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19 October 2010

Mark D. Driscoll, M.S.
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SUBJECT: FINAL REPORT
THERMAL MONITORING PROGRAM – 2ND DEPLOYMENT
LONG ISLAND REPLACEMENT CABLE PROJECT
NORWALK, CT
OSI JOB# 10ES013

Dear Mr. Driscoll:

During the period 14 April 2010 through 3 June 2010 Ocean Surveys, Inc. (OSI) conducted a sediment temperature monitoring program for ESS Group, Inc. (ESS) as part of the ongoing environmental investigation for the Long Island Replacement Cable (LIRC) Project in Norwalk, CT. This was the second sediment temperature monitoring program conducted since the new cables were installed. The first occurred during the fall of 2008/winter of 2009. Two locations were chosen representing the benthic sediments found within Sheffield Harbor (Figure 1), and measurements were taken over a time period long enough to capture the full range of tidal variations. All work was conducted from the ***R/V Echo Echo*** by a three-person OSI field team consisting of a Project Manager (Diver), Project Scientist (Diver), and a Field Engineer (Dive Tender). The following report outlines the operational aspects of the instrument installation including the equipment and methods used during the survey, a summarized schedule of operations and a detailed data discussion accompanied by time series plots of all of the data.

Field Operations Schedule

Fieldwork was completed over a 51-day period and included two separate trips to the project site. The first trip was made on 14 April 2010 and included all equipment installations. OSI returned on 3 June 2010 for the recovery of the *in situ* instrumentation.

The following is a summary of survey operations.

Day 1 (14 April 2010)	Diver installation of *in situ* thermal probe
Day 51 (3 June 2010)	Diver recovery of *in situ* thermal probe

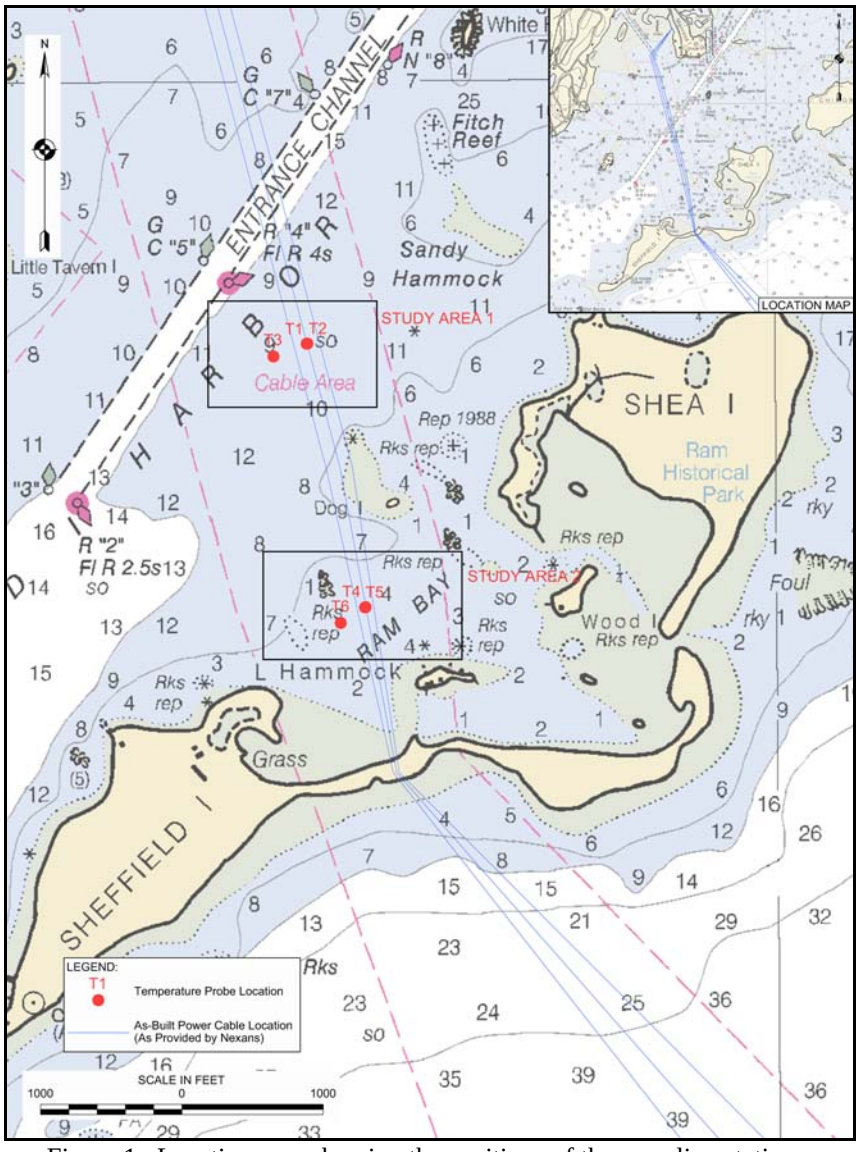

Figure 1. Location map showing the positions of the sampling stations.

VESSEL AND EQUIPMENT

The fieldwork was completed on the ***R/V Echo Echo***, a 25-foot fiberglass survey vessel with an open cabin and a single 150 HP outboard engine. The boat was equipped with a suite of instrumentation including radar and VHF radio to ensure safe vessel navigation in a wide range of weather conditions.

Vessel Navigation and Equipment Positioning

A Trimble DSM 4000 series Global Positioning System (GPS) interfaced with a HYPACK hydrographic software package was used for vessel navigation and instrument positioning. The navigation system receives GPS satellite transmissions every second and converts these data into x-y grid coordinates in the specified coordinate system. Differential position correctors received from a local U.S. Coast Guard DGPS radio transmitter are applied to the stand-alone satellite transmissions by the GPS receiver. This is done to correct for transmission errors caused by atmospheric variability and multi-path error. The corrected position data are recorded by the navigation computer and displayed as a text string in real-time. The navigation computer simultaneously projects a facsimile of the survey vessel onto a geo-referenced digital image of the survey area, and displays this image on a video monitor visible to the vessel operator. The complete navigation system provides a highly accurate visual representation of the survey vessel location in real time as well as simultaneous target acquisition and data logging capabilities.

All project coordinates were referenced to the New York State Plane Coordinate System, Long Island Zone, North American Datum 1983 (NAD 83), in units of feet. All times are expressed in UTC, Universal Coordinated Time (or Greenwich Mean Time - GMT).

Sediment Temperature Monitoring

The purpose of the thermal monitoring program was to document any changes in sediment temperatures at 4-foot, 2-foot, and 1-foot intervals below the sediment/water interface. Data were collected from within two specific areas within Sheffield Harbor: The first, in soft sediment adjacent to an oyster lease and close to the Federal channel in Sheffield Harbor, (T1-T3) and the second was just north of Sheffield Island in shallower water within soft sediments (T4-T6). Three thermal probes were installed within each of the two study areas. Specifically, probes were placed:

- Directly over the top of Cable #2, (T1 and T4)
- 3-feet east of Cable #2, (T2 and T5)
- At a control point 200ft west of Cable #2 (T3 and T6)

Temperatures were collected using specialized thermal probes (Figure 3). Located in each of these probes were (7) Onset HOBO Water Temp Pro v2 data loggers (Figure 2). These data loggers have an accuracy of ±0.3 °F and were set up to record every 15 minutes. The loggers were positioned within each probe so that temperatures were recorded at:

- 0.1 foot above the sediment/water interface (1 primary unit)
- 1-foot below the sediment/water interface (1 primary and 1 backup unit)
- 2-feet below the sediment/water interface (1 primary and 1 backup unit)
- 4-feet below the sediment/water interface (1 primary and 1 backup unit)

The thermal probes were installed using a three-person dive team. The divers jetted the probes into the sediment to the desired depth using a high-pressure water jetting system. The probes were recovered in the same manner after the deployment period concluded. Probe T1 and T4 were placed directly over Cable #2 within the approximate 1-foot deep cable trench. The "as built" drawings of the cable's burial depth, provided by Nexans and Northeast Utilities, reveal that the bottom temperature sensor at 4 feet below the sediment/water interface was approximately 2.7 feet from the power cable at T1 and less than 1.0 feet from the power cable at T4. The "as built" drawings also indicated that split pipe was used over the cable in the area of T4. The recorded temperature data from the thermal probes are presented as time series plots and provided as ASCII data listings on CD-ROM.

Figure 2. Onset HOBO Water Temp Pro V Data Logger.

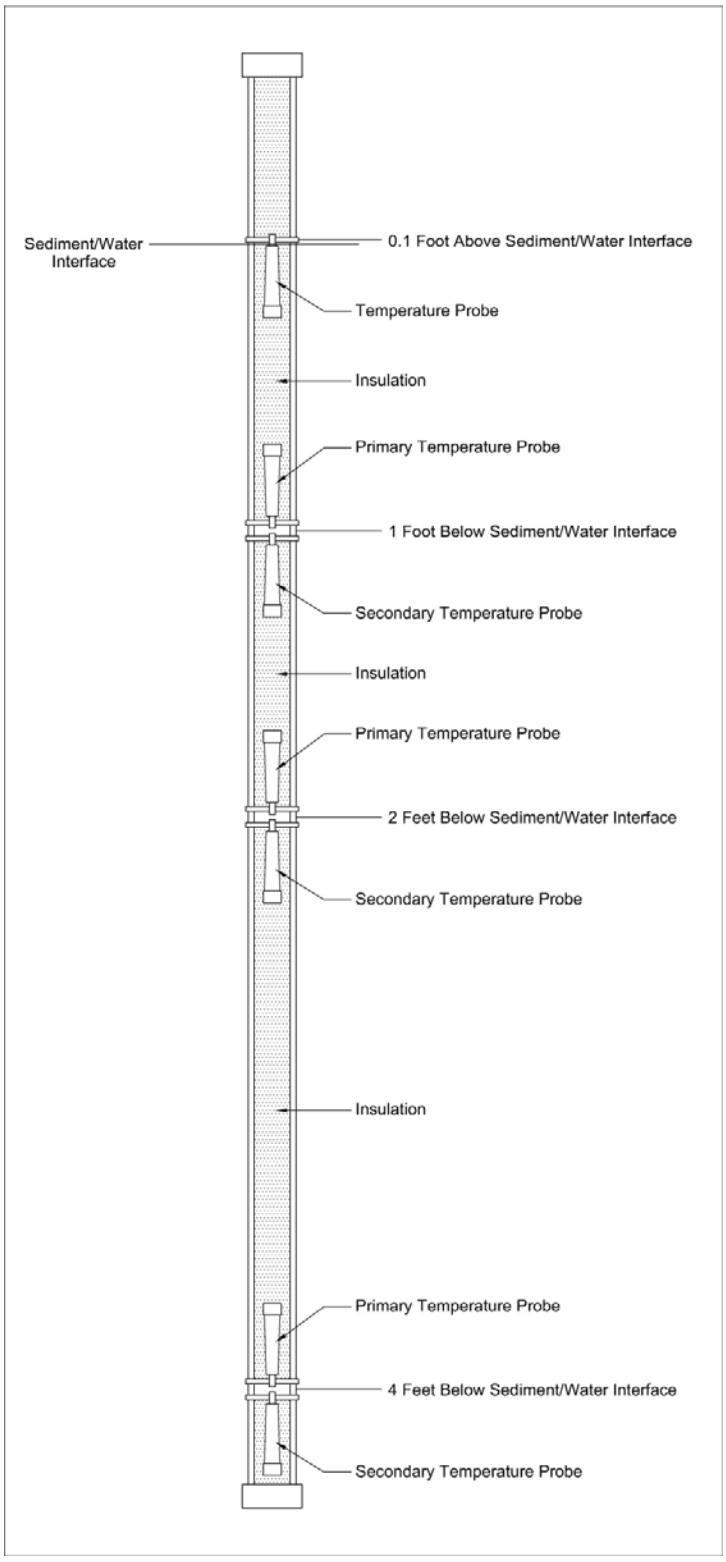

Figure 3. Thermal Probe

DATA DISCUSSION

Overview

The temperature data collected by the probes reflected a small seasonal change throughout the monitoring period. The mean starting temperature in April for Study Area 1 was 45.1 °F while Study Area 2 averaged 46.0 °F. The mean ending temperature in June for Study Area 1 was 53.5 °F and Study Area 2 55.3 °F, see Table 1.

Table 1. Mean Temperature Values

Probe Depth	Study Area 1		Study Area 2	
	Starting Temperature	Ending Temperature	Starting Temperature	Ending Temperature
- 0.1 ft	46.3 °F	59.2 °F	47.2 °F	61.4 °F
1.0 ft	44.9 °F	54.7 °F	46.5 °F	57.0 °F
2.0 ft	44.5 °F	51.8 °F	45.5 °F	53.3 °F
4.0 ft	44.8 °F	48.5 °F	44.8 °F	49.6 °F
Mean	45.1 °F	53.5 °F	46.0 °F	55.3 °F

Generally, the water temperatures recorded at the near bottom probes (-0.1 foot) were warmer than the sediment temperatures recorded throughout the study period. The difference between the water temperature and the sediment temperatures appears to increase as the water gets warmer signifying an insulating factor within the sediments. Water temperatures increased an average of 13.5 °F throughout the deployment, while the deepest sediment temperatures only increased an average of 4.3 °F.

Water Temperatures

The near bottom water temperature probes installed 0.1 ft off the bottom experienced tidal fluctuations twice a day on the order of 2 to 4 °F (Figures 4 & 5). This was seen primarily at Study Area 1 since Study Area 2 was located outside the main flow of tidal currents. At thermal probe T1, this tidal fluctuation was less evident and would indicate that the near bottom probe had become partially covered in sediment and insulated from the tidal fluctuations. Larger regional fluctuations on the order of 4 to 10 days were most likely caused by local weather/rain events.

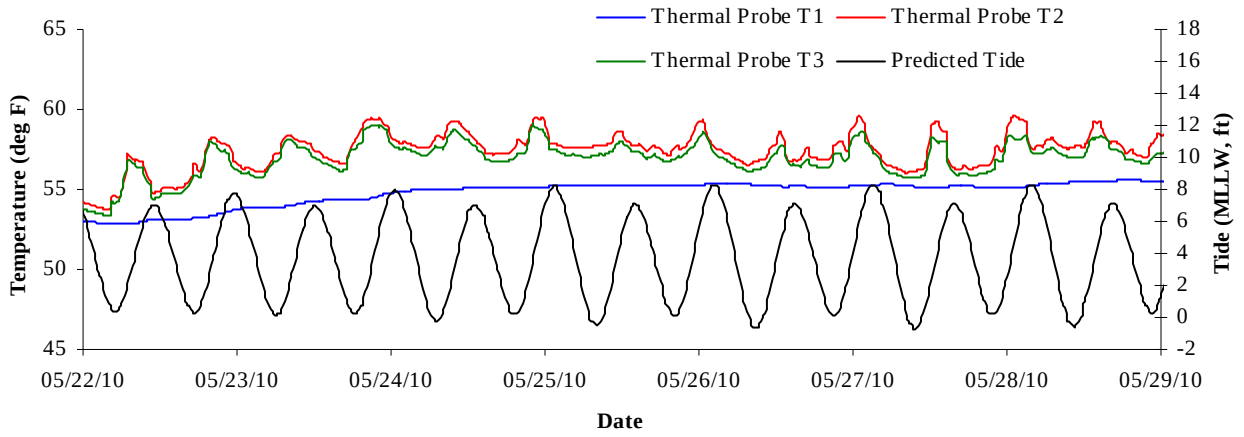

Figure 4. Near-bottom water temperature at Study Area 1

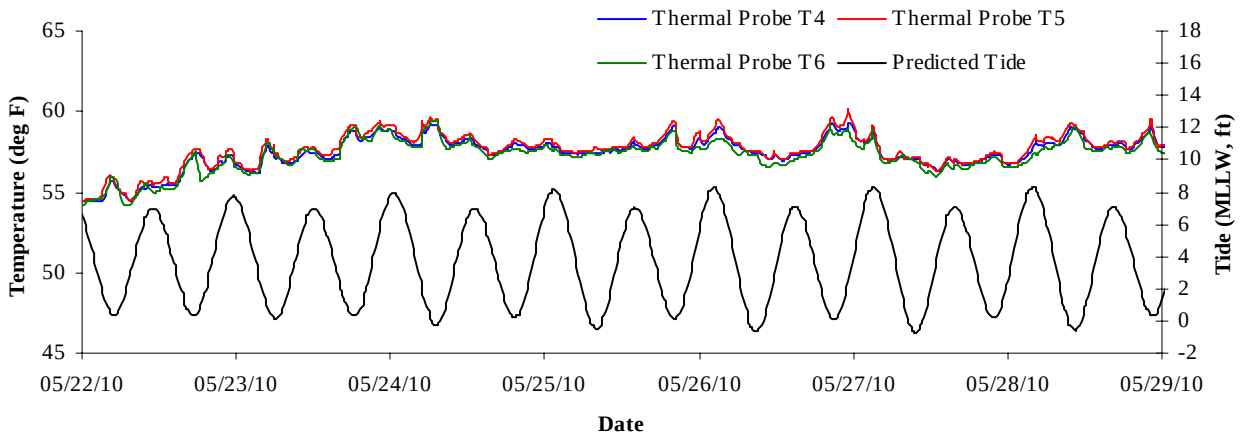

Figure 5. Near-bottom water temperature at Study Area 2

Temperature at Depth Comparison

The following graphs show temperature comparisons for the same sediment depths for each probe within the study areas. Figures 6-8 represent Study Area 1 while Figures 9-11 represent Study Area 2. In general, both study areas exhibit higher fluctuations in the temperature data closer to the sediment/water interface as would be expected due to the tidal, weather, and seasonal fluctuations seen in the near bottom sensors. At each depth and at both study areas the temperature was recorded higher on the probes placed over the cables as opposed to the adjacent or control locations. Although the cable may have some influence, some of this temperature offset may be due to the difference in elevation between a probe place 4 ft down within a 1 ft trench and the control or adjacent probes place 4 ft down from the original, undisturbed seabed. One trend seen in the graphs is the faint but noticeable decline in temperature recorded at Stations T1 and T4 (over the cables) on or around May 14th. This trend can be seen at each depth but tends to be more noticeable at the 4 foot depth sensors.

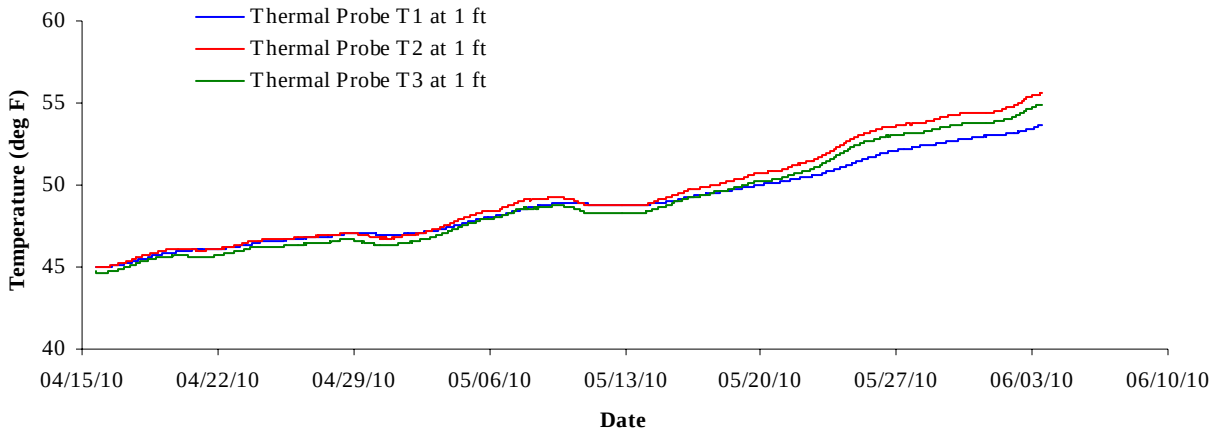

Figure 6. Study Area 1 temperature data 1 ft into sediment

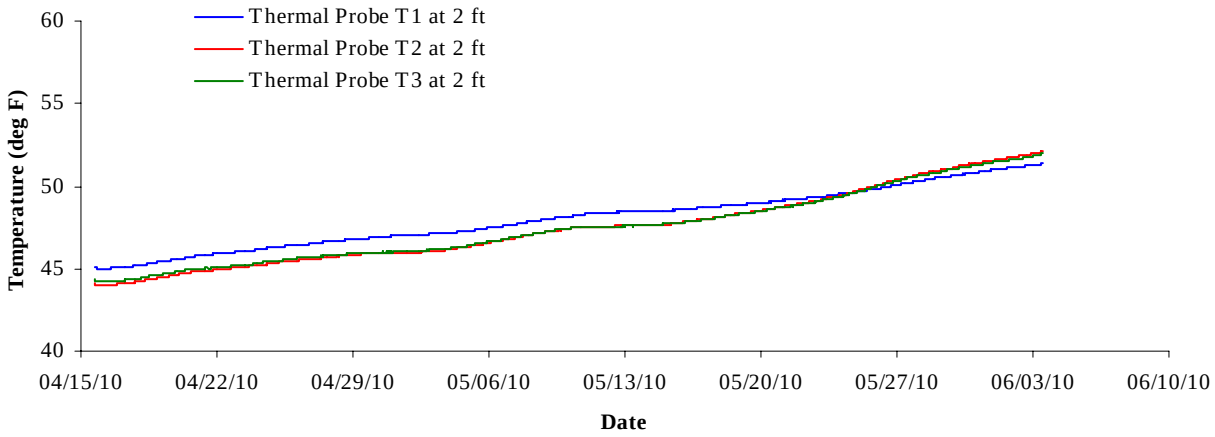

Figure 7. Study Area 1 temperature data 2 ft into sediment

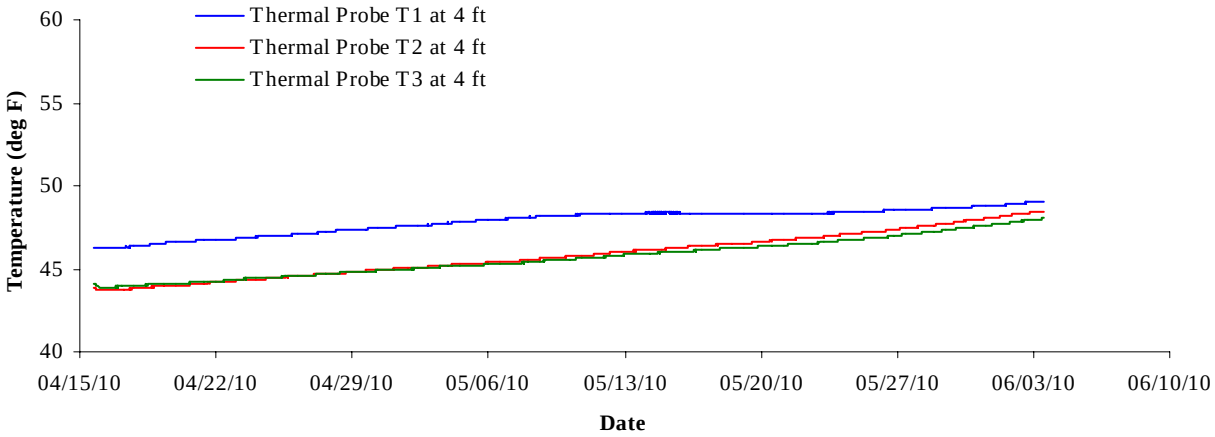

Figure 8. Study Area 1 temperature data 4 ft into sediment

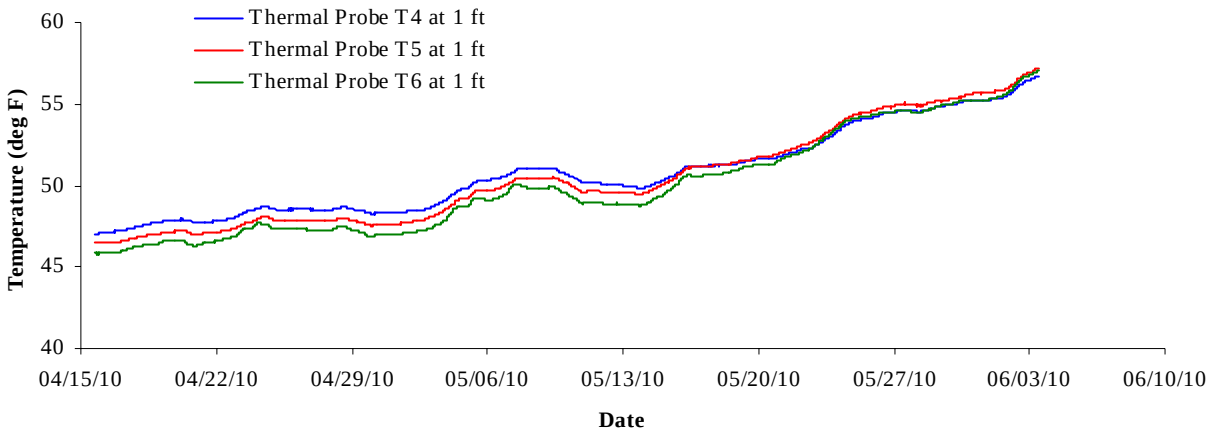

Figure 9. Study Area 2 temperature data 1 ft into sediment

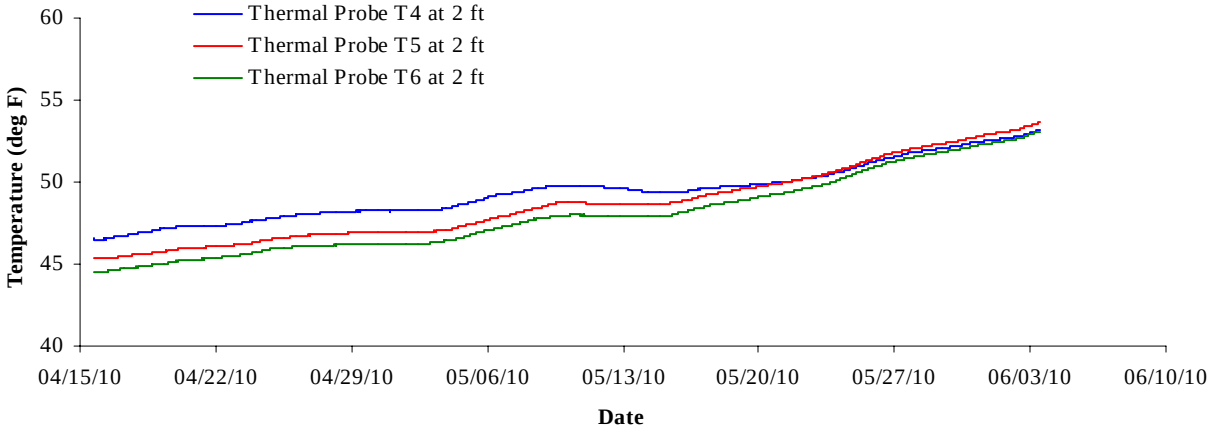

Figure 10. Study Area 2 temperature data 2 ft into sediment

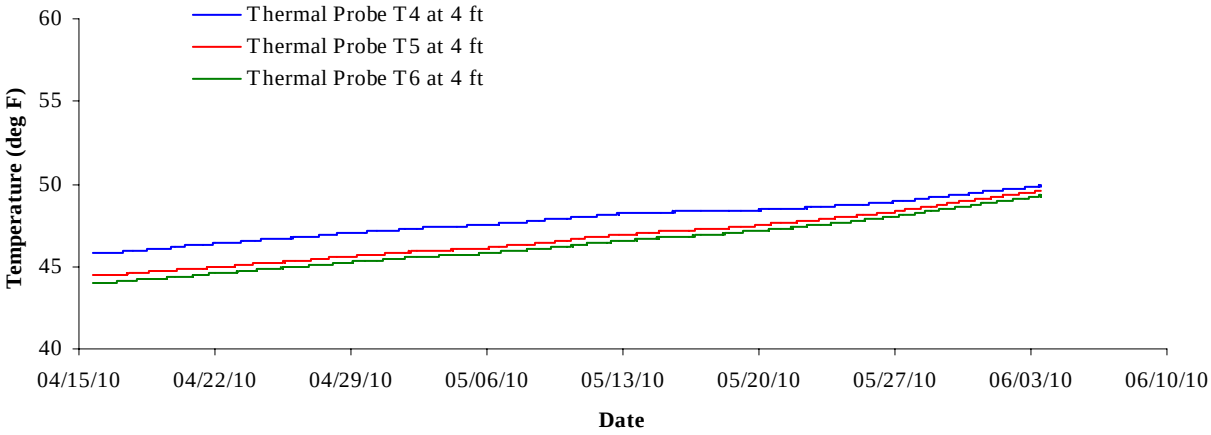

Figure 11. Study Area 2 temperature data 4 ft into sediment

Cable Load Influences

The faint decline in temperature noted at Stations T1 and T4 over the power cables appears to be related to cable operations. Figures 12 and 13 display the sediment temperature of Study Areas 1 and 2 at the 4 foot depth as it relates to cable load data provided by Northeast Utilities. Although the cable load data appears to fluctuate throughout the first half of the monitoring program, the temperatures at both study areas appear to be in a relatively steady state. On 14 May 2010, the load on the power cable appears to have been reduced to a minimum level and the temperature near cable probes (T1 and T4) begins to gradually decline to similar values seen at the adjacent (T2 and T5) and control (T3 and T6) locations. On average, temperatures gradually declined by 0.8-1.0 °F over a two-week period.

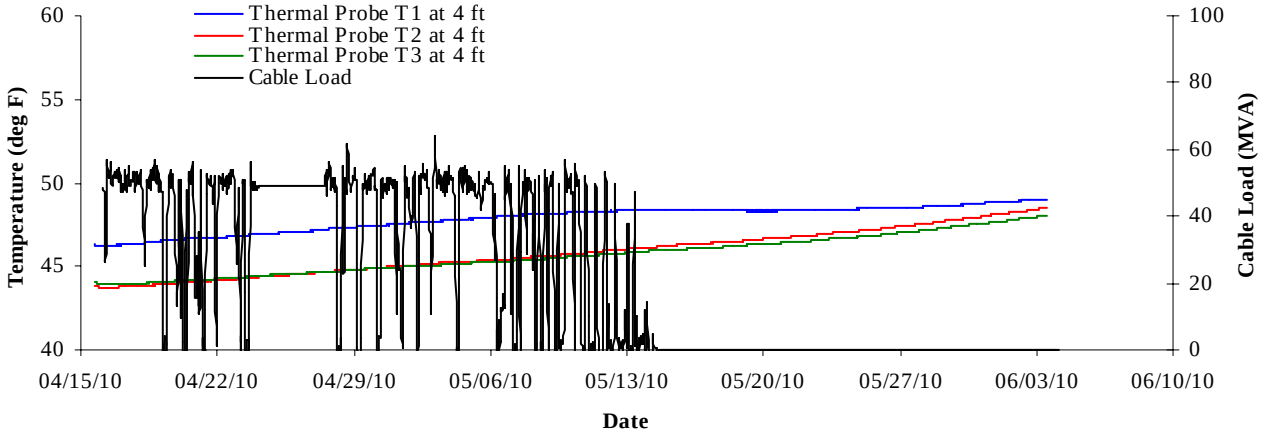

Figure 12. Cable load influences on Study Area 1 at 4 ft

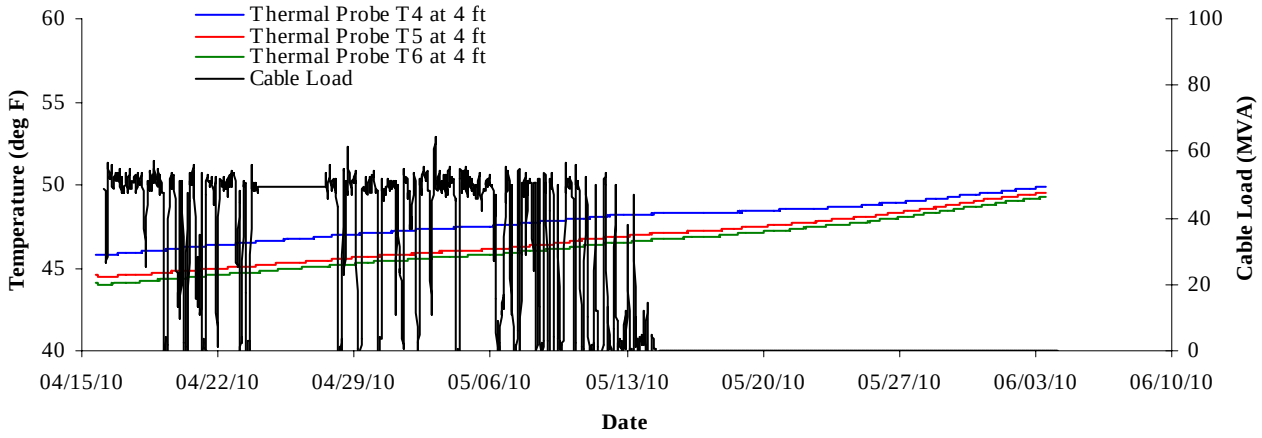

Figure 13. Cable load influences on Study Area 2 at 4 ft

Summary

The probes placed over the cables during both the current spring 2010 deployment and the fall 2008 deployment recorded changes in sediment temperature related to the power cables. However, the influence of the cables differed between deployments. During the spring 2010 deployment, the power load on the cable was fairly stable at 50 MVA and the decline of the sediment temperature after the cable shifted to a minimal level was gradual over the course of several weeks. The fall 2008/winter 2009 cable load reached a maximum of only 40 MVA and was more irregular in nature, with temperatures responding immediately to power load changes.

A digital copy of this report, including all attachments and project data files, is included on the enclosed CD-ROM.

If you have any further questions regarding the operational aspects of this project, please do not hesitate to contact me. It has been a pleasure to contribute to this project, and we look forward to working with you in the future.

Sincerely,

Ken Cadmus

Ken Cadmus
Manager – Coastal Science