnical coring and visual analyses of the cores to determine whether the reflectors' sources were terrestrial or marine in nature. The contents of the vibratory coring specimens VC05-05, VC05-06, and VC05-07 contained no visible evidence indicating the presence of paleosols. VC05-05 and VC05-06 contained medium to coarse sands, fine gravels, and shell hash, while VC05-07 contained marine sediments, shell hash, and fine silts interpreted to be potentially lagoonal in nature.

Based on the results of the analyses of data generated from the supplemental marine archaeological survey of the revised offshore portion of the proposed Cape Wind Energy project area, the detected anomalies and areas with sub-bottom profiler reflectors are considered to have little or no probability of representing potentially significant archaeological deposits or archaeologically sensitive paleosols. All archaeologically sensitive areas identified by the marine archaeological investigations conducted to date within the offshore portion of the Project APE have been avoided; consequently, no additional archaeological investigation is recommended. In the event that marine archaeological deposits are encountered during the Project's construction, the response protocol outlined in the Unanticipated Discovery Plan of the Programmatic Agreement will be followed.

## References

Robinson, David S., Ben Ford, Holly Herbster, and Joseph N. Waller, Jr.
2004 *Marine Archaeological Reconnaissance Survey, Cape Wind Energy Project, Nantucket Sound, Massachusetts*. Technical Report submitted to Cape Wind Associates, LLC, Boston, MA. PAL Report No. 1485, Pawtucket, RI.

***Table 1A. Cape Wind 2005 Supplemental Survey - Magnetic Anomalies***

| OSI Mag # | Easting (ft) | Northing (ft) | Amplitude | Type |
|---|---|---|---|---|
| **M7** | | | 20g | M- |
| **M13** | | | 15g | M+ |
| **M14** | | | 13g | M+ |
| **M17** | | | 11g | M- |
| **M19** | | | 62g | D |
| **M34** | | | 25g | M+ |
| **M36** | | | 10g | D |
| **M39** | | | 25g | M+ |
| **M41** | | | 18g | M+ |
| **M42** | | | 22g | D |
| **M43** | | | 51g | CD |
| **M44** | | | 11g | M+ |
| **M48** | | | 12g | M- |
| **M55** | | | 10g | M+ |
| **M58** | | | 13g | D |
| **M61** | | | 12g | M+ |
| **M65** | | | 14g | CD |
| **M69** | | | 13g | D |
| **M70** | | | 95g | D |
| **M71** | | | 21g | M- |
| **M73** | | | 47g | M+ |
| **M74** | | | 11g | M- |
| **M79** | | | 17g | D |
| **M80** | | | 38g | D |
| **M81** | | | 30g | D |
| **M84** | | | 11g | M+ |
| **M91** | | | 14g | M- |
| **M92** | | | 10g | M+ |
| **M101** | | | 10g | D |
| **M102** | | | 28g | M+ |
| **M104** | | | 17g | D |

**M +/-** = monopolar anomaly (positive/negative)
**D =** dipolar anomaly
**CD =** complex dipolar anomaly

***Table 1B. Cape Wind 2005 Supplemental Survey - Side Scan Sonar Anomalies***

| OSI SSS# | Easting (ft) | Northing (ft) | Height (ft) | Width (ft) | Length (ft) |
|---|---|---|---|---|---|
| | | | | | |
| **S05-1** | | | 1.7 | 1.5 | 11.5 |
| **S05-2** | | | 0.8 | 1.8 | 8.2 |
| **S05-3** | | | 1.6 | 2.5 | 5.5 |
| **S05-4** | | | 2.4 | 2.1 | 5.1 |
| **S05-5** | | | 2.9 | 5.5 | 5.4 |
| **S05-7** | | | 0.0 | 1.4 | 3.9 |
| **S05-8** | | | 0.6 | 0.4 | 6.2 |
| **S05-9** | | | 1.3 | 1.7 | 2.6 |
| **S05-10** | | | 2.3 | 5.5 | 9.4 |
| **S05-13** | | | 5.7 | 1.7 | 8.0 |
| **S05-16** | | | 0.0 | 5.1 | 8.6 |
| **S05-17** | | | 3.6 | 5.0 | 7.4 |
| **S05-18** | | | 0.0 | 1.7 | 9.6 |
| **S05-19** | | | 0.0 | 5.6 | 8.6 |
| **S05-20** | | | 0.0 | 0.8 | 85.4 |