INDIAN POINT No. 2
ROUTINE MONTHLY THERMAL MONITORING

REPORT No. 3
SUPPLEMENT

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SUPPLEMENT

JULY 1974

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

MAY 1975

ABSTRACT

River temperature measurements conducted in the vicinity of the Indian Point Nuclear Generating Station, with minimal influence from the thermal effluent from the station, disclose considerable natural diurnal, lateral and longitudinal temperature variations. These natural variations are maximum on the surface and decrease with depth, indicating that plant induced thermal effects are less than what one would have determined using customary procedures on the selection of an ambient or natural temperature.

A more precise estimation of the intensity and extent of a thermal plume can be realized if the assessment is based on subsurface measurements.

ACKNOWLEDGEMENT

The report contained herein was prepared by the Emissions Control Section of the Nuclear and Emissions Control Engineering Department. The temperature data was obtained by a field crew from Dames & Moore. The principal investigator was Dr. Leon C. Paretsky. Assistance in the preparation of this document was provided by Dr. Han C. Moy, and Messrs. Robert Ondrus and Ralph Navarrete.

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EMISSIONS CONTROL SECTION
NUCLEAR AND EMISSIONS CONTROL ENGINEERING DEPARTMENT

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I. INTRODUCTION

This report presents the results of a thermal survey of the Hudson River in the environs of Consolidated Edison Company of New York, Inc. (Con Edison) Indian Point Nuclear Generating Station, located at Buchanan, New York, on the east shore of the Hudson. This survey was designed to supplement previous routine monthly thermal surveys (I-1, I-2, I-3), by observing river conditions with only minimal thermal influence from the Indian Point Units. There are currently two units in operation, Unit One with a licensed power level corresponding to an electrical output of 275 MWe (gross), and Unit Two with a licensed power level corresponding to an electrical output of 906 MWe(gross). Both Units One and Two were off-line during the 48 hours preceding the field operation; Unit Two remained off-line during the day of the survey, while Unit One was brought on-line by mid-day, and by 1600 was generating about 200 MWe(gross).

Two additional generating stations are located in the reach of the Hudson covered by prior routine monthly thermal

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I-1 "Indian Point No. 2 Routine Monthly Thermal Monitoring, Report No. 1, May 1974." Prepared by Dames & Moore and Consolidated Edison Company of New York, Inc. September, 1974.

I-2 "Indian Point No. 2 Routine Monthly Thermal Monitoring, Report No. 2, June 1974." Prepared by Dames & Moore and Consolidated Edison Company of New York, Inc. December, 1974.

I-3 "Indian Point No. 2 Routine Monthly Termal Monitoring, Report No. 3, July 1974." Prepared by Dames & Moore and Consolidated Edison Company of New York, Inc. March, 1975.

survey. Lovett Generating Station, which consists of five units with a total station capacity of 503 MWe, and Bowline Generating Station, consisting of two identical units with a capacity of 624 MWe (gross), each. Lovett is located on the opposite or west shore of the Hudson, approximately 1 mile south (or downstream) of Indian Point. Bowline is also on the west shore, approximately 5 miles south of Indian Point.

River conditions were monitored over five successive tidal phases (flood, HWS, ebb, LWS, flood) on July 30, 1974 from a mobile monitoring platform. Temperature and salinity were obtained at several lateral and longitudinal locations from Croton Point to north of the Bear Mountain Bridge. The region south of Indian Point, between Croton and Verplanck, was surveyed during flood and high water slack, while the region north of Indian Point, from Round Island to north of the Bear Mountain Bridge was surveyed during ebb and low water slack. The field procedure and equipment utilized in the survey are described in Section II. The results are presented and discussed in Section III.

Examination of temperature data outside the region of influence of the power plants discloses a natural variation longitudinally and laterally in river temperature that in many cases exceeds the effects of the power plants (outside the near field region). In addition, there is a diurnal variation in water temperature, with a warming trend during the daylight hours and a cooling trend as evening approaches. Consideration of the hydrological and morphological characteristics of the Hudson in

the vicinity of Indian Point, along with the results of this field investigation, indicates that the "ambient temperature" is an abstract physical property, making it difficult to quantify with precision the intensity and extent of the Indian Point thermal plume. Furthermore, the actual intensity and extent of the Indian Point thermal plume appears to be in many instances less than what has been previously reported because of the aforementioned variation in temperature.

II. FIELD EQUIPMENT AND PROCEDURE

On Tuesday, July 30, 1974 longitudinal and lateral scans, and vertical profiling transects of the Hudson River were conducted over five consecutive tidal phases (1 1/4 tidal cycles) by a Dames & Moore field crew.

A. EQUIPMENT

The scans were conducted from a power boat equipped with an Endeco Model 133 thermistor system for monitoring the temperature at three depths.

The thermistor system, which had the capacity of sequentially recording and digitizing the temperatures at the three depths, was interfaced with a digital printer. Navigation was by sextant and by employing straight line scans between pre-positioned channel markers. Vessel speed was approximately 2 to 5 knots.

The static profiling transects were conducted with a Hydrolab Model 6D Surveyor water analysis system. Data obtained were temperature and conductivity as a function of depth.

Intake temperatures were monitored utilizing either an Inter Ocean Model 518A temperature monitor or a Hydrolab Model TC-2 conductivity-temperature meter.

B. PROCEDURE

The following is a sequential list of the transects and profiles performed during each tidal phase, along with the time of measurement:

B.1 Early Flood: (Figure 8.2)

1.1 Croton Point lateral transect scan from east to west shore. Thermistor string at 0, 3 and 6 foot depths. Data intervals of 10 seconds (temperature: 0808 - 0815).

1.2 Croton Point vertical profile transect. Vertically equidistant intervals to river bottom at east, west and mid-channel stations (temperature and salinity: 0801-0826).

2.1 Croton Point to Bowline longitudinal river transect scan along center channel. Thermistor string at 0, 3 and 6 foot depths. Data intervals of 10 seconds (temperature: 0830 - 0858).

3.1 Haverstraw lateral transect scan from west to east shore (Grassy Point to Georges Island). Thermistor string at 0, 3 and 6 foot depths. Data interval of 10 seconds (temperature: 0916 - 0924).

3.2 Haverstraw vertical profile transect between Grassy Point and Georges Island. Data obtained at vertically equidistant intervals to river bottom at east, west and

mid-channel stations (temperature and salinity: 0904 - 0934).

4.1 Haverstraw - Verplanck longitudinal river transect scan along center channel. Thermistor string at 0, 3 and 6 foot depths. Data intervals of 10 seconds (temperature: 0940 - 0953).

5.1 Verplanck lateral transect scan from east to west shore (Verplanck to Tomkins Cove). Thermistor string at 0, 3 and 6 foot depths. Data intervals of 10 seconds (temperature: 0956 - 1000).

6.1 West shore cove (across the river from Indian Point) transect scans from west shore eastward for approximately 1000 feet. Sequence of four, each successive one is about 500 feet further north. Thermistor string at surface. Data interval of 5 seconds (temperature: 1008 - 1021).

B.2 High Water Slack: (Figure 11.2)

1.1 Croton Point lateral transect scan from east to west shore. Thermistor string at 0, 3 and 6 foot depths. Data interval of 10 seconds (temperature: 1104 - 1112).

1.2 Croton Point lateral transect scan from west to east shore. Thermistor string at 9, 12 and 15 foot depths. Data interval of 10 seconds (temperature: 1115 - 1123).

1.3 Croton Point vertical profile. Data obtained at equidistant vertical intervals to bottom of river at mid-channel station (temperature and salinity: 1130).

2.1 Haverstraw lateral transect scan from east to west shore (Georges Island to Grassy Point. Thermistor string at surface, 3 and 6 foot depths. Data intervals of 10 seconds (temperature: 1150 - 1157).

2.2 Haverstraw lateral transect scan from west to east shore (Grassy Point to Georges Island). Thermistor string at 9, 12 and 15 foot depths. Data interval of 10 seconds (temperature: 1200 - 1206).

2.3 Haverstraw vertical profile transect between Grassy Point and Georges Island. Data obtained at vertically equidistant intervals to river bottom at east, west and mid-channel stations (temperature and salinity: 1211 - 1219).

3.1 Verplanck lateral transect scan from east to west shore (Verplanck to Tomkins Cove). Thermistor string at surface, 3 and 6 foot depths. Data interval of 10 seconds (temperature: 1230 - 1234).

B.3 Ebb: (Figure 14.2)

1.1 Bear Mountain Bridge lateral transect scan from east to west shore. Thermistor string at surface, 3 and 6 foot depths. Data intervals of 5 seconds (temperature: 1358 - 1400).

1.2 Bear Mountain Bridge vertical profile transect. Data obtained at vertically equidistant intervals at east, west

and mid-channel stations (temperature and salinity: 1400 - 1410)

2.1 Bear Mountain Bridge to Fort Montgomery longitudinal river transect scan (south to north) along center channel of river. Thermistor string at surface, 3 and 6 foot depths. Data interval of 10 seconds (temperature: 1418 - 1425).

3.1 Bear Mountain Bridge to Iona Island longitudinal river transect scan (north to south) along center channel of river. Thermistor string at surface, 3 and 6 foot depths. Data interval of 10 seconds (temperature: 1429 - 1435).

4.1 Round Island lateral transect scan from west to east shore (Round Island to Fish Island). Thermistor string at surface, 3 and 6 foot depths. Data interval of 10 seconds (temperature: 1439 - 1441).

4.2 Round Island vertical profile transect. Data obtained at vertically equidistant intervals at east, west and mid-channel stations (temperature and salinity: 1440-1452).

5.1 Lents Cove transect scans, from Lents Cove westward to about 1000 feet into river channel. Sequence of three east to west scans, each subsequent scan northward of previous scan. Thermistor string at surface. Data interval of 5 seconds (temperature: 1507 - 1517).

6.1 Peekskill Bay transect scans, the first from south to north, the other from north to south. Thermistor string at surface. Data intervals of 10 seconds (temperature: 1522 - 1537).

B.4 Low Water Slack: (Figure 17.2)

1.1 Bear Mountain Bridge lateral transect scan from east to west shore. Thermistor string at surface, 3 and 6 foot depths. Data interval of 5 seconds (temperature: 1703 - 1705).

1.2 Bear Mountain Bridge lateral transect scan from west to east shore. Thermistor string at 9, 12 and 15 foot depths. Data interval of 5 seconds (temperature: 1707 - 1709).

1.3 Bear Mountain Bridge vertical profile transect. Data obtained at vertically equidistant intervals at east, west and mid-channel stations (temperature and salinity: 1712 - 1720).

2.1 Bear Mountain Bridge to Iona Island longitudinal river transect scan (north to south) along center channel of river. Thermistor string at surface, 3 and 6 foot depths. Data intervals of 5 seconds (temperature: 1724 - 1730).

3.1 Round Island lateral transect scan from west to east shore (Round Island to Fish Island). Thermistor string at surface, 3 and 6 foot depths. Data interval of 5 seconds (temperature: 1734 - 1737).

3.2 Round Island lateral transect scan from east to west shore (Fish Island to Round Island). Thermistor string at 9, 12 and 15 foot depths. Data interval of 5 seconds (temperature: 1738 - 1740).

3.3 Round Island vertical profile transect. Data obtained at vertically equidistant intervals at east, west and mid-channel stations (temperature and salinity: 1744 - 1752).

4.1 Round Island to Roa Hook longitudinal river transect scan (north to south) along center channel of river. Thermistor string at surface, 3 and 6 foot depths. Data interval of 10 seconds (temperature 1754 - 1760).

B.5 Late Flood: (Figure 20.2)

1.1 Croton Point lateral transect scan from east to west shore. Thermistor string at surface, 3 and 6 foot depths. Data interval of 10 seconds (temperature: 1920 - 1929).

2.1 Bowline Point to Haverstraw (Grassy Point longitudinal river transect scan (south to north) along center channel. Thermistor string at surface, 3 and 6 foot depths. Data interval of 10 seconds (temperature: 1940 - 1954).

3.1 Haverstraw lateral transect scan from west to east shore (Grassy Point to Georges Island). Thermistor string at surface, 3 and 6 foot depths. Data interval of 10 seconds (temperature: 1957-2006).

4.1 Haverstraw to Verplanck longitudinal river transect scan (south to north) along center channel. Thermistor string at surface, 3 and 6 foot depths. Data interval of 10 seconds (temperature: 2011 - 2023).

5.1 Verplanck lateral transect scan from east to west shore (Verplanck to Tomkins Cove). Thermistor string at

surface, 3 and 6 foot depths. Data interval of 10 seconds (temperature: 2024 - 2029).

6.1 Indian Point lateral transect scan from west to east shore. Thermistor string at surface. Data interval of 10 seconds (temperature: 2038 - 2045).

Intake temperatures were monitored periodically during the survey at the northernmost and southernmost intake bays of Units One and Two. Temperatures were monitored at bottom, 2/3 total depth, 1/3 total depth and surface.

C. STATION OPERATING DATA

As previously mentioned, both Units One and Two were off-line the forty-eight hours preceding the day of the survey, Tuesday, July 30, 1974. Unit Two remained off-line for the duration of the survey while Unit One came on-line at 1124, and by 1600 (Tuesday) was at about 200 MW(e) gross. Lovett Units 1, 2 and 3 were not operating on Tuesday, while Units 4 and 5 were generating about 150 MW(e) and 200 MW (e), respectively, during the survey period. Bowline Units 1 and 2 were operating with an average output of approximately 580 MW (e) and 300 MW (e), respectively, for the duration of the survey. Specific details on the power level and the circulating water flow rate for Indian Point, Lovett and Bowline are presented in Tables 1, 2 and 3 and Figures 2.1, 2.2 and 2.3.

III RESULTS

A. SUMMARY

A sequence of temperature scans and profiles were conducted, both south and north of the Indian Point site, to obtain insight into the natural temperature variation in the Hudson River with minimal influence from the Indian Point Station.

The natural temperature variation, attributable to the morphological, hydrological and meteorological influences in the Croton-Bear Mountain reach, makes it difficult to determine the extent of plant-induced effects. Any estimate of the intensity and extent of the Indian Point Station thermal plume utilizing similar methodology for the determination of ambient (or natural temperature) as employed in previous surveys would be conservative (III-1, III-2, III-3).

Longitudinal and lateral temperature scans were conducted south of Indian Point, between Croton Point and Verplank, during

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III-1 "Indian Point No. 2 Routine Monthly Thermal Monitoring, Report No. 1, May 1974." Prepared by Dames & Moore and Consolidated Edison Company of New York, Inc. September, 1974.

III-2 "Indian Point No. 2 Routine Monthly Thermal Monitoring, Report No. 2, June 1974. Prepared by Dames & Moore and Consolidated Edison Company of New York, Inc. December, 1974.

III-3 "Indian Point No. 2 Routine Monthly Thermal Monitoring, Report No. 3, July 1974." Prepared by Dames & Moore and Consolidated Edison Company of New York, Inc. March, 1975.

flood current.

Similar scans were conducted north of Indian Point, between Bear Mountain Bridge and Round Island during ebb current flow. Examination of these data indicates that the Croton-Haverstraw-Verplanck region experiences a great deal of surface warming during the day. The surface temperature of the flood water past Croton Point increased about 1.5°F from 76.71°F at 0809 to 78.25°F at 1104; at 3 foot depth the increase was about 0.5°F from 76.81°F to 77.33°F, while at 6 foot depth the change was insignificant. There is a definite increase in surface water temperature as one gets further into the Haverstraw Bay region during this time period (0800 to 1200), whereas the temperature beneath the surface changes slightly. (See Figure 22.1.)

Comparison of the Croton through Verplanck data with Indian Point surface intake data (Table 11) discloses that during flood the Indian Point data closely corresponds to the values obtained at Croton at 0800 and at Verplanck at 0956 (at comparable times at Indian Point, thus indicating the effect of surface warming. Any attempt at a definitive correlation would be misleading. The Indian Point data is the result of a vertical profile with a single surface measurement, whereas the scans are the results of several scores of temperature measurements across the river.

The difficulty in the identification of a natural temperature upon which to superimpose (or subtract the effect of Indian Point is clearly demonstrated. "Croton Point Water" does not reflect the natural temperature perturbations that occur

between Croton and Indian Point. Also, "Croton Point Water" measured, say at HWS, does not reach Indian Point. Haverstraw (Grassy Point to Georges Island) or even Verplanck should be employed: however, it is difficult to definitely ascertain that Verplanck (or to a lesser extent Haverstraw) are not influenced by any thermal plume. A rapid examination of the data discloses that the surface temperature of the flood profiles increases as one progresses from Croton to Verplanck; however, this increase is only slightly (if at all) due to Bowline Point Station. There was a two hour difference between the time the Croton and the Verplanck profiles were conducted, and the increase is definitely due to surface warming. The uniformity of the three and six foot depth readings attest to this, as can be seen from Figure 10.1.

One can logically conclude from examination of the Croton-Verplanck profiles that any attempt to assign a natural surface temperature to the Indian Point reach through field measurements south of Indian Point is difficult, if not impossible. The utilization of Croton presumably underestimates the value of the Indian Point natural temperature. An improvement would be to utilize the temperature at a depth wherein surface perturbations are minimal. The employment, for example, of the three foot depth as a reference for criteria evaluation would apparently reduce the uncertainty in the determination of the surface width (or more appropriately the upper layer) and the cross-sectional area affected by a heated effluent.

The region north of Indian Point also exhibits complex morphological, hydrological and meteorological changes as one

proceeds from the Bear Mountain Bridge towards Indian Point. The Round Island and Bear Mountain longitudinal and lateral temperature scans conducted at ebb and LWS do not show any (statistical) differences with respect to location; however, there was over a 1°F decrease from ebb (at 1400) to LWS (at 1700) at the surface, but only about a 1/2°F decrease at the 6 foot level (see Figures 16.1 and 19.1). Comparison of these data with Indian Point intake surface data, recalling the limitations cited with the Croton-flood intake comparison, disclose that the Indian Point surface temperature data is about 1°F higher than at Bear Mountain. (See Table 11).

This increase in temperature as one proceeds south from Bear Mountain Bridge is understandable. The Bear Mountain transects were obtained in a river valley, with a river surface width of about 1500 feet, whereas the Peekskill Bay region north of the plant has surface widths in excess of 6000 feet. This increase of surface area can only increase the propensity for surface heating. The warmer temperature (in excess of 80°F) measured in Peekskill Bay substantiate this proposition. It should be noted that surface temperatures in excess of 90°F were recorded in Lents Cove. The aforementioned indicates that the extent of the thermal plume for ebb current reported in the previous surveys was apparently overestimated, since the natural temperatures upon which the plant induced effects were determined were underestimated.

The above suggests that the proposition previously presented for the establishment of a reference datum for flood

measurements be also employed for ebb, that is, representative reference for surface (or upper layer) computations. This would reduce but not eliminate the influence of natural temperature perturbations.

Several scans conducted near the west shore across from Indian Point disclosed that Lovett did not have a significant effect in this region.

A comparison between the scan and profile temperatures, presented in Table 12, indicates the differences between the surface averages obtained utilizing each approach. These differences diminish if an upper layer average is computed, since here the data base for the profile measurements is expanded, thus minimizing the effect of a randomly selected hot or cold pocket of water. If possible, within the constraints of the survey, the scan technique appears to be the preferable way of acquiring ambient (or natural) temperature data.

B. DISCUSSION

1. Flood Current Measurements

A sequence of lateral and longitudinal temperature measurements were conducted thrice during flood current flow. These can be classified, for the purpose of discussion, as:

(1) Early or First Flood Measurements (0800-1000)
(2) High Water Slack into Ebb (1100-1230)
(3) Late or Second Flood (1900-2030)

These provide a representative sample, in terms of the daily variation in meteorological conditions, for an interpretation of the behavior of the region south of Indian Point.

Each sequence listed above involved measurements covering the Croton Point-Verplanck reach, starting initially at Croton Point and then progressing northward towards Indian Point. The list of measurements is presented in Section II.B. above. These were:

(a) Lateral transects at Croton Point, Haverstraw and Verplanck at 0, 3 and 6 foot depths for all three sequences, save that additional data was acquired at 9, 12 and 15 foot depths during sequence (2).

(b) Longitudinal transects up the channel of the river at 0, 3 and 6 foot depths, between each lateral transect during sequence (1) and (3).

Examination of the first flood sequence (Figure 10.1) discloses that there is a gradual increase in surface temperature as one proceeds from the Croton Point transect towards the Verplanck transect. There was no statistical difference between the temperatures obtained at the six foot depths (mean temperatures with one standard deviation), and aside from the Croton Point transect no statistical difference at the 3 foot depth.

This increase in temperature is correlated with the time of measurement. The Croton Point transect was conducted at 0800, while the Verplanck data was acquired by 1000. During this period the ambient air temperature began to increase from its

nightly minimum, and the net radiation became positive (Table 13). These would, of course, increase the surface temperature. There was, however, insufficient time for this increase to affect the lower depths, hence the increase occurs only at the surface.

A quick glance at the data might lead to the supposition that the surface increase can be attributed to the operation of the Bowline or the Lovett facility. However this was a period of flood current flow, hence the impact of Lovett can be dismissed. Furthermore, the longitudinal transect south of Bowline gives almost identical temperatures (through the measured water column) as the lateral transect north of Bowline, at Haverstraw, thus indicating that the effect of Bowline on the Haverstraw transect is minimal (Figure 10.1). In addition, the aforementioned surface temperatures (at Haverstraw) are lower than the surface measurements attained from both the Haverstraw-Verplanck longitudinal transect and the Verplanck lateral transect. These two transects were conducted later in the day. If indeed Bowline had an effect, the Haverstraw transect would have produced the higher temperature.

All this indicates the temporal and spatial variability of the surface measurements, and the virtual impossibility of assigning a natural temperature to a region on the basis of surface temperature measurements in another region located upstream of the current flow. For example, the surface temperature differential between Haverstraw and Verplanck was 0.5°F. However, at the three foot depth the differential becomes about 0.25°F, and at the six foot level the difference becomes

nil. Recalling that we are also talking about a 0.8°F surface temperature differential between Croton and Verplanck, and realizing that this is (primarily) not a plant induced differential, it becomes apparent that the selection of a surface natural temperature based on measurements upstream of a net flow becomes speculative. It therefore appears logical to utilize a different basis for estimating plant induced thermal effects. The three foot depth level appears to be a logical choice. This proposition will be elaborated upon utilizing other tidal phase measurements.

Turning attention now to sequence (2) above, illustrated in Figure 13.1, one notes similar behavior with an increase in temperature from Croton towards Verplanck. The differential between Croton and Haverstraw decreased with depth. The Haverstraw and Verplanck measurements for this sequence intruded into ebb, hence a definitive comparison as conducted with sequence (1) is difficult, save for general trends.

The effect of surface heating becomes apparent through comparison of the increase in surface temperature at the various transects.

Locations	Surface Temperature, °F, (and time) Sequence (1)	Sequence (2)
Croton	76.71 (0807)	78.25 (1104)
Haverstraw	77.03 (0916)	79.22 (1149)

We observed an increase in surface temperature of about 1.5°F, at Croton, and an increase of over 2°F at Haverstraw. It is noteworthy that the increase over this period at the 6 foot depth at Croton was about 0.1°F, and 0.6°F at Haverstraw. (See Figure 22.1.)

Examination of the morphological structure of the Hudson in this region, with due consideration to the meteorological conditions prevalent during the survey, provides an explanation for the above behavior. The area south of Croton, Croton Bay and Tappan Zee, is relatively wide (over 9000 feet with large shallow areas. The Haverstraw Bay area between Croton and Verplanck is likewise relatively wide (about 10,000 feet with large shallow areas. This enhances surface warming by exposing a greater volume of water. As mentioned previously, examination of local meteorological data discloses the concurrent increase in ambient air temperature and net radiation (Table 13) during this period.

One further comment is appropriate. The standard deviation (S.D.) of the temperature scanning measurements for each transect apparently increased from sequence (1) to sequence (2). This could be attributed to the increased wind speed, and reflects a large shore to shore (and point to point variation. For example, the surface S.D. at Croton increased from ±0.18°F to ±0.44°F, whereas the 6 foot S.D. changed from ±0.26 to ±0.30.

Analysis of the second, or late flood data reflects the reverse trend. This survey examined the temperature patterns from about 1930 to 2030. The Croton Point temperatures were higher than the Haverstraw or Verplanck data, with the difference

decreasing with time. Here we have the water surface transferring energy to the atmosphere, as exhibited by the negative values (indicating loss) of net radiation. Contrasting the Croton and Haverstraw data at the surface and the six foot depths we have:

	Surface		6 feet	
	Croton (°F)	Haverstraw (°F)	Croton (°F)	Haverstraw (°F)
Sequence				
(1)	76.71	77.03	76.54	76.74
(2)	78.25	79.22	76.48	77.31
(3)	78.94	77.29	78.33	77.46

The surface diurnal variation at both Croton and Haverstraw is 2°F, whereas at a depth of 6 feet it is less at both locations.

The large S.D. obtained during the late flood surface measurement at Croton (±0.50) are indicative of the lateral variation in temperature.

Comparison between the surface intake measurements at Indian Point with those conducted south of the facility during early flood show a warming trend at Indian Point, from 76.6°F (0815) to 77.3°F (1040). The corresponding measurements were 76.71°F (0807) at Croton and 77.47°F (0956) at Verplanck. The reservations mentioned earlier should be understood; this provides only a qualitative interpretation. It must be noted that, as previously stated, the Croton Point water does not reach Indian Point. During late flood the Indian Point facility was

operating, hence any attempt at comparison during this tidal phase should be avoided.

2. Ebb Current Measurements

A sequence of lateral and longitudinal temperature measurements were conducted twice during ebb current flow. These can be classified for the purpose of discussion as:

(1) Maximum Ebb Measurements (1400-1430)
(2) Low Water Slack Measurements (1700-1800)

These provide a representative sample for an investigation of natural temperature variations in the region north of Indian Point during a four hour period in mid-afternoon.

Each sequence listed above involved measurements covering the Bear Mountain - Peekskill Bay reach, starting initially at Bear Mountain Bridge and then progressing southward, towards Indian Point. The list of measurements are presented in Section II.B. above. They include:

(a) lateral transects at Bear Mountain Bridge and Round Island at 0, 3 and 6 foot depths for both sequences (1) and (2), and 9, 12 and 15 foot depths for sequence (2).

(b) longitudinal transects in the above region.

Examination of the ebb measurements discloses that there is no statistical differences (at a given depth) between any of the Bear Mountain or Round Island Measurements; however, there is a variation with depth. The 3 foot measurements are approximately 0.75°F lower than the surface, and the 6 foot

measurements are about 1°F cooler than the surface (Figure 16.1). The existence of warmer temperatures at the surface can be associated with daylight surface warmings, as was discussed above with reference to the Haverstraw Bay measurements.

The low water slack measurements conducted later in the day did not exhibit the natural thermal stratification prevalent during the ebb measurements, but disclosed the water column to be more isothermal (Figure 19.1). The surface temperatures exhibited a decrease of over 1°F from ebb, whereas the 6 foot depths decreased about 1/4°F. This indicates the potential diurnal variation at Bear Mountain. It should be emphasized that these measurements were conducted about four hours apart during ebb current only, indicating the potential for even larger temperature changes.

While at first glance the above indicates that the selection of a natural temperature for the Indian Point reach is more tractable for ebb current than for flood, comparison of the intake surface temperature measurements with the northern transects conducted at a comparable time indicates the difficulty in assigning a natural temperature.

Indian Point °F (time)	Round Island °F (time)	Bear Mountain °F (time)
78.2 (1355)	-	77.56 (1308)
77.9 (1450)	77.75 (1439)	-
77.5 (1810)	76.55 (1734)	76.57 (1703)

It can be readily seen that the surface temperature at the Indian Point intake is noticeable higher than these transect temperatures (III-4). These locations were employed for the determination of ambient during previous surveys. Apparently, the selection of these locations generated low natural temperatures upon which the excess temperature differential produced by the Indian Point Station was calculated. Therefore, the actual intensity and extent of the excess temperature isotherms are smaller than previously reported.

This conclusion becomes apparent when one examines the structure of the Hudson in the region north of Indian Point. The river passes through a river valley and emerges at Roa Hook, just north of Peekskill Bay. The width of the river increases from about 1500 feet at Round Island to over 6000 feet in Peekskill Bay. The eastern section is shallow and occupies about half the river's width, and thus exhibits a great propensity for surface heating.

Measurements conducted in Peekskill Bay and Lents Cove are indicative of this phenomenon. Temperatures in excess of 80°F were recorded in Peekskill Bay (Figure 16.7) and temperatures in excess of 90°F were measured in Lents Cove (Figure 16.6), during the ebb measurement, subsequent to recording temperatures of about 77.7°F at Round Island.

III-4 These increases could, at first glance, be attributed to recirculation, however Unit 1 came on line at about noon while HWS was about 1100 therefore the influence of Unit 1 is minimal.

Again, as with the flood measurement, the above data demonstrates the difficulty in employing surface measurements to determine the excess temperature attributable to a heated effluent. Examination of the natural variations in the water column indicates that the 3 foot depth can be an acceptable basis for computing the impact of the heated effluent, for one can minimize the effect of surface variations and yet include the impact of the buoyant plume.

C. CONCLUSIONS

The uncertainty in obtaining a representative temperature and corresponding sampling locations for evaluating the excess temperature produced by the Indian Point thermal discharge has been demonstrated through thermal measurements outside the region of influence of any thermal discharges. Longitudinal, lateral, and temporal variation of a degree or more on the surface illustrate the uncertainity in attempting to quantify the surface intensity and extent of the thermal effluent. Short term temporal variations of over a degree have been observed. A consistent methodology is required to ascertain the estuarine temperature prior to the addition of heat from a thermal effluent in order to evaluate the magnitude of the resultant thermal plume.

It is concluded that the evaluation of the intensity and extent of a thermal plume should be based on measurements at the

3 foot depth. The upper three feet of the water column in the vicinity of Indian Point is less than 8% of the total water column, and is almost equal to the mean tidal range in this region.

The adoption of this procedure would allow a more uniform evaluation of the extent of the thermal discharge from the Indian Point facility.

TABLE 1

INDIAN POINT STATION ELECTRICAL GENERATION
DURING SURVEY

DATE	TIME	UNIT 1 MWe(gross)	UNIT 2 MWe(gross)
7/28/74	0400	OFF-LINE	OFF-LINE
	0800		
	1200		
	1600		
	2000		
	2400		
7/29/74	0400	OFF-LINE	OFF-LINE
	0800		
	1200		
	1600		
	2000		
	2400		
7/30/74	0100		OFF-LINE
	0200		
	0300		
	0400		
	0500		
	0600		
	0700		
	0800		
	0900		
	1000		
	1100		
	1200	110*	
	1300	145	
	1400	156	
	1500	125	
	1600	195	
	1700	199	
	1800	199	
	1900	200	
	2000	200	
	2100	200	
	2200	200	
	2300	200	
	2400	210	

* On line 1124

TABLE 2

LOVETT STATION ELECTRICAL GENERATION
DURING SURVEY

DATE	TIME	UNIT 4[1] MWe	UNIT 5[1] MWe
7/28/74	0400	47	80
	0800	49	80
	1200	89	139
	1600	130	121
	2000	140	139
	2400	97	108
7/29/74	0200	65	100
	0400	48	80
	0600	48	80
	0800	62	86
	1000	135	126
	1200	165	197
	1400	165	197
	1600	165	195
	1800	152	180
	2000	150	158
	2200	155	160
	2400	149	145
7/30/74	0200	73	85
	0400	50	85
	0500	50	85
	0600	62	85
	0700	62	85
	0800	78	100
	0900	125	156
	1000	125	155
	1100	138	156
	1200	132	177
	1300	165	197
	1400	165	196
	1500	161	197
	1600	145	200
	1700	162	202
	1800	155	202
	1900	140	202
	2000	155	175
	2100	150	165
	2200	130	105
	2300	127	103
	2400	128	85

(1) Units 4 and 5 have rated capacities of 185 and 205 MWe, respectively. Their condenser cooling water flow rates are 104,300 and 120,000 gpm for Units 4 and 5, respectively.

TABLE 3

BOWLINE POINT STATION ELECTRICAL GENERATION
DURING SURVEY

DATE	TIME	UNIT 1[1] MWe	UNIT 2[1] MWe
7/28/74	0400	298	278
	0800	299	275
	1200	298	280
	1600	297	273
	2000	298	277
	2400	300	274
7/29/74	0400	297	272
	0800	444	279
	1200	555	584
	1600	554	582
	2000	567	551
	2400	329	287
7/30/74	0200	295	287
	0400	290	285
	0500	290	285
	0600	293	285
	0700	332	283
	0800	516	283
	0900	576	288
	1000	584	299
	1100	583	297
	1200	581	297
	1300	580	297
	1400	581	298
	1500	579	303
	1600	580	306
	1700	580	304
	1800	580	343
	1900	576	498
	2000	576	571
	2100	575	578
	2200	579	582
	2300	556	556
	2400	338	383

(1) Units 1 and 2 each have a rated capacity of 624 MWe(gross). The condenser cooling water flow during the day of the survey was 257,000 gpm for each unit.

TABLE 4

RIVER GAUGE FLOW OVER TROY LOCK
(INCLUDING POWER HOUSE)

DATE	FLOW (cfs)	DATE	FLOW (cfs)
June 1	11,200	July 1	8,070
2	10,500	2	4,430
3	9,580	3	30,280
4	9,710	4	51,330
5	9,710	5	29,380
6	9,660	6	30,280
7	8,850	7	20,480
8	8,270	8	14,370
9	6,050	9	13,090
10	5,240	10	9,280
11	6,560	11	7,880
12	7,450	12	6,740
13	7,520	13	7,580
14	7,480	14	7,370
15	6,750	15	5,780
16	6,470	16	7,510
17	7,280	17	7,840
18	10,200	18	7,200
19	12,300	19	7,400
20	8,560	20	5,860
21	8,300	21	6,530
22	10,200	22	6,700
23	10,100	23	5,140
24	6,950	24	6,020
25	9,080	25	6,020
26	9,490	26	5,690
27	10,090	27	6,210
28	9,900	28	4,860
29	7,970	29	6,340
30	7,680	30	13,200
		31	11,800

TABLE 5

INDIAN POINT INTAKE TEMPERATURES

	UNIT 1[1]			UNIT 2[1]		
Tidal Phase	Time	Surface Temperature °C (°F)	Average Temperature °C (°F)	Time	Surface Temperature °C (°F)	Average Temperature °C (°F)
Early Flood				0815	24.8 (76.6)	24.8 (76.6)
HWS				1040	25.2 (77.3)	25.0 (77.0)
HWS	1130	25.3 (77.6)	25.9 (76.9)			
Ebb				1355	25.7 (78.2)	25.4 (77.6)
Ebb	1450	25.5 (77.9)	25.3 (77.6)			
LWS				1810	25.3 (77.5)	24.9 (76.8)
Late Flood	1830	25.3 (77.5)	25.0 (77.0)			

(1) Temperatures measured in front of northernmost and southernmost intake bays of each Unit.

TABLE 6

SCAN TEMPERATURES: FIRST FLOOD

Time	Location and Direction	Average Temperature at Depth (°F) Surface	3 ft.	6 ft.
0807	Croton Point E to W	76.71 (±0.18)	76.80 (±0.21)	76.54 (±0.26)
0830	Croton-Bowline S to N	77.01 (±0.06)	77.07 (±0.20)	76.75 (±0.18)
0916	Haverstraw E to W	77.03 (±0.12)	77.07 (±0.20)	76.74 (±0.21)
0940	Haverstraw-Verplanck S to N	77.29 (±0.09)	77.25 (±0.12)	76.83 (±0.18)
0956	Verplanck E to W	77.47 (±0.19)	77.29 (±0.14)	76.74 (±0.22)

TABLE 7

SCAN TEMPERATURES: HWS

Time	Location and Direction	Average Temperature at Depth (°F) Surface	3 ft.	6 ft.	9 ft.	12 ft.	15 ft.
1104	Croton Point E to W	78.25 (±0.44)	77.33 (±0.28)	76.48 (±0.30)			
1115	Croton Point W to E				77.07 (±0.53)	76.94 (±0.33)	76.28 (±0.28)
1149	Haverstraw E to W	79.22 (±0.51)	78.49 (±0.52)	77.31 (±0.39)			
1159	Haverstraw W to E				77.81 (±0.26)	77.80 (±0.23)	76.90 (±0.33)
1229	Verplanck E to W	79.43 (±0.96)	78.36 (±0.69)	76.96 (±0.23)			

TABLE 8

SCAN TEMPERATURES: EBB

Time	Location and Direction	Average Temperature at Depth (°F) Surface	3 ft.	6 ft.
1358	Bear Mountain Bridge E to W	77.56 (±0.42)	77.09 (±0.41)	76.74 (±0.30)
1417	Bear Mountain Bridge-Fort Montgomery S to N	77.76 (±0.32)	76.99 (±0.39)	76.64 (±0.24)
1429	Bear Mountain Bridge-Iona Island N to S	77.74 (±0.34)	76.93 (±0.41)	76.64 (±0.36)
1439	Round Island E to W	77.75 (±0.29)	76.98 (±0.23)	76.83 (±0.19)

TABLE 9

SCAN TEMPERATURES: LWS

Time	Location and Direction	Average Temperature at Depth (°F) Surface	3 ft.	6 ft.	9 ft.	12 ft.	15 ft.
1703	Bear Mountain Bridge E to W	76.57 (±0.10)	76.04 (±0.14)	76.19 (±0.25)			
1707	Bear Mountain Bridge W to E				76.11 (±0.06)	75.80 (±.11)	76.14 (±.17)
1724	Bear Mountain Bridge - Iona Island N to S	76.26 (±0.11)	76.02 (±0.12)	76.20 (±0.24)			
1734	Round Island W to E	76.55 (±0.09)	76.35 (±0.13)	76.53 (±0.19)			
1738	Round Island E to W				76.46 (±0.08)	76.27 (±0.10)	76.50 (±0.20)
1754	Round Island-Fish Island N to S	76.65 (±0.07)	76.36 (±0.11)	76.46 (±0.17)			

TABLE 10

SCAN TEMPERATURES: SECOND FLOOD

Time	Location and Direction	Average Temperature at Depth (°F) Surface	3 ft.	6 ft.
1920	Croton Point E to W	78.94 (±0.56)	78.56 (±0.57)	78.33 (±0.51)
1940	Bowline-Haverstraw S to N	78.46 (±1.25)	78.28 (±0.24)	78.28 (±1.02)
1957	Haverstraw W to E	77.29 (±0.21)	77.09 (±0.31)	77.46 (±0.27)
2011	Haverstraw-Verplanck S to N	76.95 (±0.12)	76.89 (±0.38)	77.21 (±0.18)
2024	Verplanck E to W	77.13 (±0.36)	77.10 (±0.45)	77.34 (±0.32)

TABLE 11

COMPARISON BETWEEN INDIAN POINT INTAKE SURFACE TEMPERATURE AND SCAN SURFACE TEMPERATURE BETWEEN CROTON AND BEAR MOUNTAIN

Tidal Phase	Time	Croton	Haverstraw	Verplanck	Indian Point	Round Island	Bear Mountain
Flood	0807	76.71	-	-	-	-	-
Flood	0815	-	-	-	76.6	-	-
Flood	0916	-	77.03	-	-	-	-
Flood	1040	-	-	77.42	77.3	-	-
	(1100)						
Ebb	1104	78.25	-	-	-	-	-
Ebb	1130	-	-	-	77.6	-	-
Ebb	1149	-	77.22	-	-	-	-
Ebb	1229	-	-	79.43	-	-	-
Ebb	1355	-	-	-	78.2	-	-
Ebb	1358	-	-	-	-	-	77.56
Ebb	1439	-	-	-	-	77.75	-
Ebb	1450	-	-	-	77.9	-	-
Ebb	1703	-	-	-	-	-	76.57
Ebb	1734	-	-	-	-	76.55	-
	(1746)						
Flood	1810	-	-	-	77.5	-	-
Flood	1830	-	-	-	77.5	-	-
Flood	1920	78.94	-	-	-	-	-
Flood	1957	-	77.29	-	-	-	-
Flood	2038	-	-	77.13	-	-	-

TABLE 12

COMPARISON BETWEEN SCAN AND PROFILE TEMPERATURES

Tidal Phase	Location	Surface Temperature (°F) Scan	Surface Temperature (°F) Profile	Upper Layer Temp. (°F) Scan[1]	Upper Layer Temp. (°F) Profile	Area Average Temp. (°F) Scan[2]	Area Average Temp. (°F) Profile
First Flood	Croton	76.71	76.3	76.69	76.2[3]	NA	75.8
	Haverstraw	77.03	76.4	76.95	76.5[1]	NA	76.4
HWS	Croton	78.25	77.0[4]	77.35	76.5[3,4]	77.06	75.4
	Haverstraw	79.22	78.1	78.34	77.5[3]	77.92	76.6
Ebb	Bear Mountain Bridge	77.56	77.3	77.13	76.8[5]	NA	76.5
	Round Island	77.75	77.0	77.22	76.7[5]	NA	76.4
LWS	Bear Mountain Bridge	76.57	76.1	76.27	76.0[5]	76.14	76.0
	Round Island	76.55	76.4	76.48	76.3[5]	76.44	76.2

(1) Average of approximately upper 6 feet.
(2) Average of approximately upper 15 feet.
(3) Average of approximately upper 10 feet.
(4) One station on transect.
(5) Average of approximately upper 20 feet.

TABLE 13

METEOROLOGICAL DATA - JULY 30, 1974

Hour Ending at	Ambient[1] Temp. (°F)	Dew[1] Point (°F)	Wind[1] Speed (MPH)	Wind[2] Speed (MPH)	Net Radiation (cal/cm²/min)
0100	66.0	64.5	2.5	9.0	-0.50
0200	65.0	65.0	1.0	3.0	-0.30
0300	65.0	64.5	2.0	5.5	-0.24
0400	66.0	64.5	1.0	2.0	-0.15
0500	66.0	64.5	0.5	1.0	-0.04
0600	67.0	66.0	1.5	2.0	+0.06
0700	67.0	66.0	1.5	1.5	+0.07
0800	68.5	66.5	3.0	2.0	+0.39
0900	71.0	66.5	2.5	2.0	+0.59
1000	73.5	65.5	2.5	3.0	+1.19
1100	74.5	66.0	2.5	2.0	+1.45
1200	76.0	66.5	2.5	3.5	+1.34
1300	78.5	64.5	3.0	3.5	+1.67
1400	80.5	62.0	3.5	5.0	+1.74
1500	81.0	60.0	5.0	7.0	+1.41
1600	81.0	60.0	3.0	7.0	+0.70
1700	80.0	62.5	3.5	8.5	+0.52
1800	79.0	65.0	2.5	8.0	+0.24
1900	77.0	65.0	1.5	12.0	-0.04
2000	75.5	65.0	1.0	9.0	-0.07
2100	74.5	64.0	1.0	8.5	-0.11
2200	74.0	63.0	2.0	13.0	-0.13
2300	74.0	62.0	3.0	15.5	-0.11
2400	73.0	61.5	2.5	15.0	-0.09

Source: 400 ft. Indian Point Meteorological Tower
(1) 33 foot elevation on Meteorological Tower
(2) 400 foot elevation on Meteorological Tower.

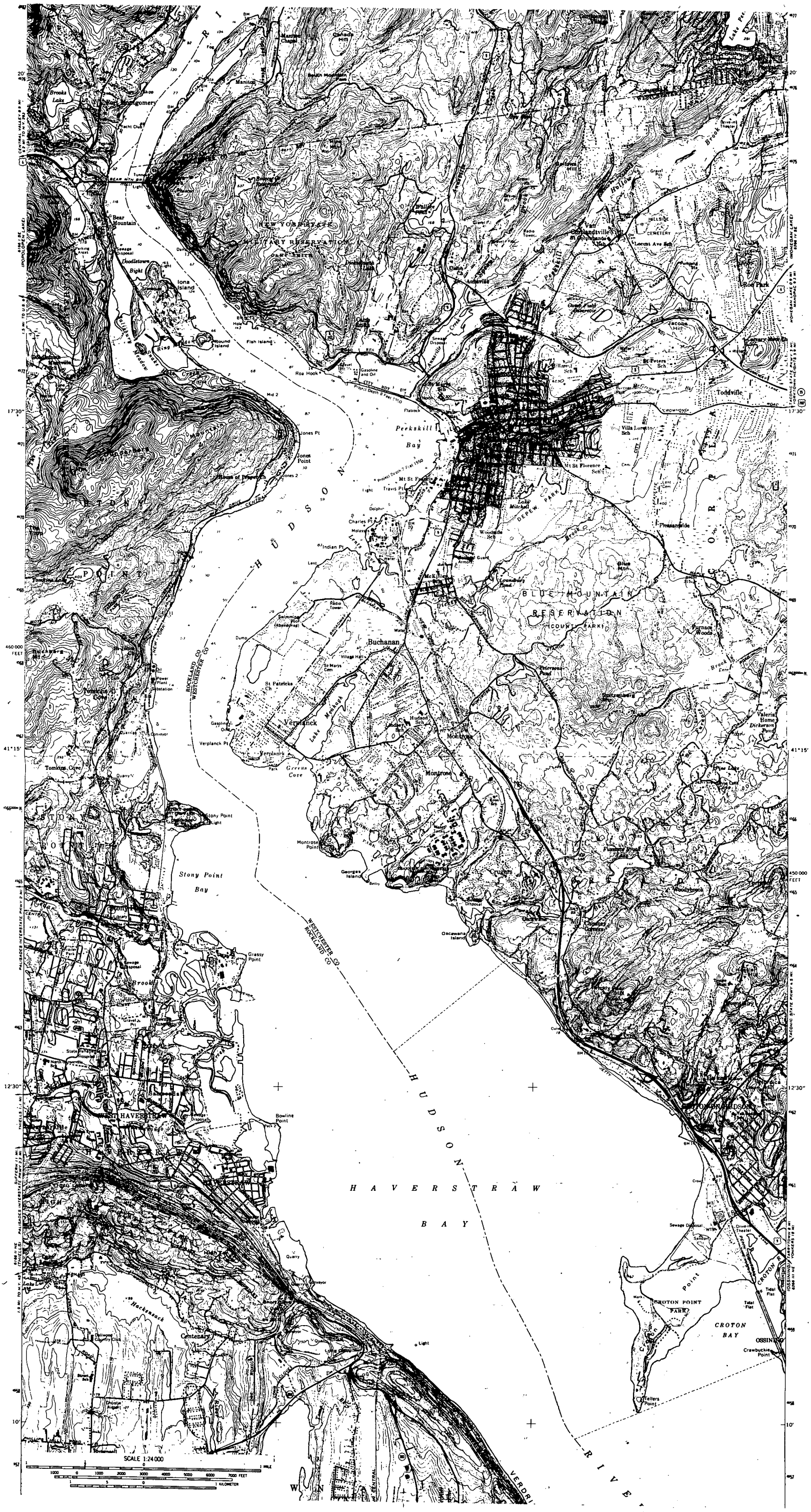
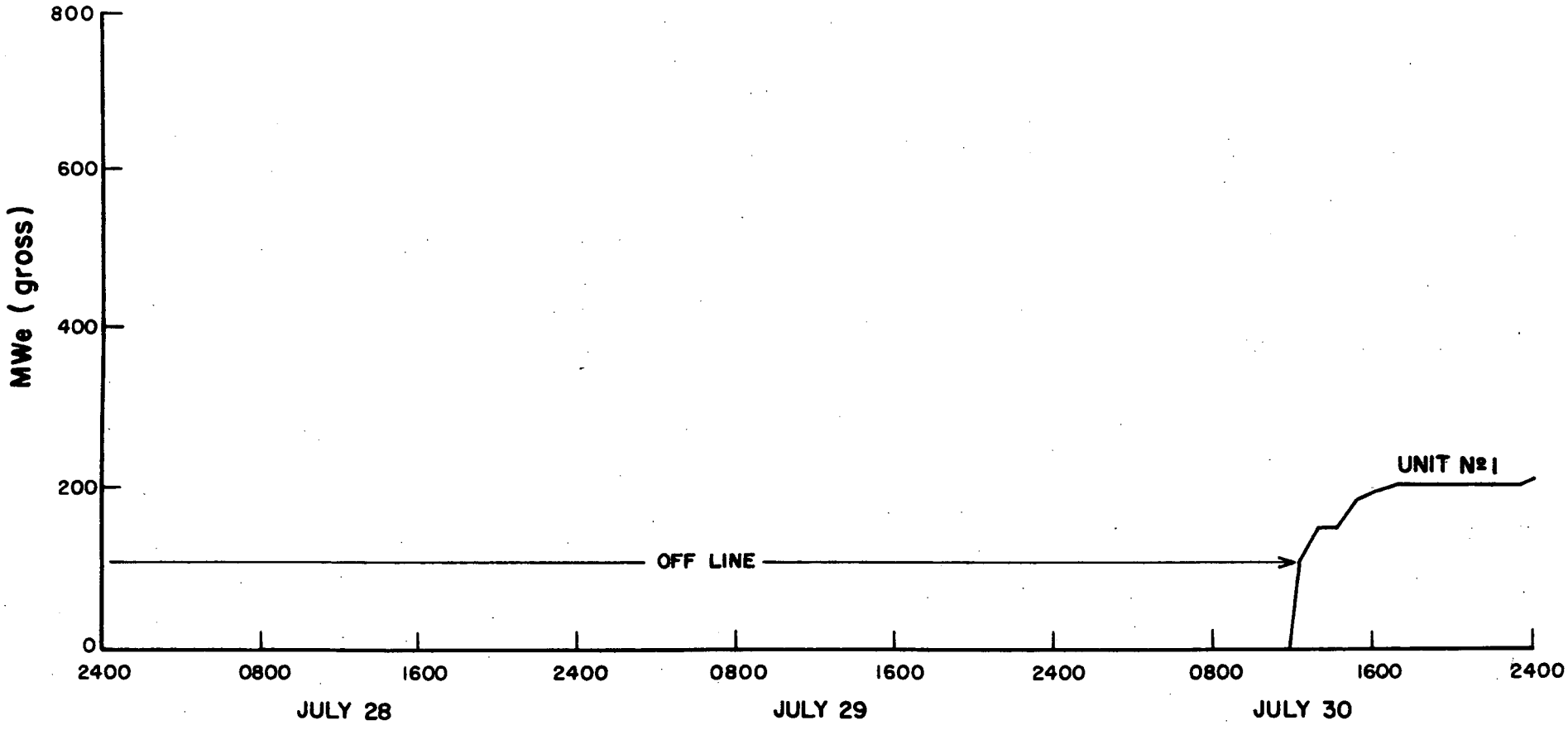


FIGURE 1.1

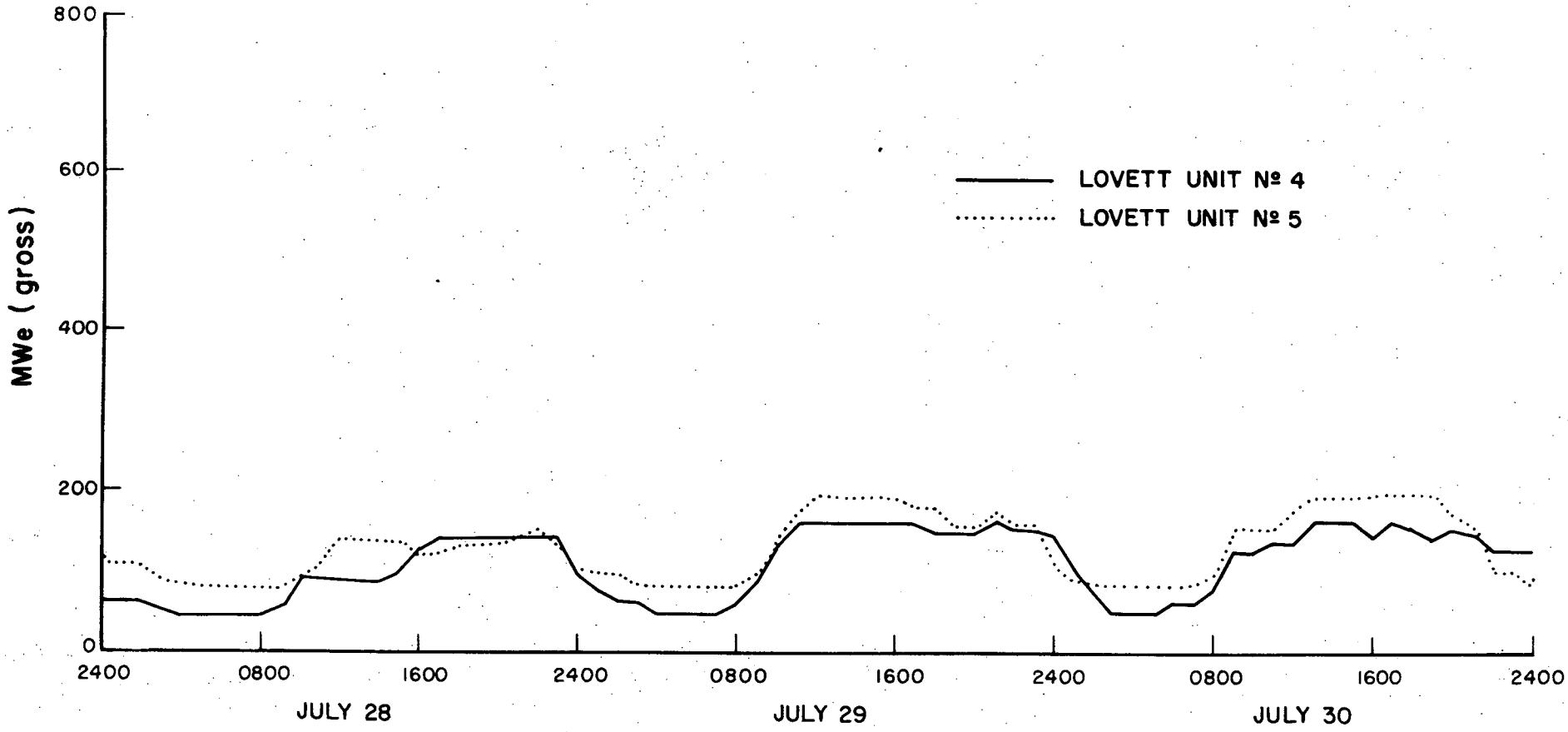
HUDSON RIVER IN VICINITY OF INDIAN POINT



INDIAN POINT STATION ELECTRICAL GENERATION:

JULY 28, JULY 29 AND JULY 30

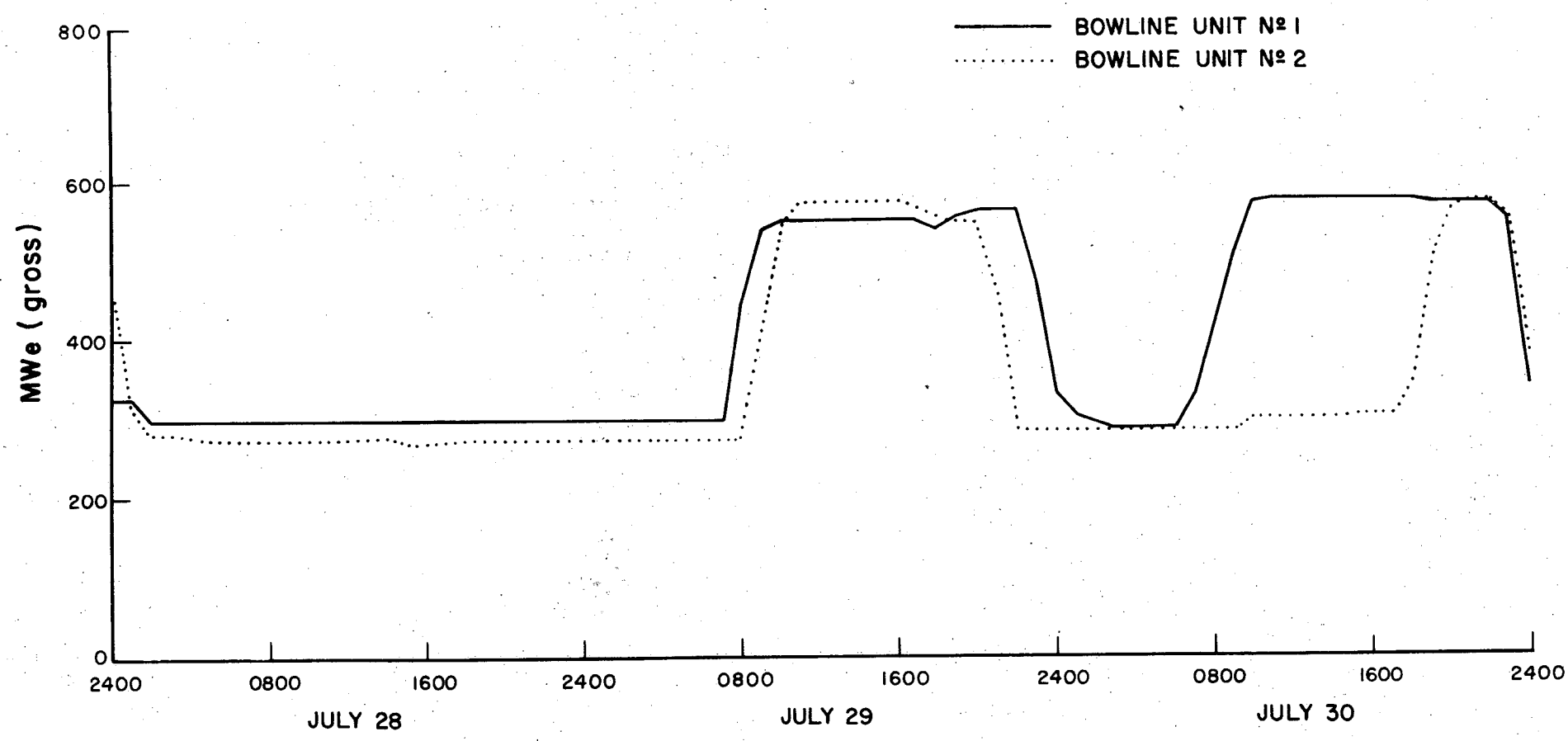
FIGURE 2.1



LOVETT ELECTRICAL GENERATION:

JULY 28, JULY 29 AND JULY 30

FIGURE 2.2



BOWLINE POINT ELECTRICAL GENERATION:

JULY 28, JULY 29 AND JULY 30

FIGURE 2.3

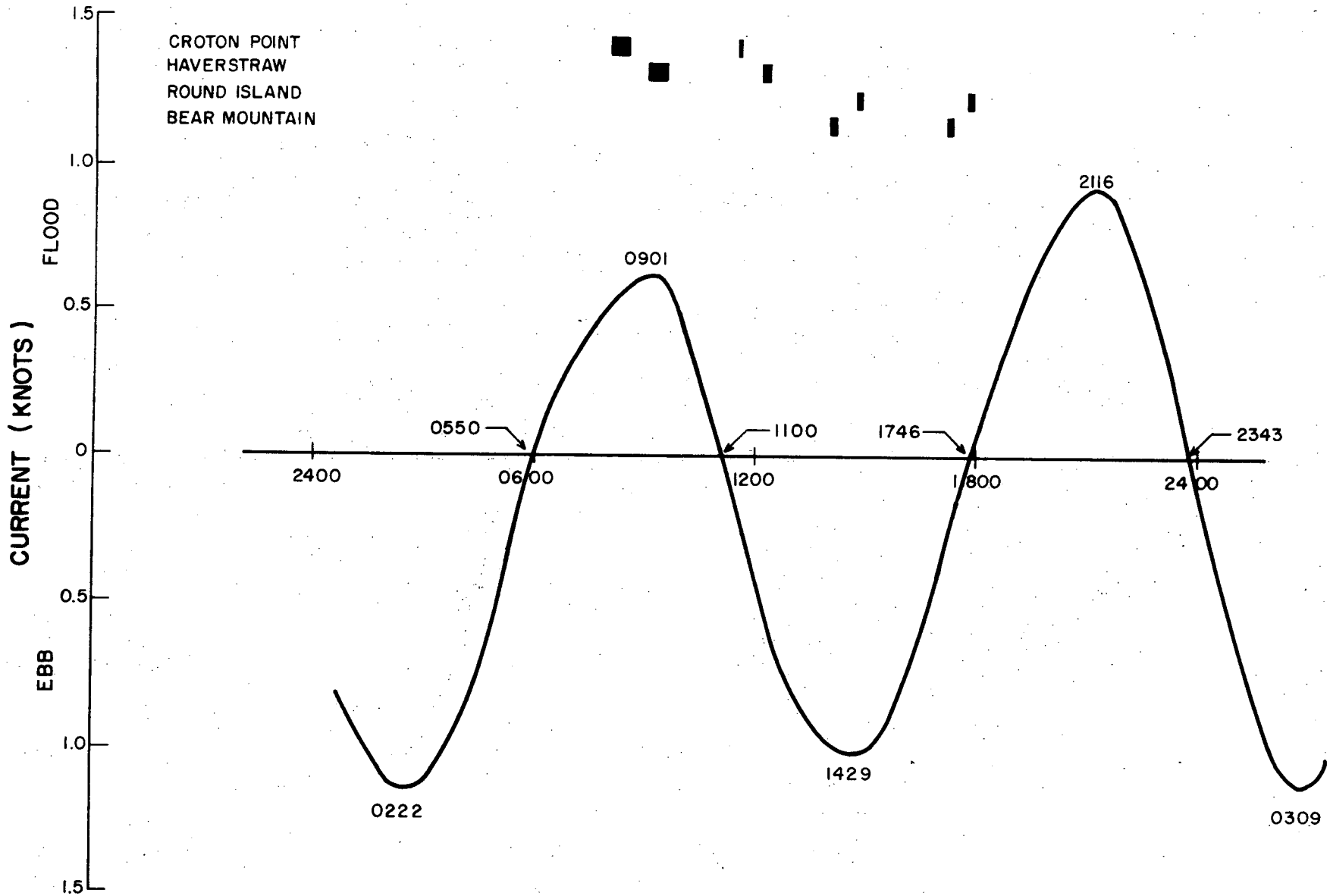
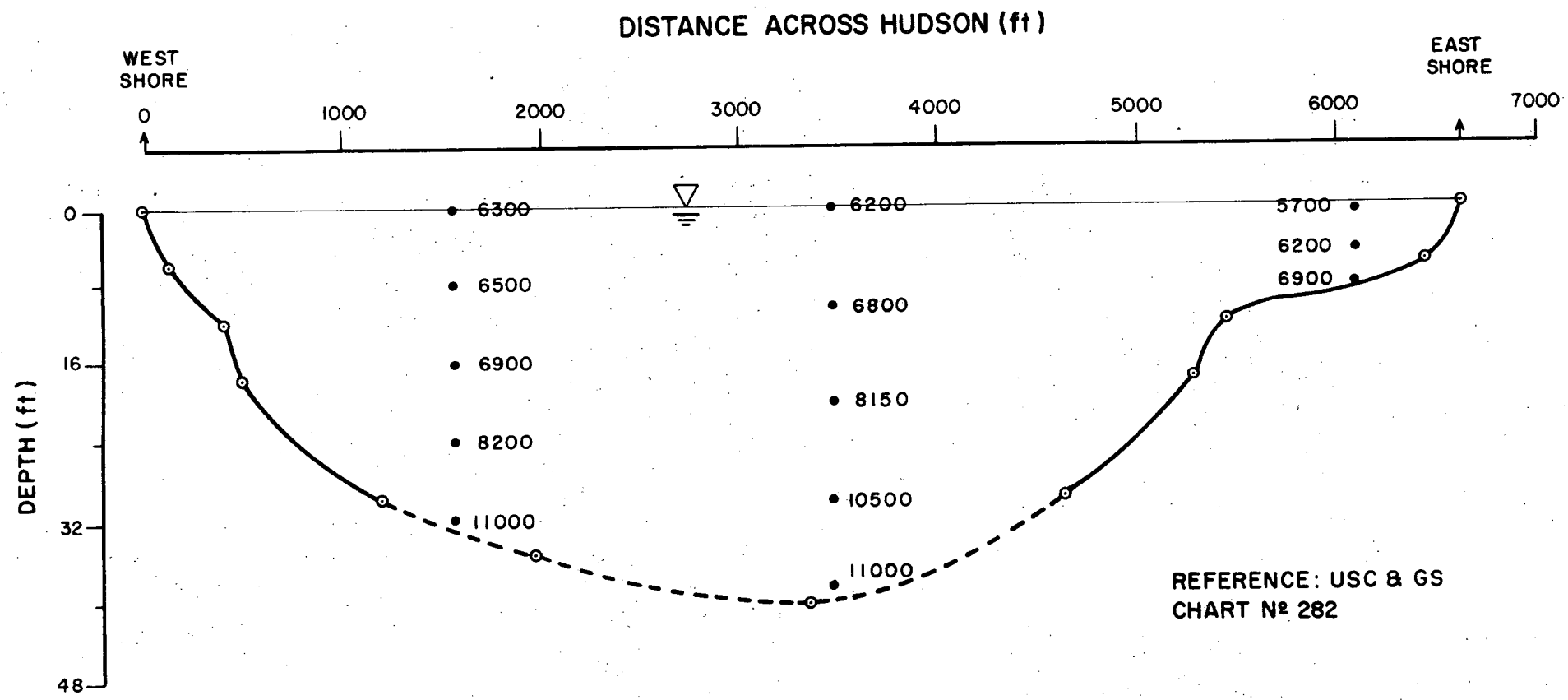


FIGURE 3.1

TIDAL CURRENT: JULY 30, 1974

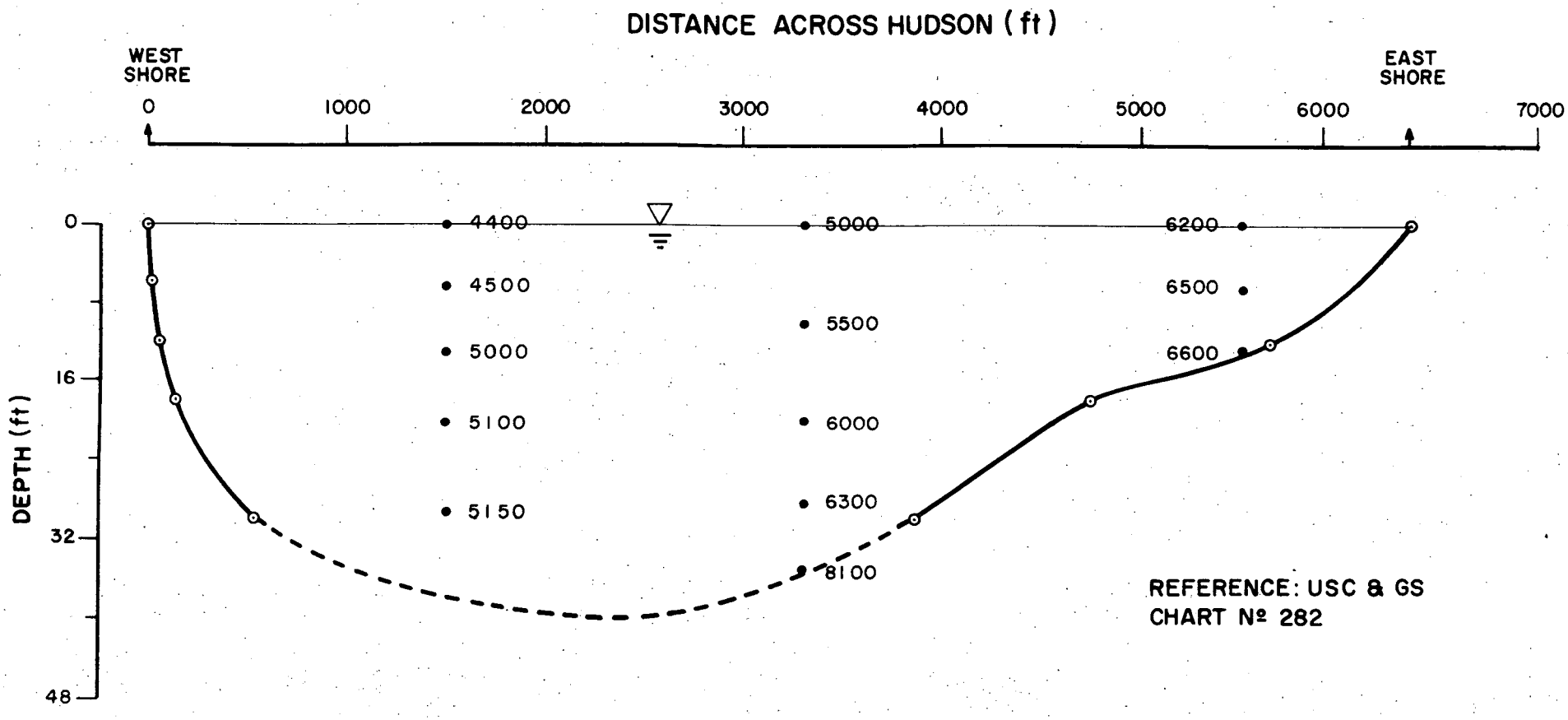
TIDAL CURRENT – TIME SEQUENCE OF CONDUCTIVITY MEASUREMENTS



TRANSECT: CROTON POINT
DATE: JULY 30, 1974
TIME: 0801 – 0826
TIDAL STAGE: FIRST FLOOD
CONDUCTIVITY (μmho)

CONDUCTIVITY PROFILE MEASUREMENTS AT CROTON POINT: FIRST FLOOD

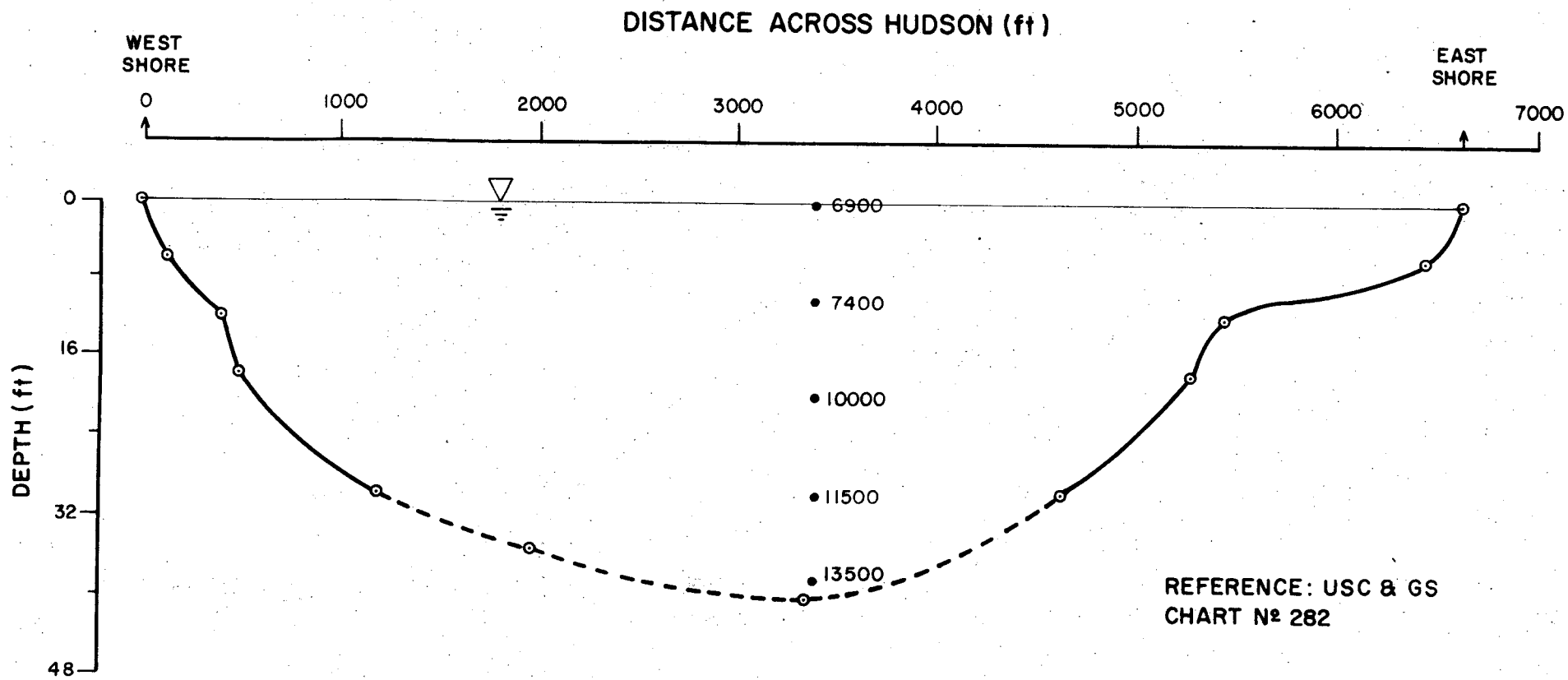
FIGURE 4.1



TRANSECT: HAVERSTRAW
DATE: JULY 30, 1974
TIME: 0904 – 0934
TIDAL STAGE: FIRST FLOOD
CONDUCTIVITY (μmho)

CONDUCTIVITY PROFILE MEASUREMENTS AT HAVERSTRAW: FIRST FLOOD

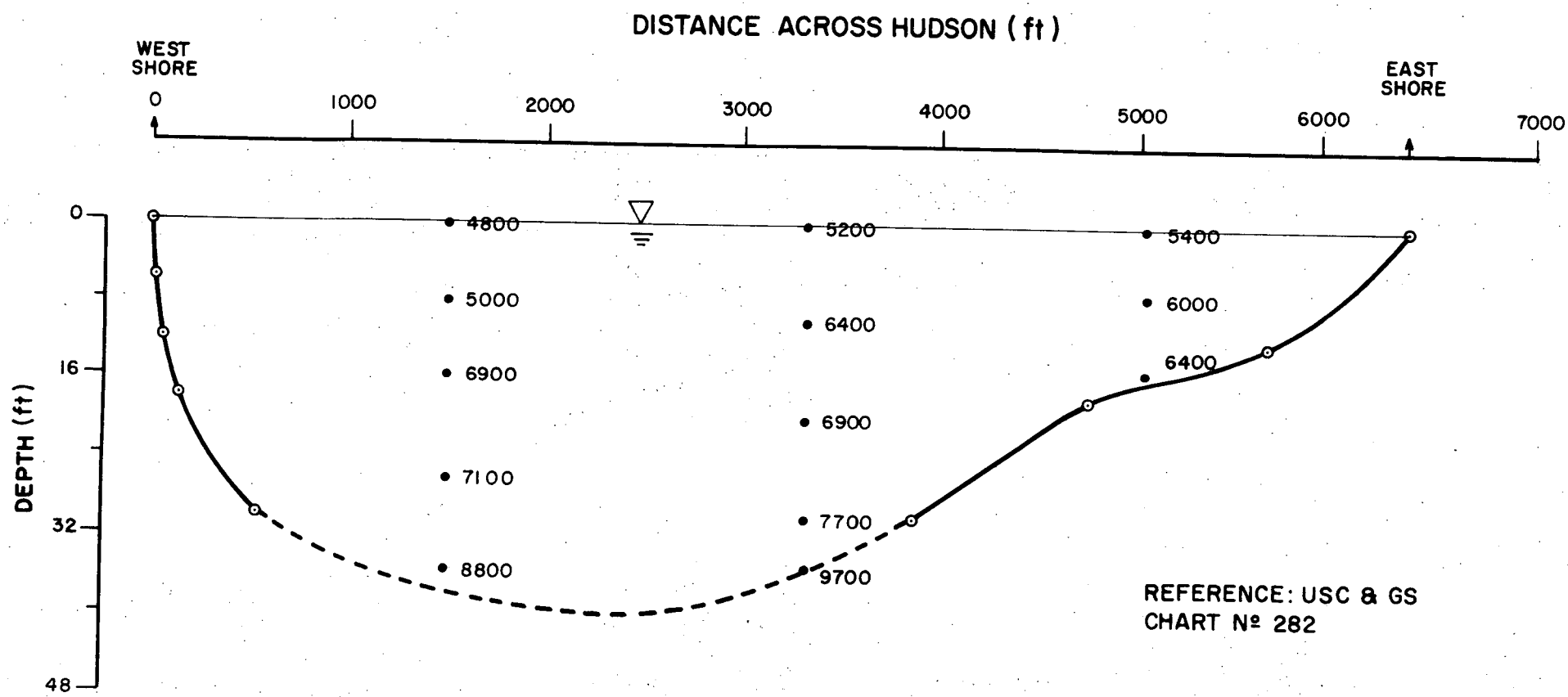
FIGURE 4.2



TRANSECT: CROTON POINT
DATE: JULY 30, 1974
TIME: 1130
TIDAL STAGE: HIGH WATER SLACK
CONDUCTIVITY (μmho)

FIGURE 5.1

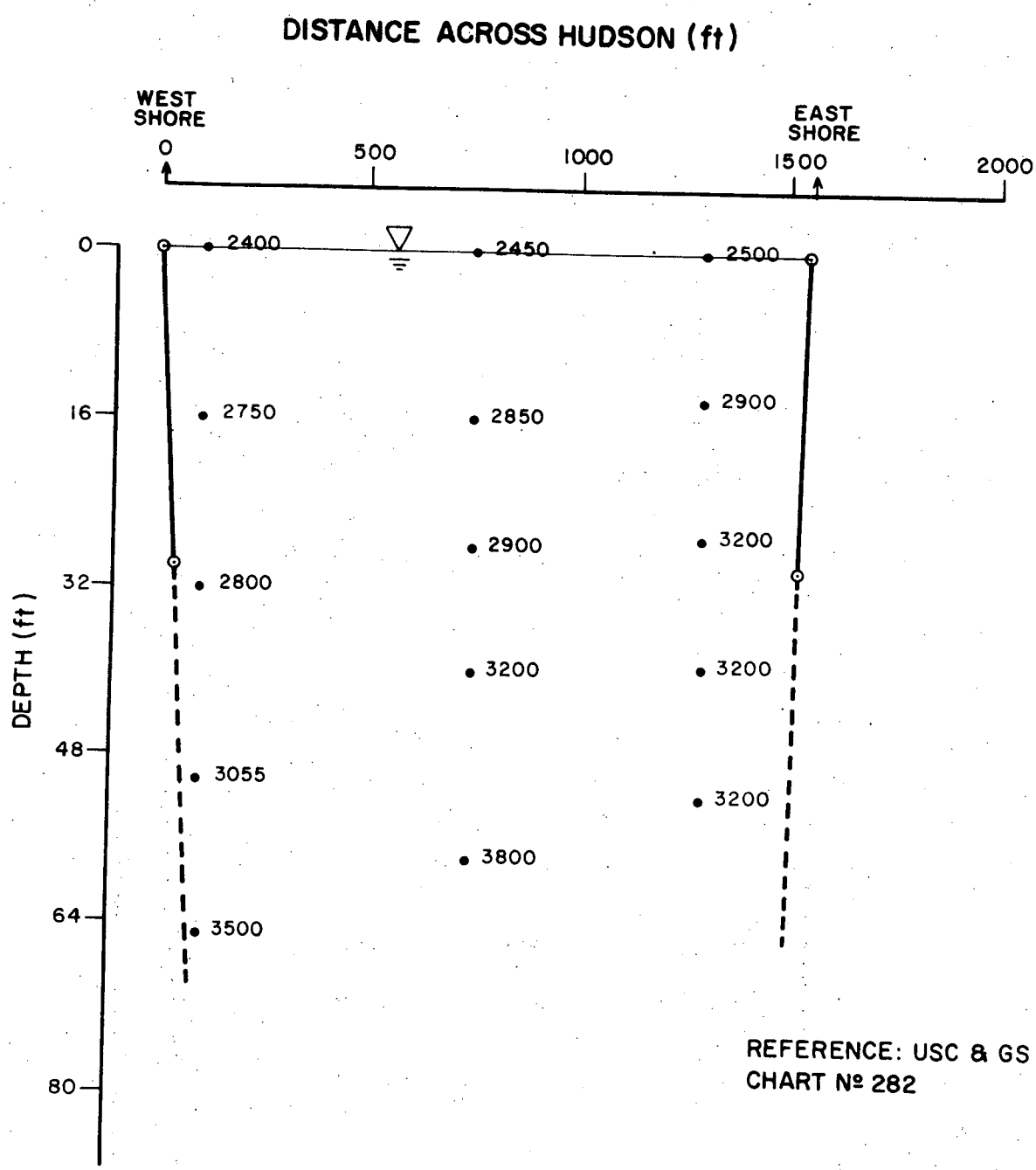
CONDUCTIVITY PROFILE MEASUREMENTS AT CROTON POINT: HIGH WATER SLACK



TRANSECT: HAVERSTRAW
DATE: JULY 30, 1974
TIME: 1211 – 1219
TIDAL STAGE: HIGH WATER SLACK
CONDUCTIVITY (μmho)

CONDUCTIVITY PROFILE MEASUREMENTS AT HAVERSTRAW: HIGH WATER SLACK

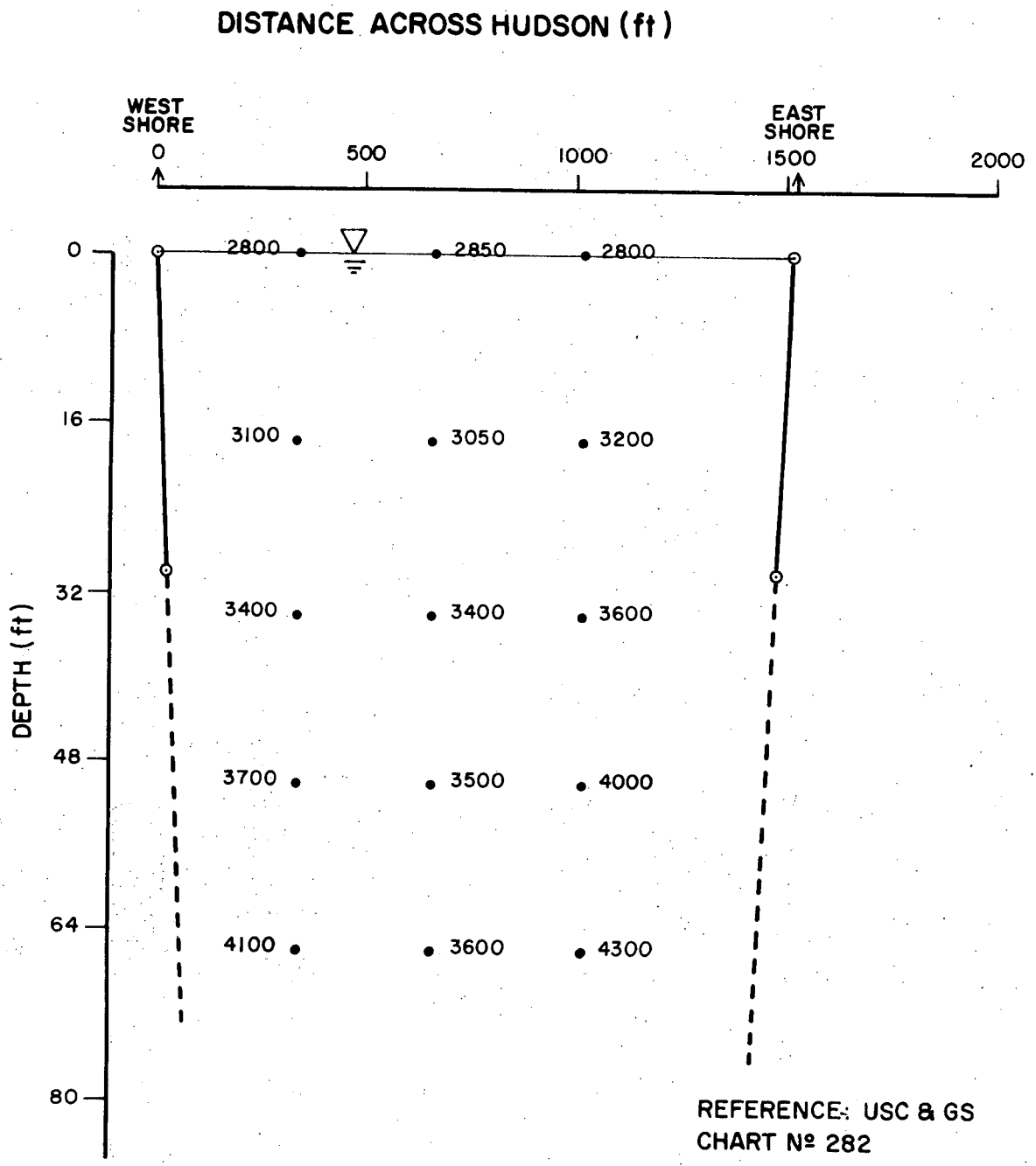
FIGURE 5.2



TRANSECT: BEAR MOUNTAIN BRIDGE
DATE: JULY 30, 1974
TIME: 1400-1410
TIDAL STAGE: EBB
CONDUCTIVITY (μmho)

CONDUCTIVITY PROFILE MEASUREMENTS
AT BEAR MOUNTAIN BRIDGE: EBB

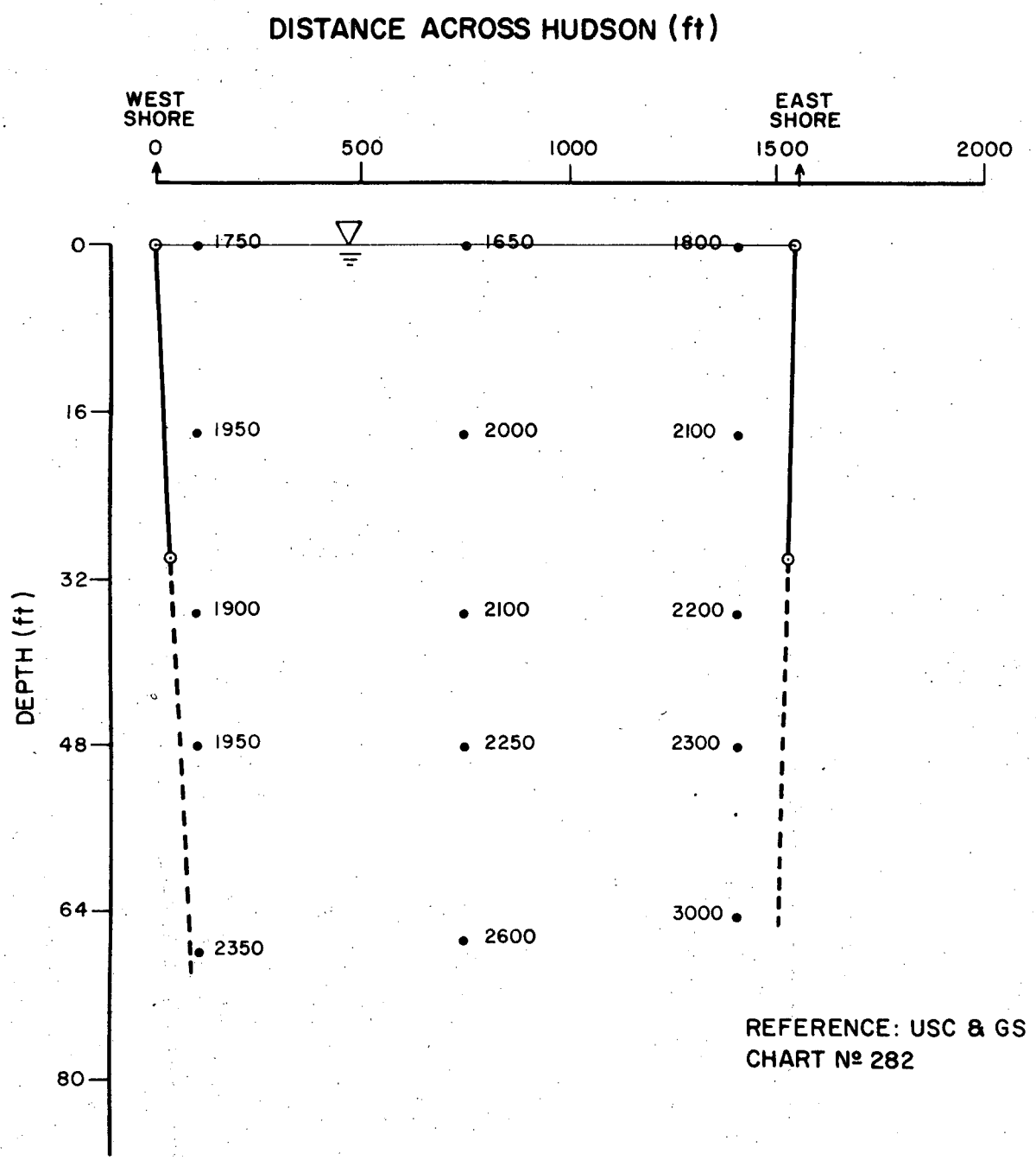
FIGURE 6.1



TRANSECT: ROUND ISLAND TO HOLE
DATE: JULY 30, 1974
TIME: 1440-1452
TIDAL STAGE: EBB
CONDUCTIVITY (μmho)

CONDUCTIVITY PROFILE MEASUREMENTS
AT ROUND ISLAND: EBB

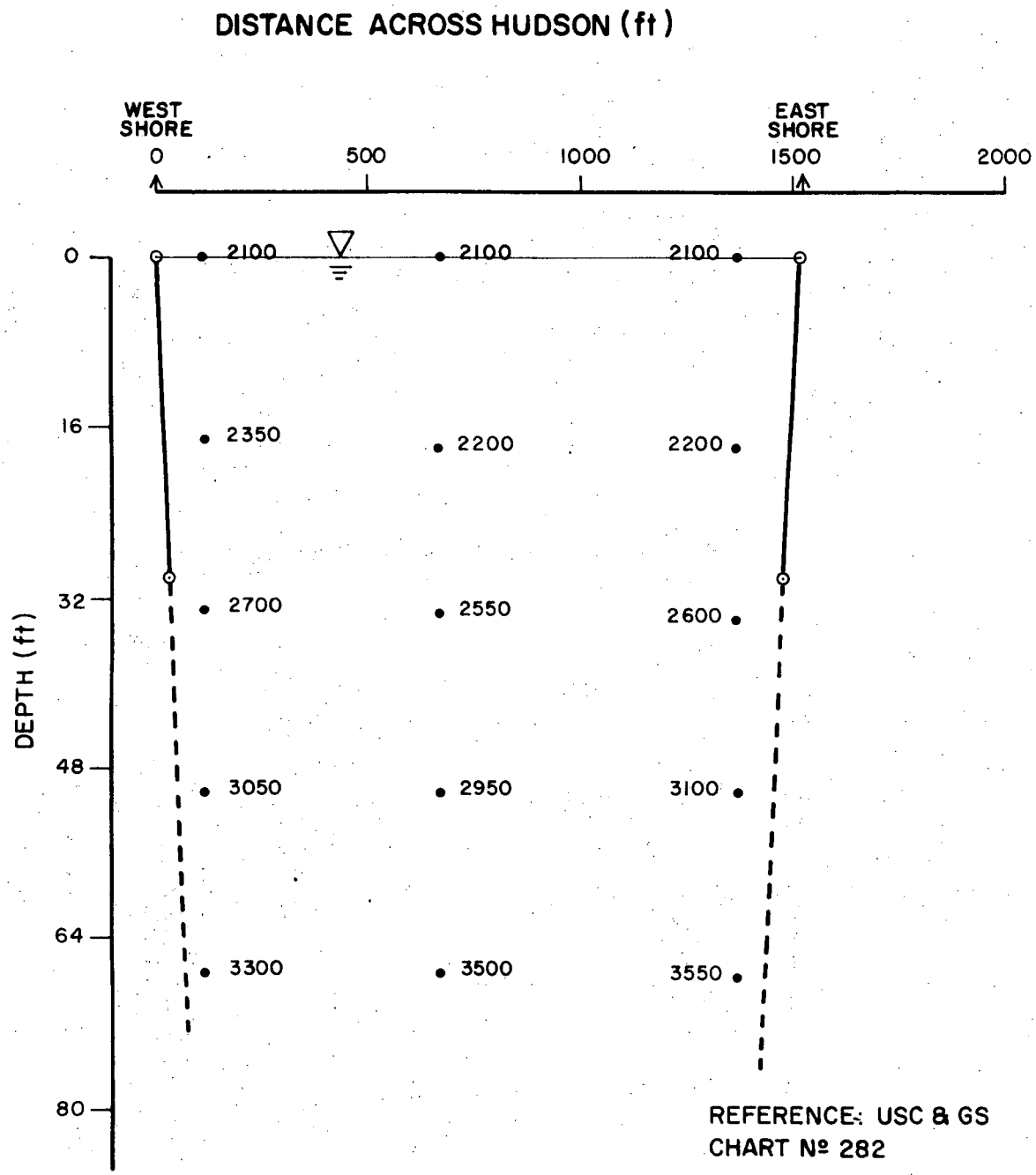
FIGURE 6.2



TRANSECT: BEAR MOUNTAIN BRIDGE
DATE: JULY 30, 1974
TIME: 1712 - 1720
TIDAL STAGE: LOW WATER SLACK
CONDUCTIVITY (μmho)

CONDUCTIVITY PROFILE MEASUREMENTS
AT BEAR MOUNTAIN BRIDGE: LWS

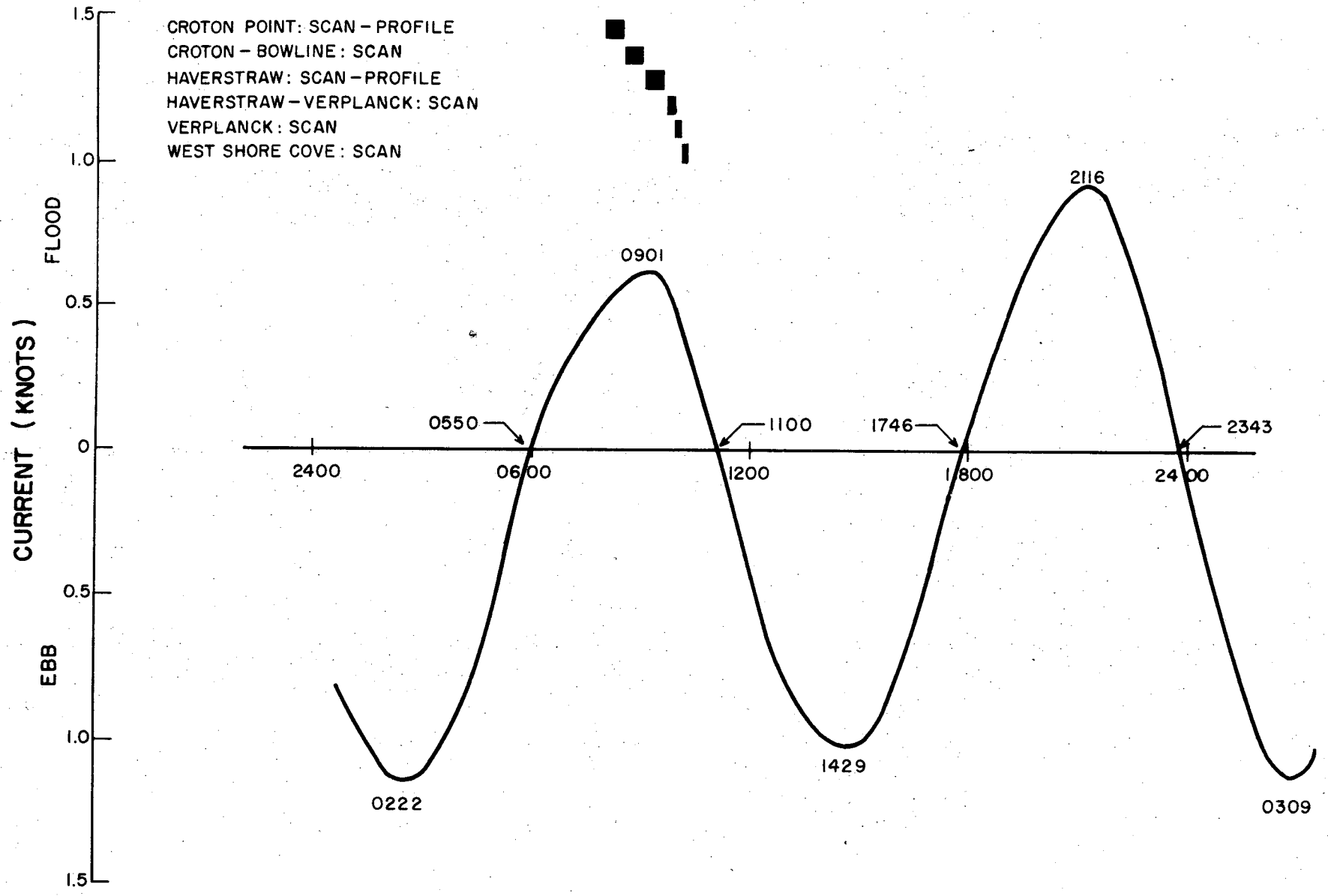
FIGURE 7.1



TRANSECT: ROUND ISLAND TO HOLE
DATE: JULY 30, 1974
TIME: 1744 - 1752
TIDAL STAGE: LOW WATER SLACK
CONDUCTIVITY (μmho)

CONDUCTIVITY PROFILE MEASUREMENTS AT ROUND ISLAND: LWS

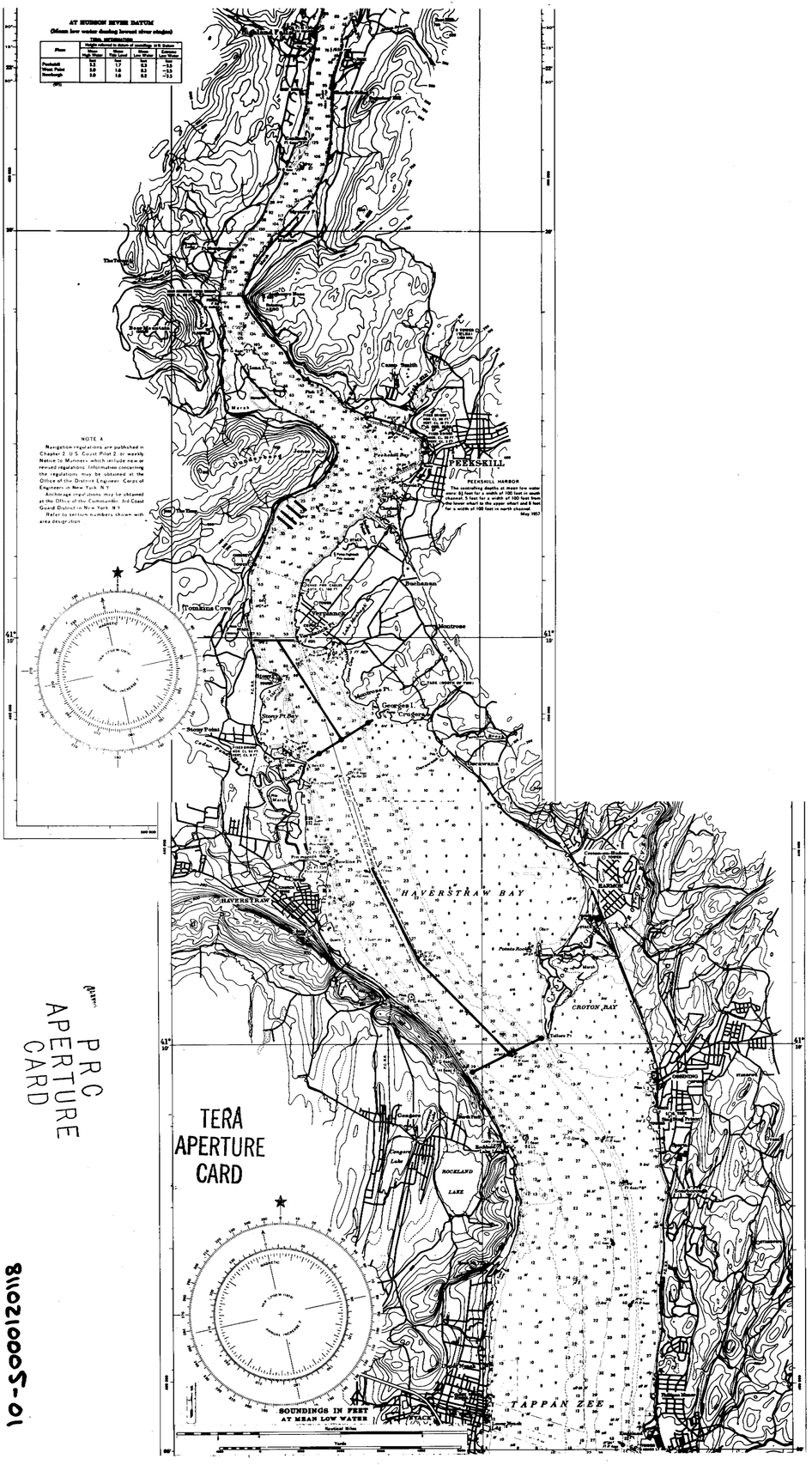
FIGURE 7.2



TIDAL CURRENT: JULY 30, 1974

TIDAL CURRENT – TIME SEQUENCE OF TEMPERATURE MEASUREMENTS: FIRST FLOOD

FIGURE 8.1



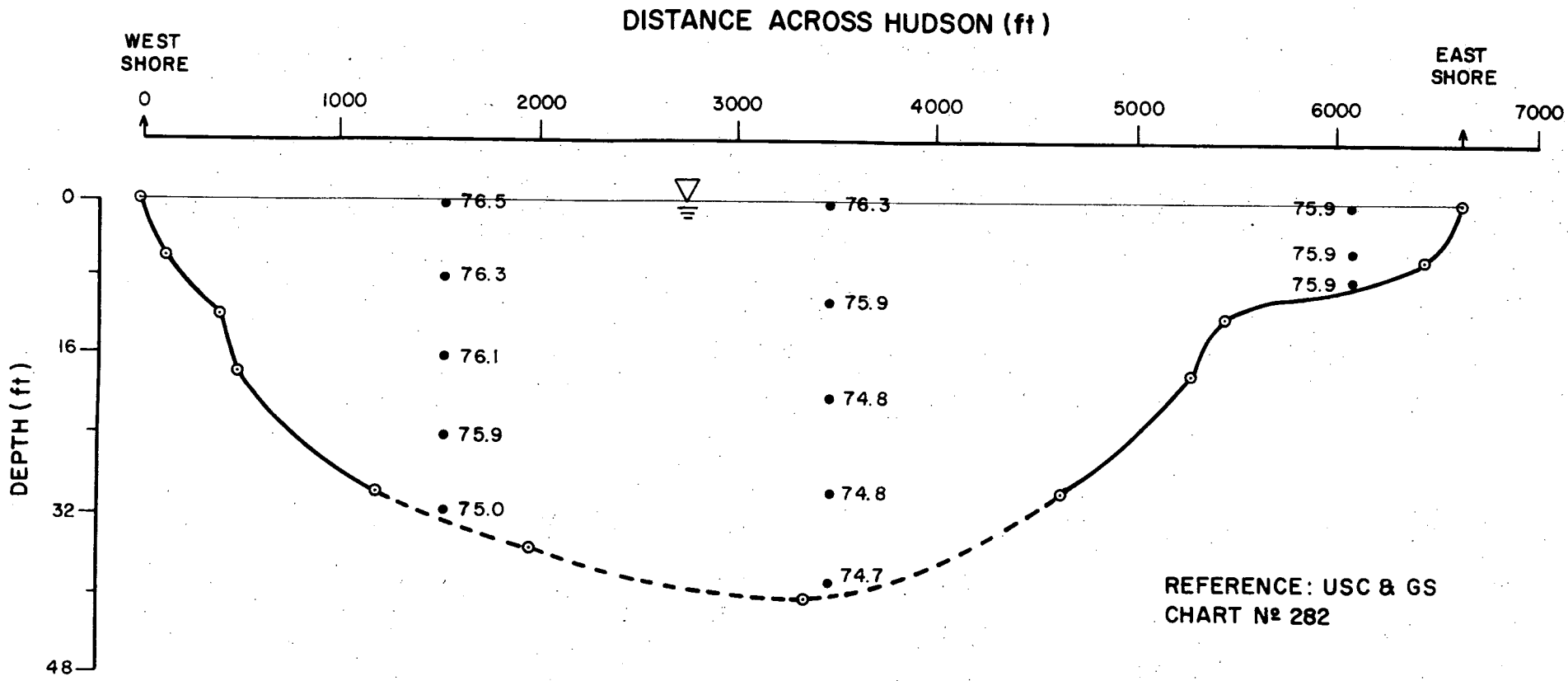
PRC APERTURE CARD

TERA APERTURE CARD

10-S0001201118

FIGURE 8.2

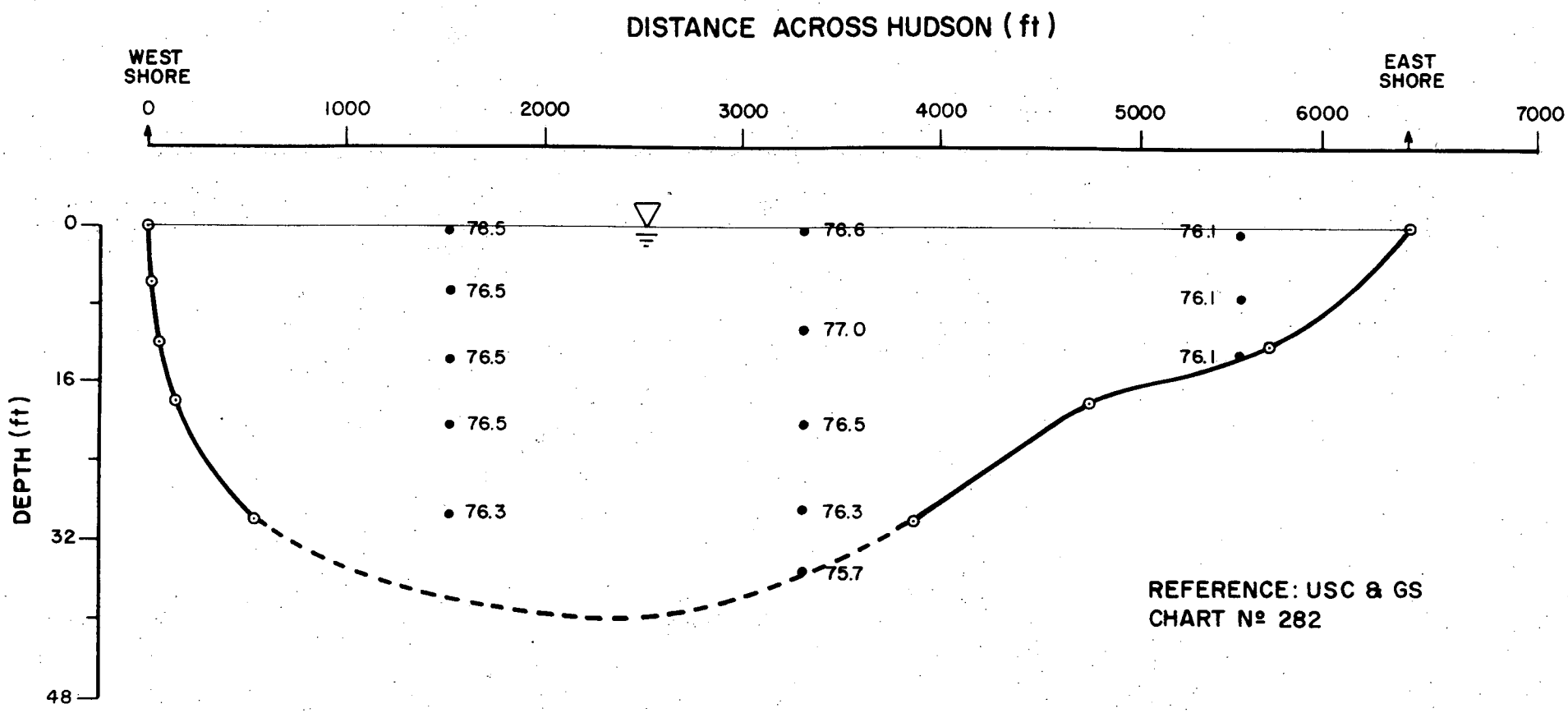
LOCATION OF TEMPERATURE MEASUREMENTS: FIRST FLOOD



TRANSECT: CROTON POINT
DATE: JULY 30, 1974
TIME: 0801 – 0826
TIDAL STAGE: FIRST FLOOD
TEMPERATURE (°F)

TEMPERATURE PROFILE AT CROTON POINT: FIRST FLOOD

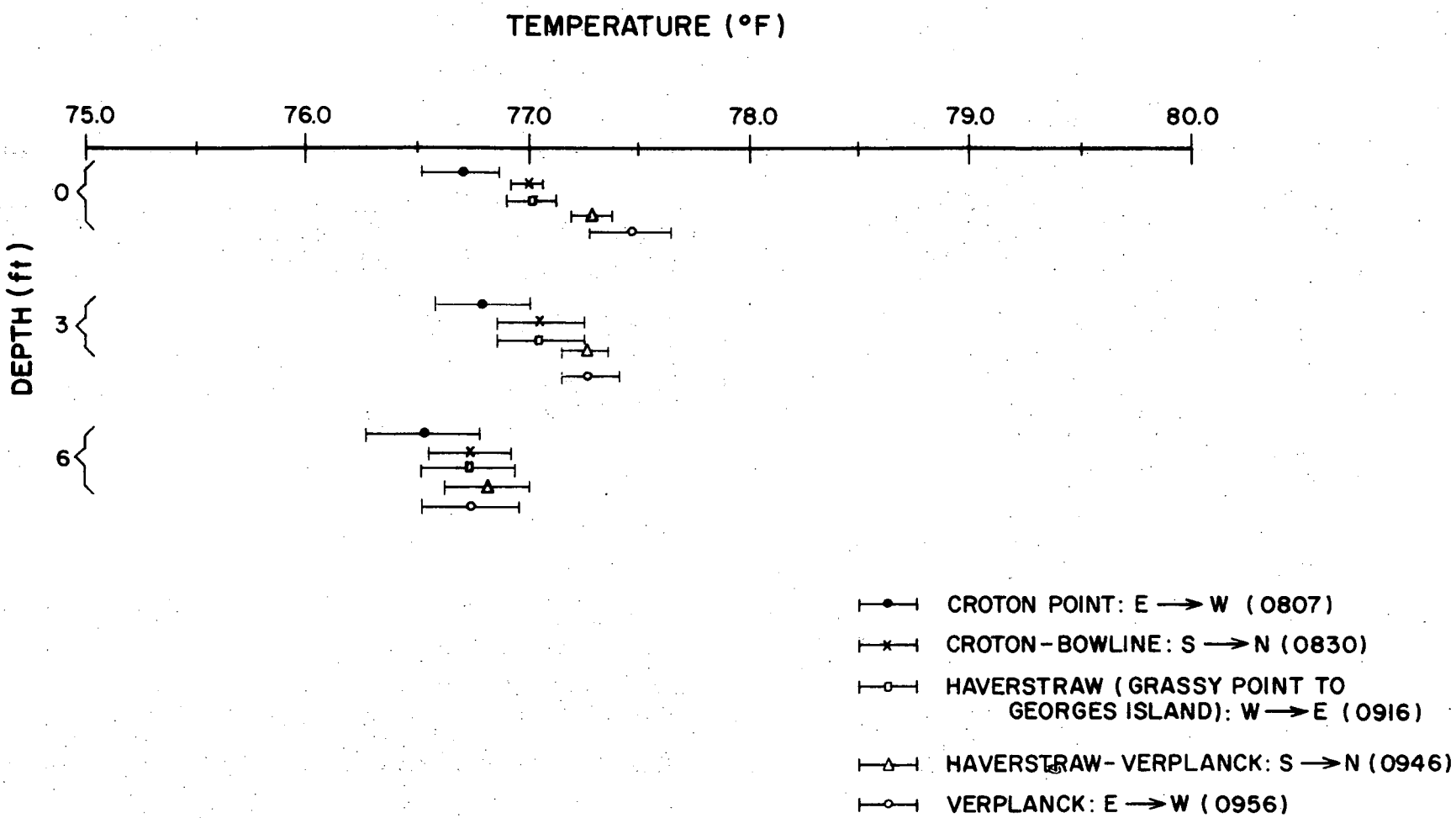
FIGURE 9.1



TRANSECT: HAVERSTRAW
DATE: JULY 30, 1974
TIME: 0904 – 0934
TIDAL STAGE: FIRST FLOOD
TEMPERATURE (°F)

TEMPERATURE PROFILE AT HAVERSTRAW: FIRST FLOOD

FIGURE 9.2



SCAN TEMPERATURES VS DEPTH: FIRST FLOOD

FIGURE 10.1

LATERAL TEMPERATURE SCAN AT CROTON POINT - SURFACE, 3 AND 6 FOOT DEPTHS: FIRST FLOOD

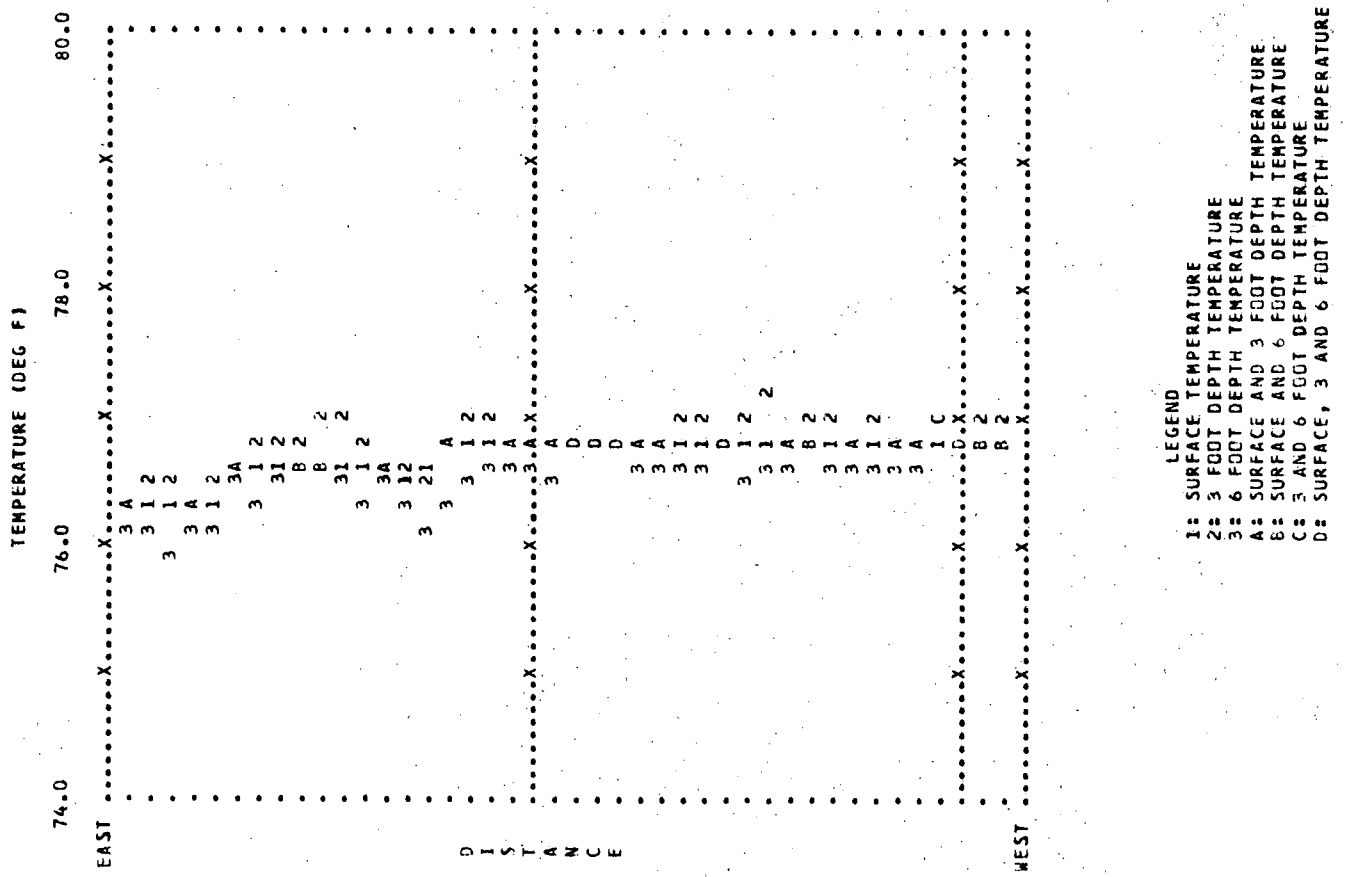
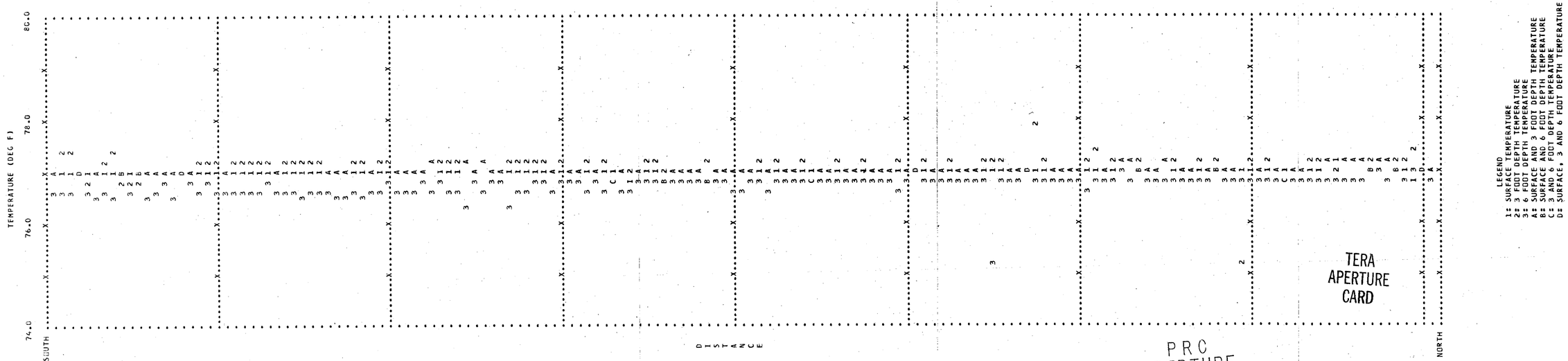


FIGURE 10.2

LONGITUDINAL TEMPERATURE SCAN, CROTON POINT
TO BOWLINE - SURFACE, 3 AND
6 FOOT DEPTHS: FIRST FLOOD



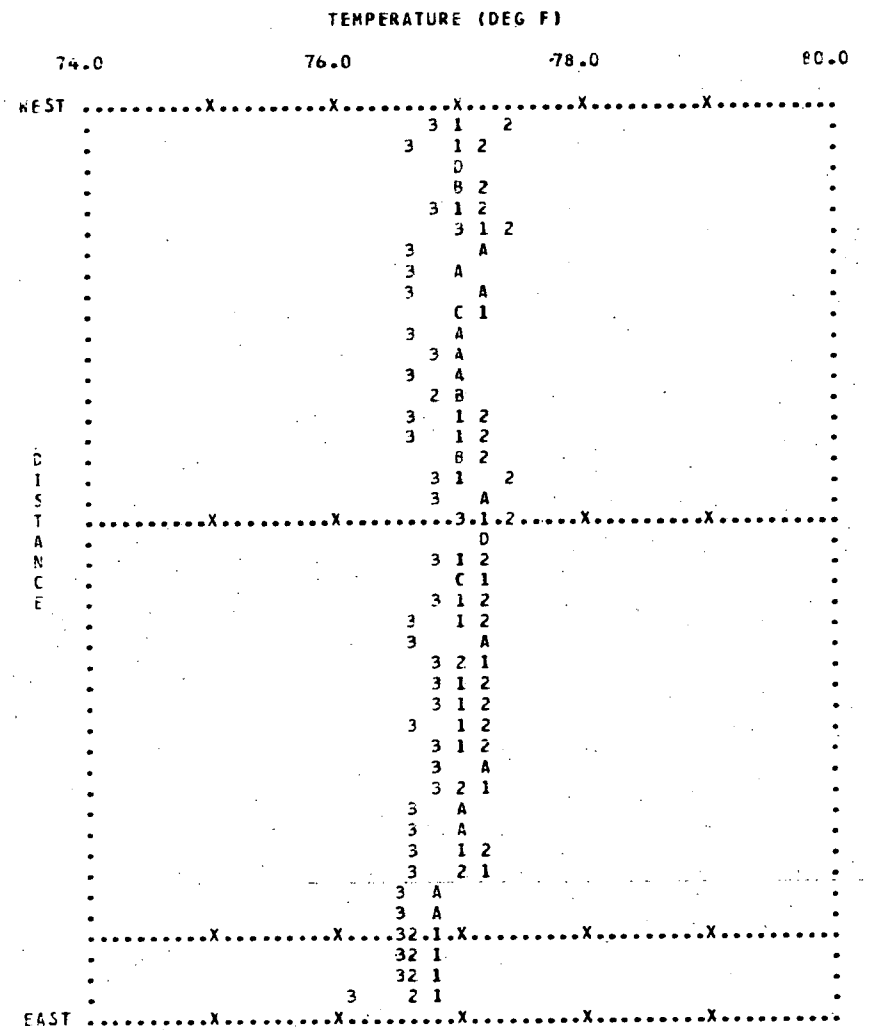
TERA
APERTURE
CARD

PRC
APERTURE
CARD

FIGURE 10.3

8110210005-02

LATERAL TEMPERATURE SCAN AT HAVERSTRAW - SURFACE, 3 AND 6 FOOT DEPTHS: FIRST FLOOD

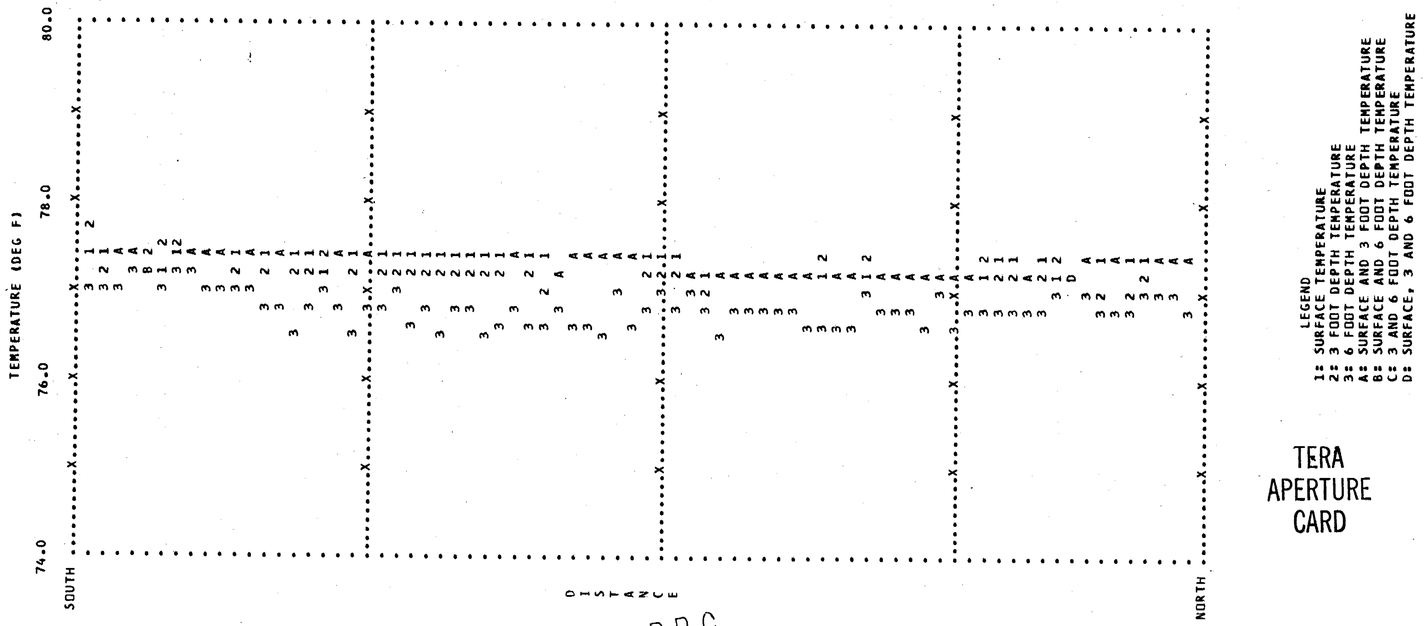


LEGEND
1: SURFACE TEMPERATURE
2: 3 FOOT DEPTH TEMPERATURE
3: 6 FOOT DEPTH TEMPERATURE
A: SURFACE AND 3 FOOT DEPTH TEMPERATURE
B: SURFACE AND 6 FOOT DEPTH TEMPERATURE
C: 3 AND 6 FOOT DEPTH TEMPERATURE
D: SURFACE, 3 AND 6 FOOT DEPTH TEMPERATURE

FIGURE 10.4

8110210005-03

LONGITUDINAL TEMPERATURE SCAN, HAVERSTRAW
TO VERPLANCK - SURFACE, 3 AND
6 FOOT DEPTHS: FIRST FLOOD



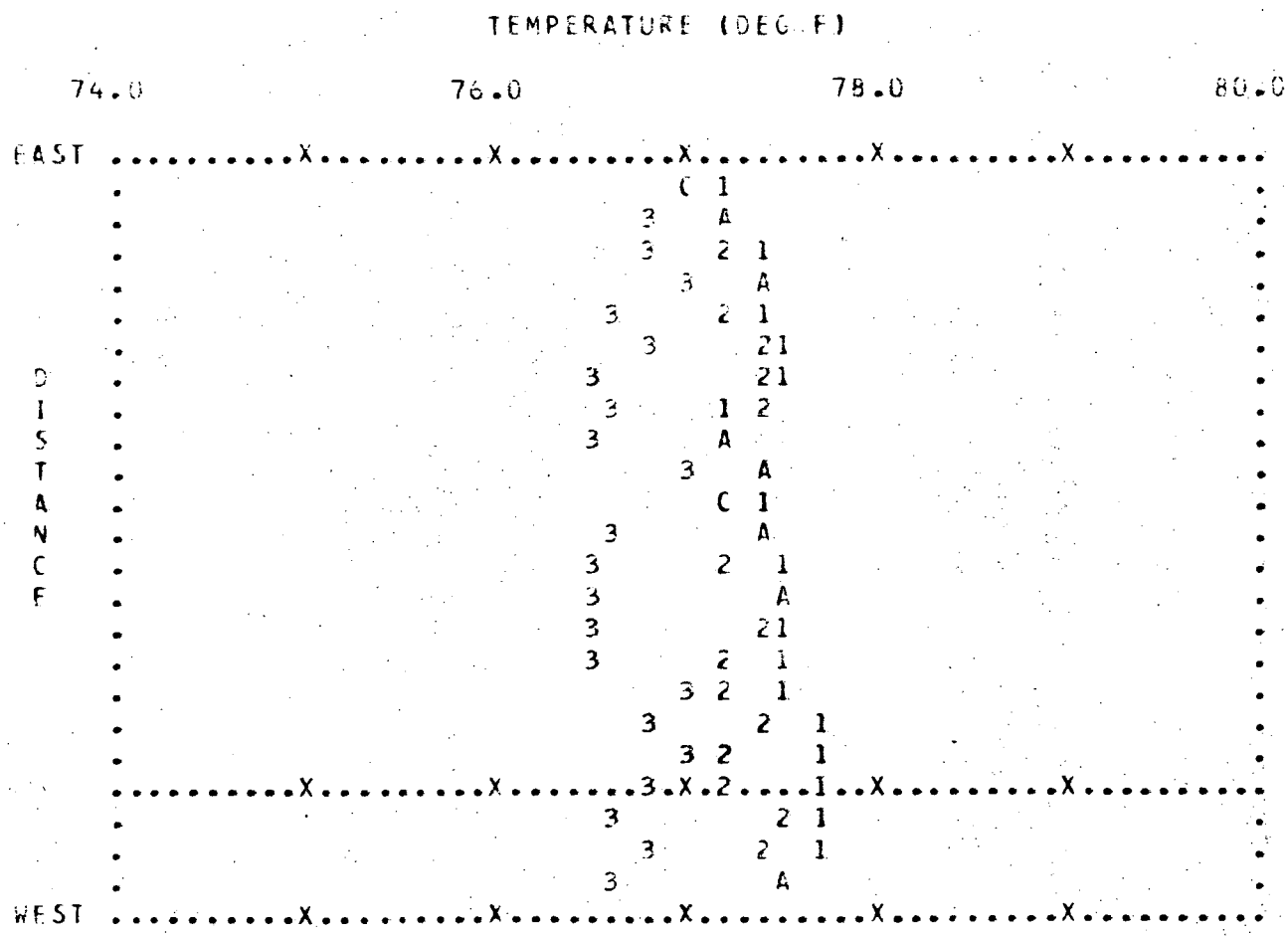
TERA
APERTURE
CARD

PRC
APERTURE
CARD

8110210005-03

FIGURE 10.5

LATERAL TEMPERATURE SCAN AT VERPLANCK - SURFACE, 3 AND 6 FOOT DEPTHS: FIRST FLOOD



LEGEND
1: SURFACE TEMPERATURE
2: 3 FOOT DEPTH TEMPERATURE
3: 6 FOOT DEPTH TEMPERATURE
A: SURFACE AND 3 FOOT DEPTH TEMPERATURE
B: SURFACE AND 6 FOOT DEPTH TEMPERATURE
C: 3 AND 6 FOOT DEPTH TEMPERATURE
D: SURFACE, 3 AND 6 FOOT DEPTH TEMPERATURE

FIGURE 10.6

TEMPERATURE SCAN, WEST SHORE AT INDIAN POINT - SURFACE: FIRST FLOOD

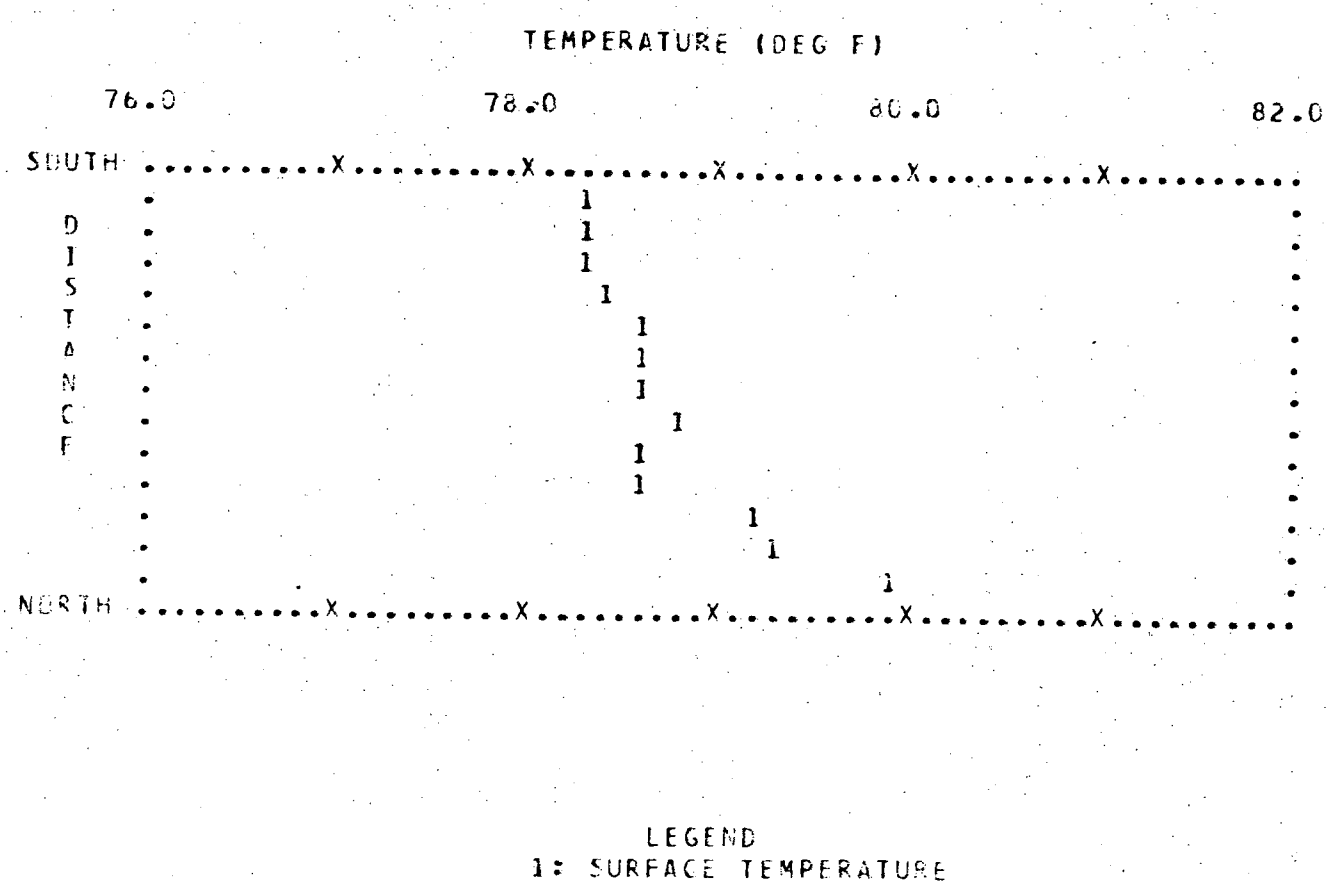


FIGURE 10.7a

TEMPERATURE SCAN, WEST SHORE AT INDIAN POINT - SURFACE: FIRST FLOOD

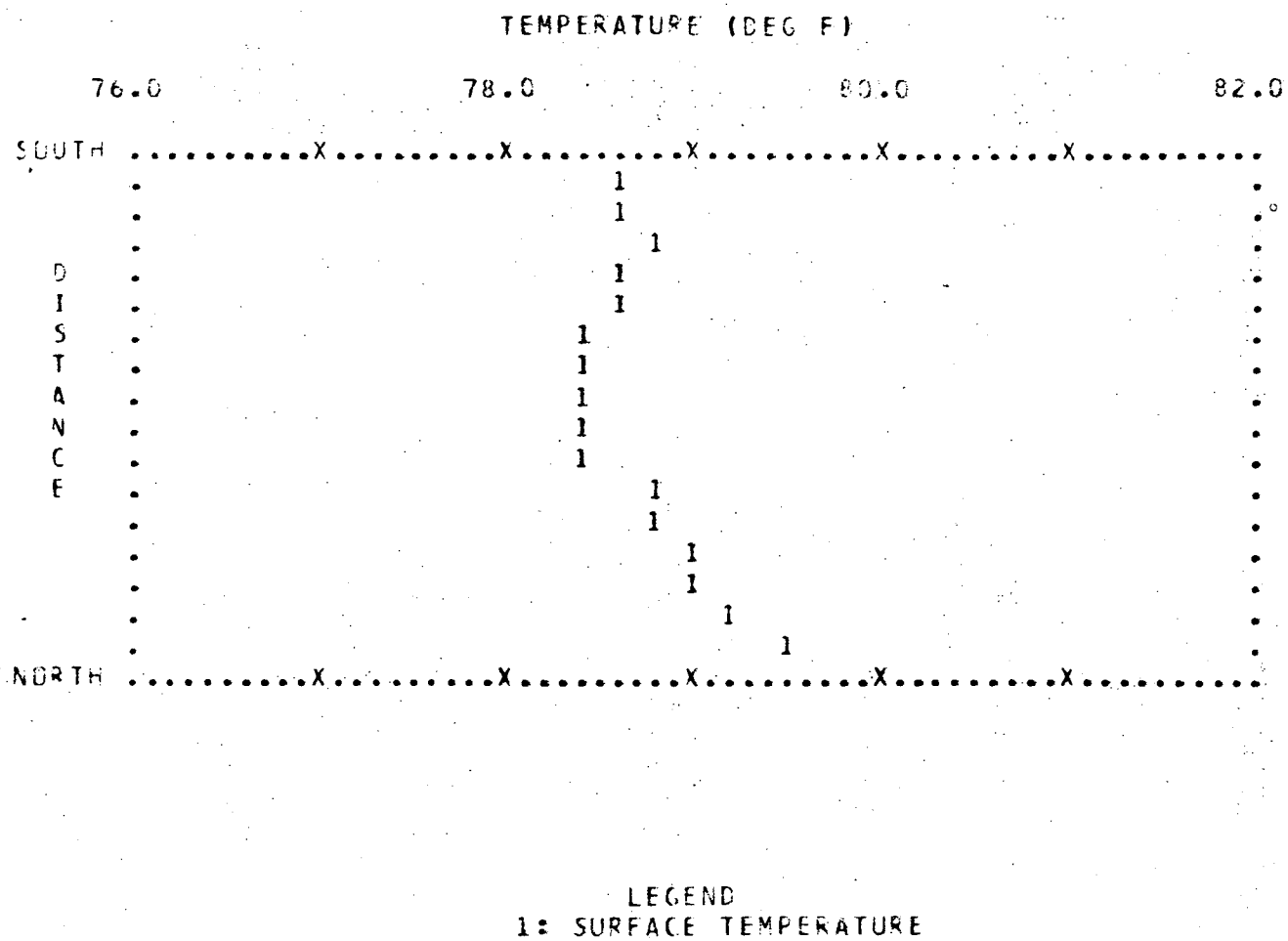


FIGURE 10.7b

TEMPERATURE SCAN, WEST SHORE AT INDIAN POINT - SURFACE: FIRST FLOOD

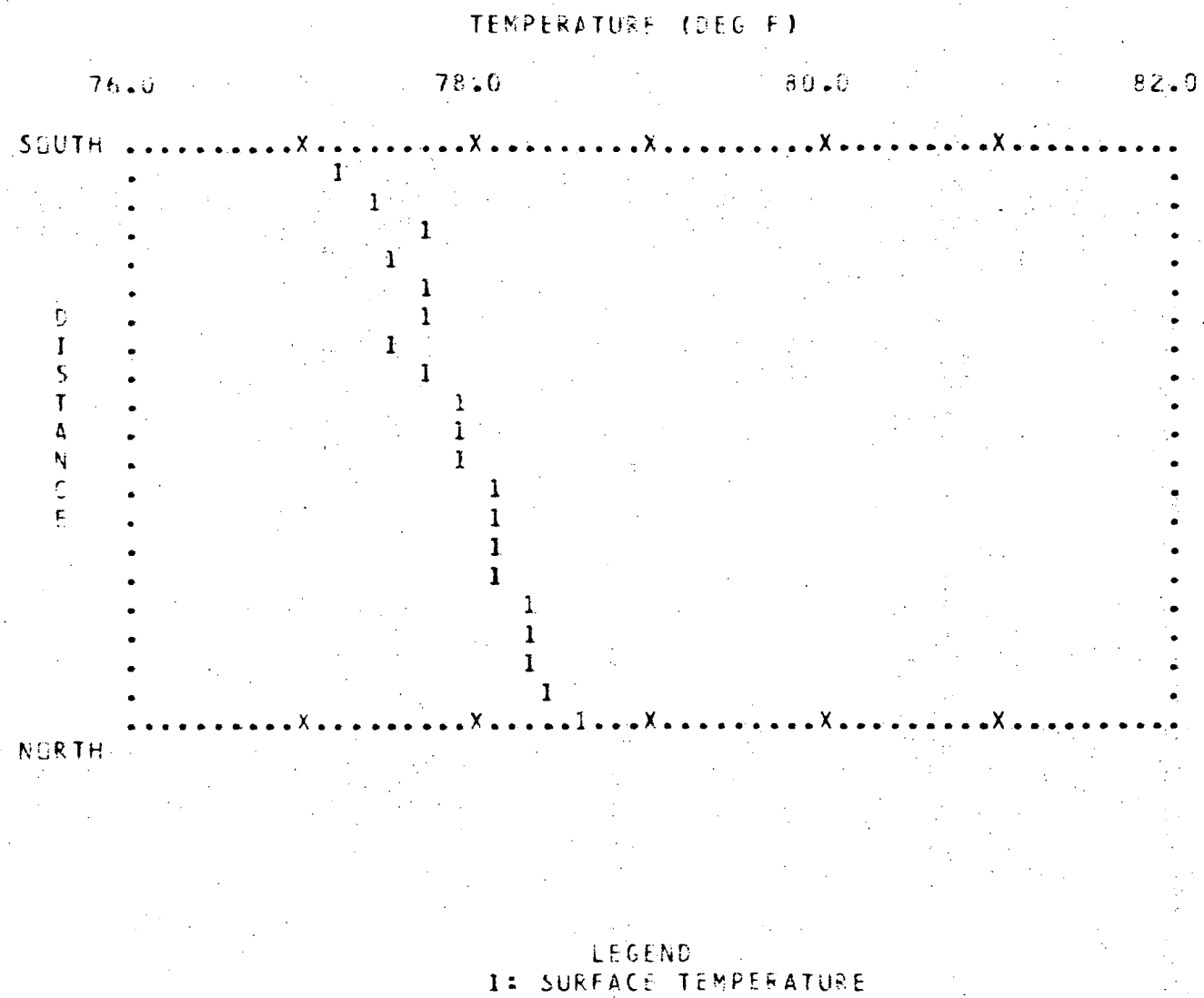
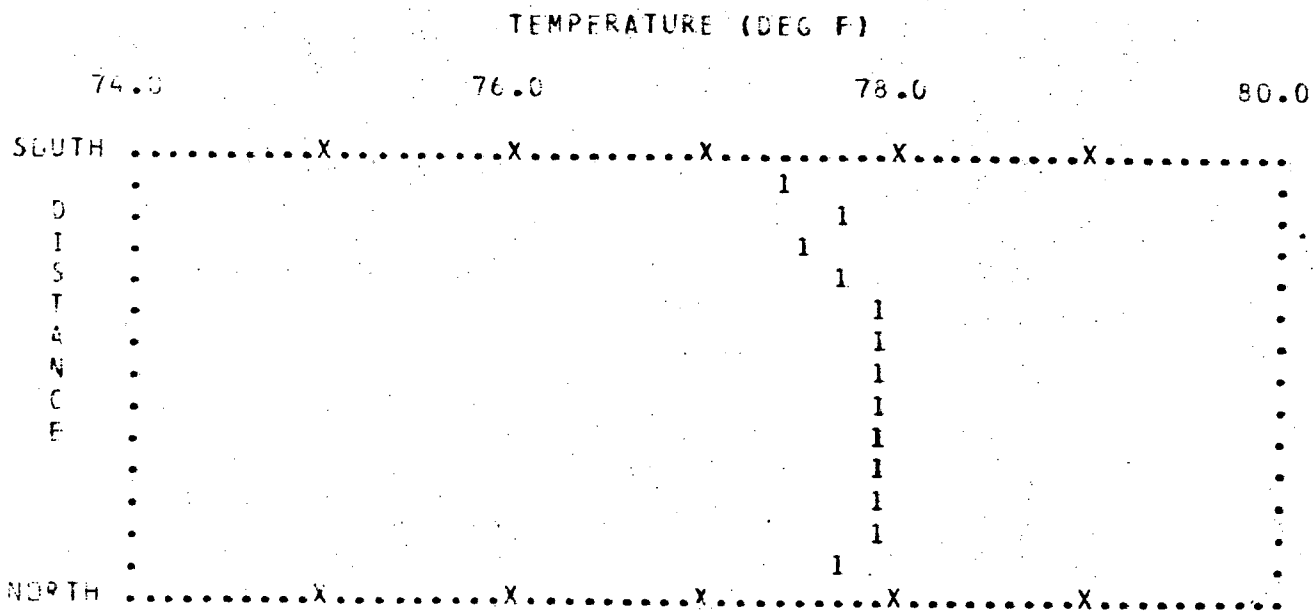


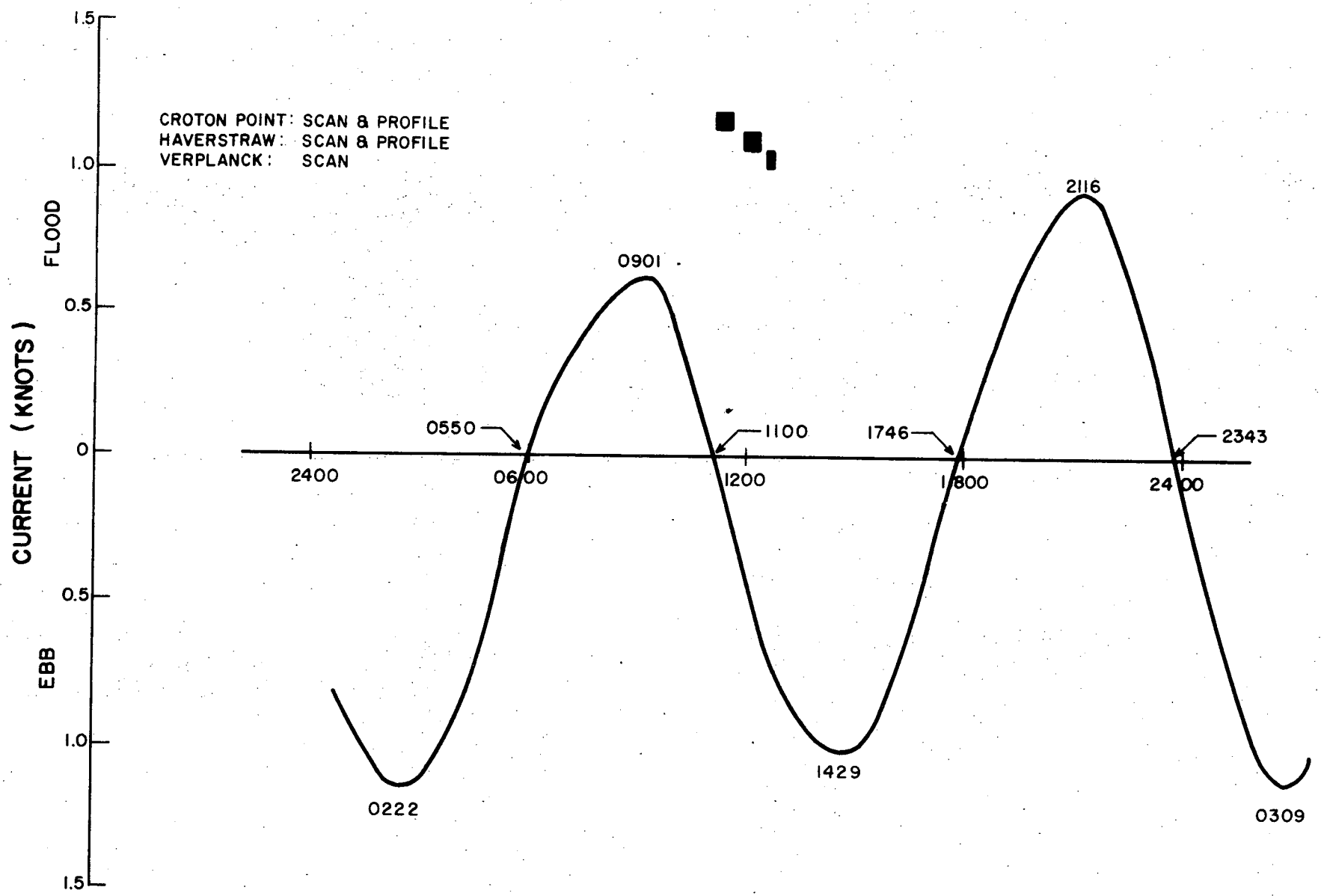
FIGURE 10.7c

TEMPERATURE SCAN, WEST SHORE AT INDIAN POINT - SURFACE: FIRST FLOOD



LEGEND
1: SURFACE TEMPERATURE

FIGURE 10.7d



TIDAL CURRENT: JULY 30, 1974

TIDAL CURRENT - TIME SEQUENCE OF TEMPERATURE MEASUREMENTS: HIGH WATER SLACK

FIGURE II.1

8110210005-04

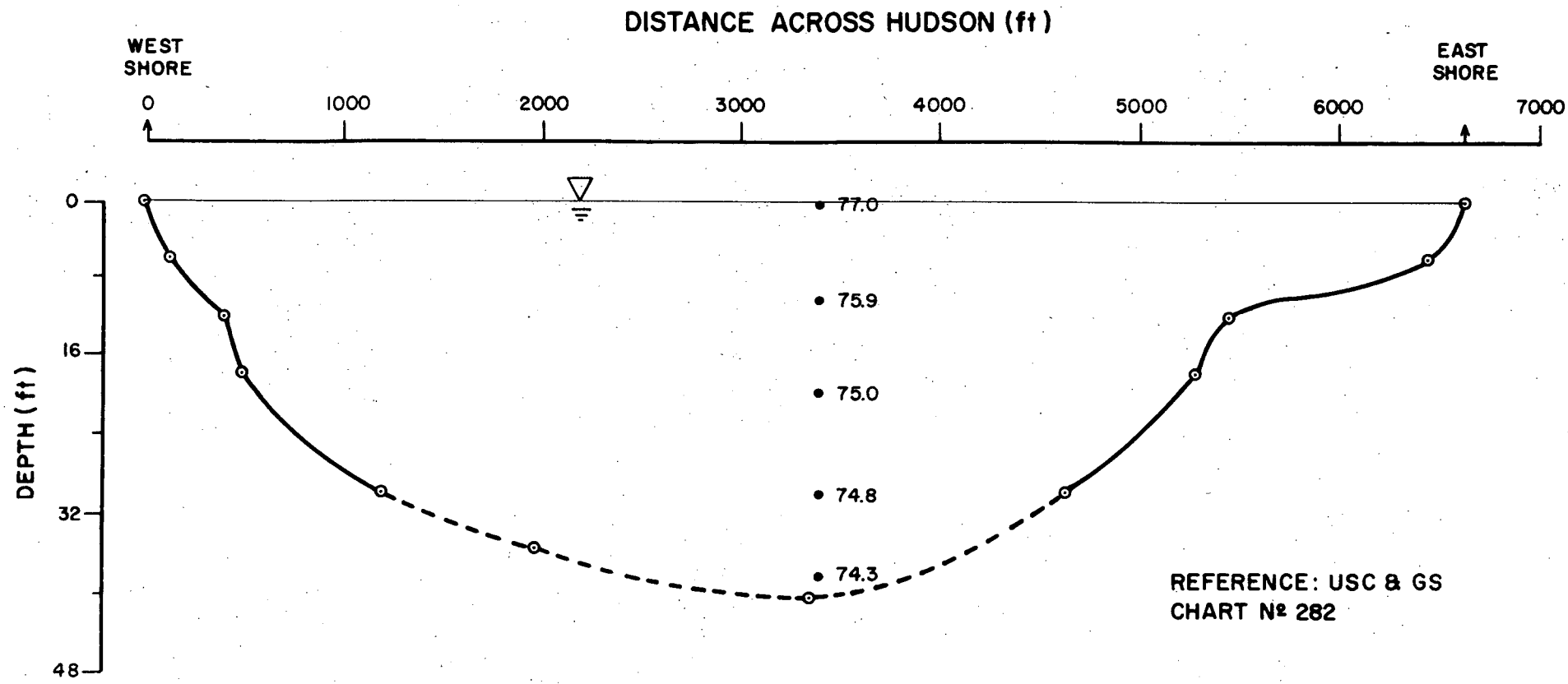
LOCATION OF TEMPERATURE MEASUREMENTS: HIGH WATER SLACK

FIGURE 11.2

PRC APERTURE CARD

TERA APERTURE CARD

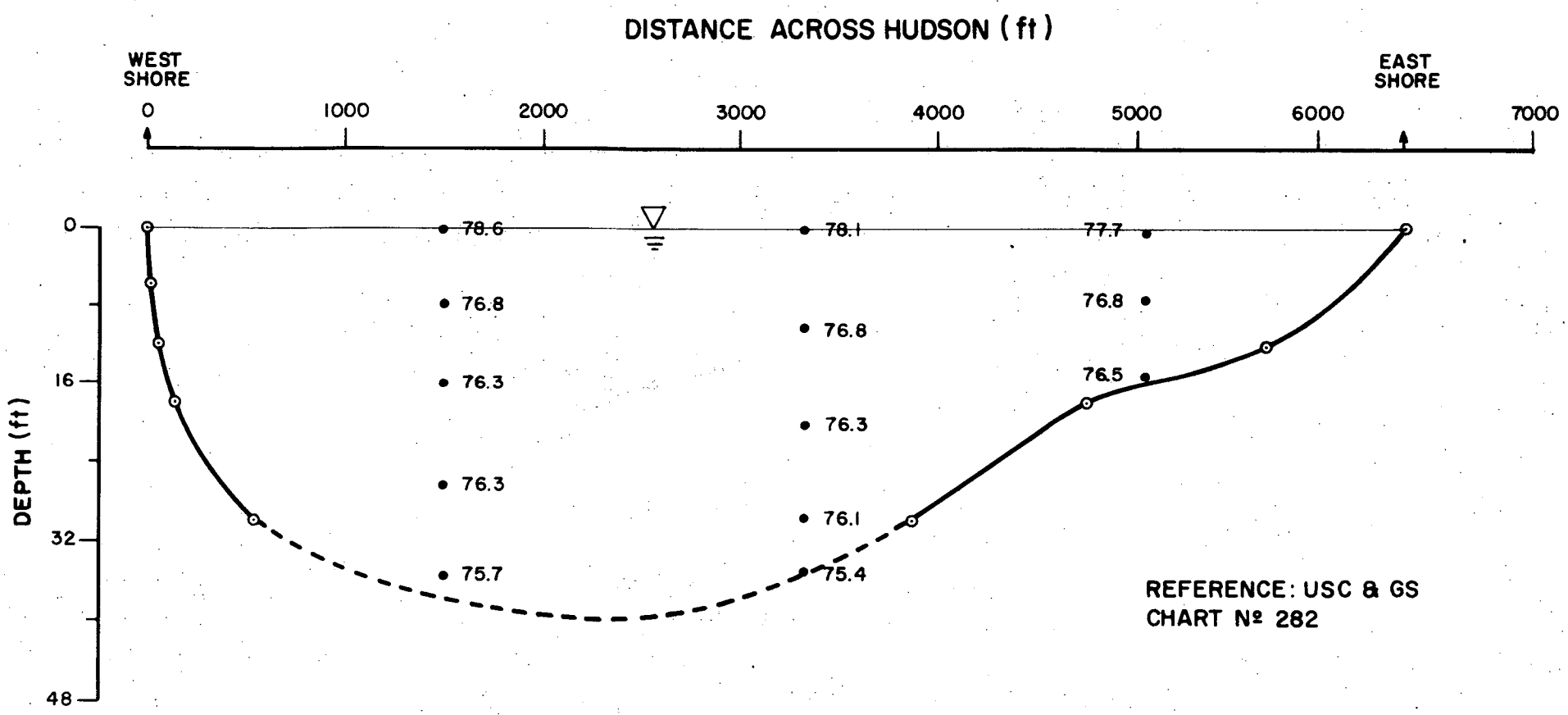
8110210005-04



TRANSECT: CROTON POINT
DATE: JULY 30, 1974
TIME: 1130
TIDAL STAGE: HIGH WATER SLACK
TEMPERATURE (°F)

TEMPERATURE PROFILE AT CROTON POINT: HIGH WATER SLACK

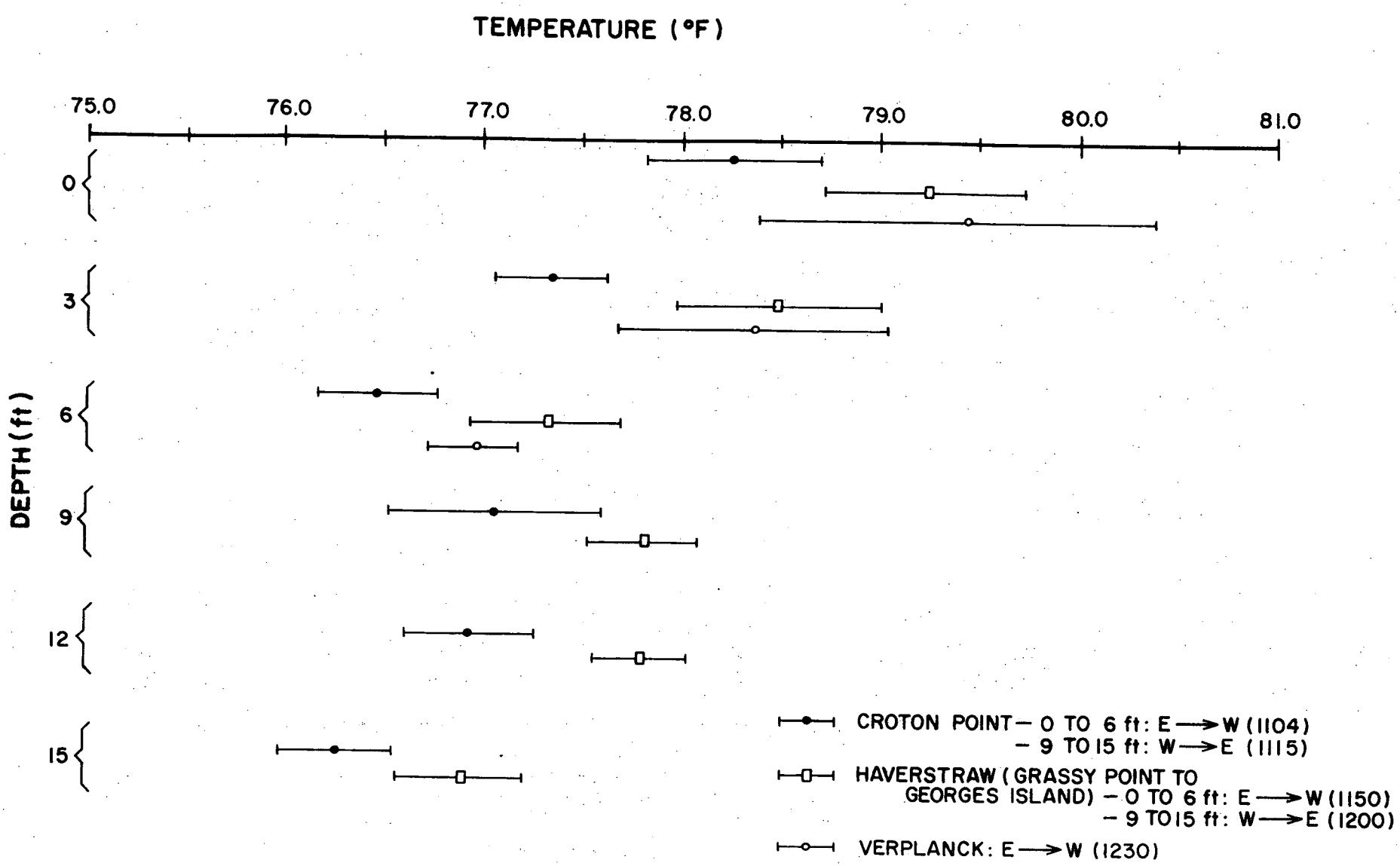
FIGURE 12.1



TRANSECT: HAVERSTRAW
DATE: JULY 30, 1974
TIME: 1211 - 1219
TIDAL STAGE: HIGH WATER SLACK
TEMPERATURE (°F)

TEMPERATURE PROFILE AT HAVERSTRAW: HIGH WATER SLACK

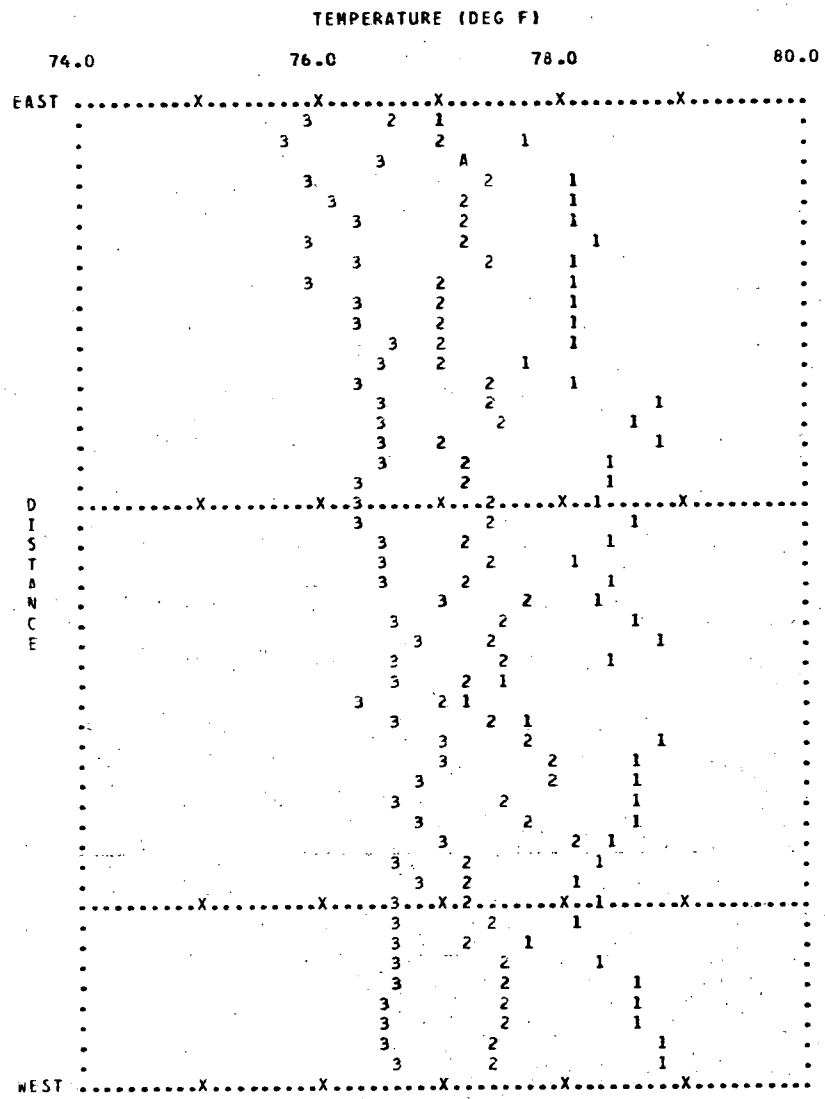
FIGURE 12.2



SCAN TEMPERATURES VS DEPTH: HWS

FIGURE 13.1

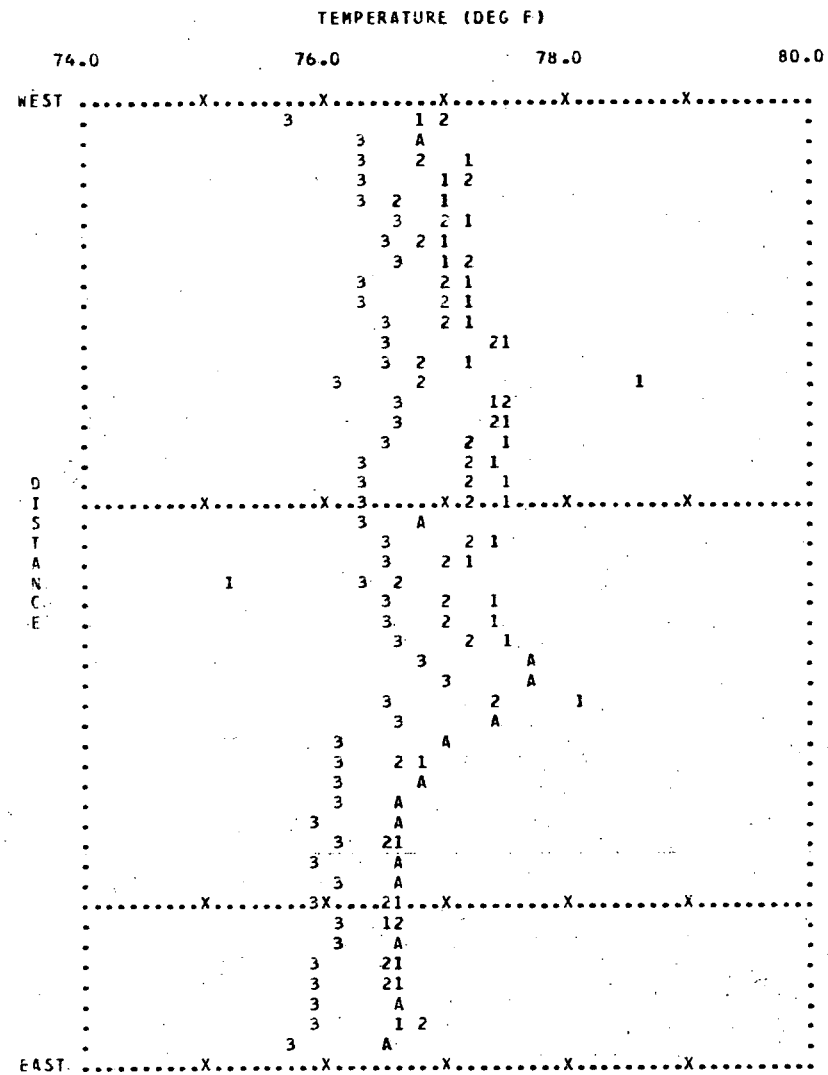
LATERAL TEMPERATURE SCAN AT CROTON POINT -
SURFACE, 3 AND 6 FOOT DEPTHS: HWS



LEGEND
1: SURFACE TEMPERATURE
2: 3 FOOT DEPTH TEMPERATURE
3: 6 FOOT DEPTH TEMPERATURE
A: SURFACE AND 3 FOOT DEPTH TEMPERATURE
B: SURFACE AND 6 FOOT DEPTH TEMPERATURE
C: 3 AND 6 FOOT DEPTH TEMPERATURE
D: SURFACE, 3 AND 6 FOOT DEPTH TEMPERATURE

FIGURE 13.2

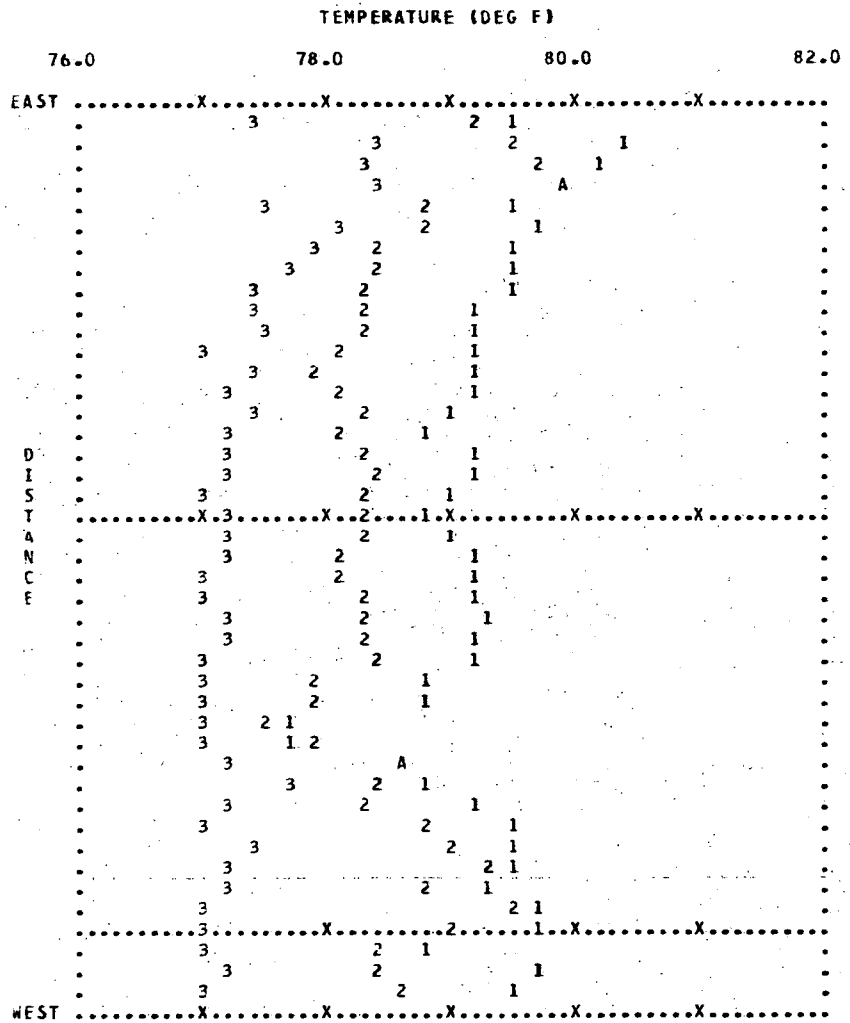
LATERAL TEMPERATURE SCAN AT CROTON POINT - 9, 12 AND 15 FOOT DEPTHS: HWS



LEGEND
1: 9 FOOT DEPTH TEMPERATURE
2: 12 FOOT DEPTH TEMPERATURE
3: 15 FOOT DEPTH TEMPERATURE
A: 9 AND 12 FOOT DEPTH TEMPERATURE
B: 9 AND 15 FOOT DEPTH TEMPERATURE
C: 12 AND 15 FOOT DEPTH TEMPERATURE
D: 9,12 AND 15 FOOT DEPTH TEMPERATURE

FIGURE 13.3

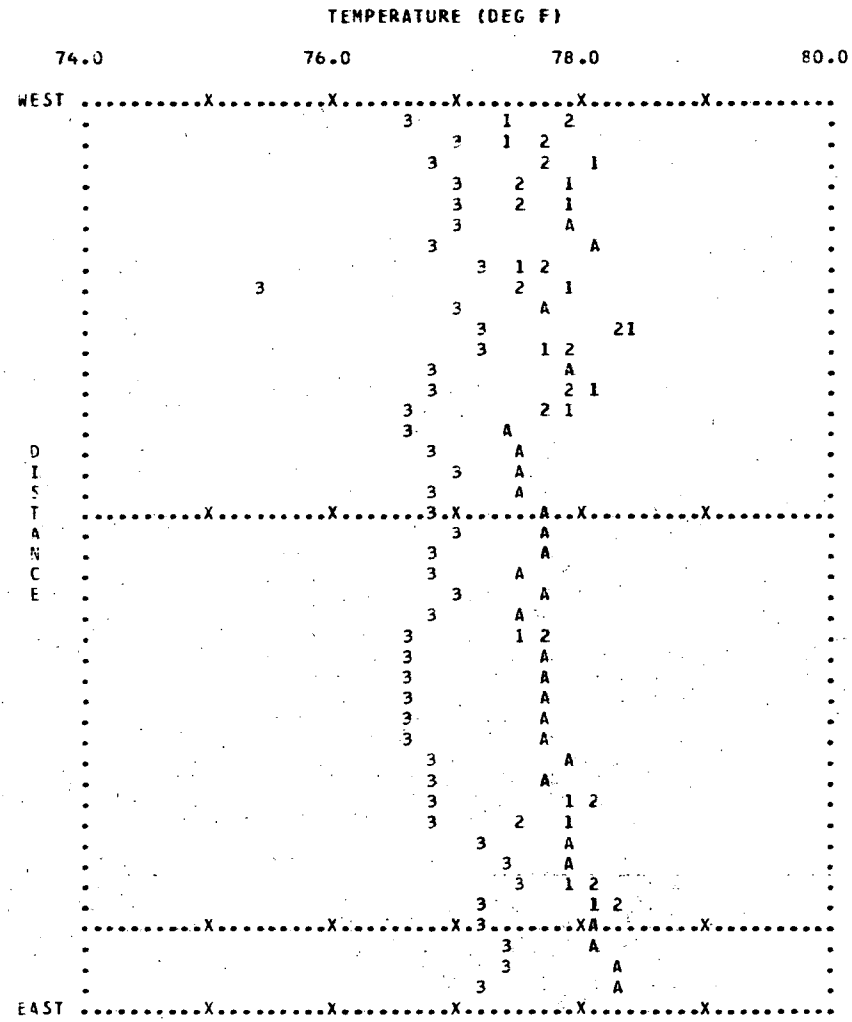
LATERAL TEMPERATURE SCAN AT HAVERSTRAW - SURFACE, 3 AND 6 FOOT DEPTHS: HWS



LEGEND
1: SURFACE TEMPERATURE
2: 3 FOOT DEPTH TEMPERATURE
3: 6 FOOT DEPTH TEMPERATURE
A: SURFACE AND 3 FOOT DEPTH TEMPERATURE
B: SURFACE AND 6 FOOT DEPTH TEMPERATURE
C: 3 AND 6 FOOT DEPTH TEMPERATURE
D: SURFACE, 3 AND 6 FOOT DEPTH TEMPERATURE

FIGURE 13.4

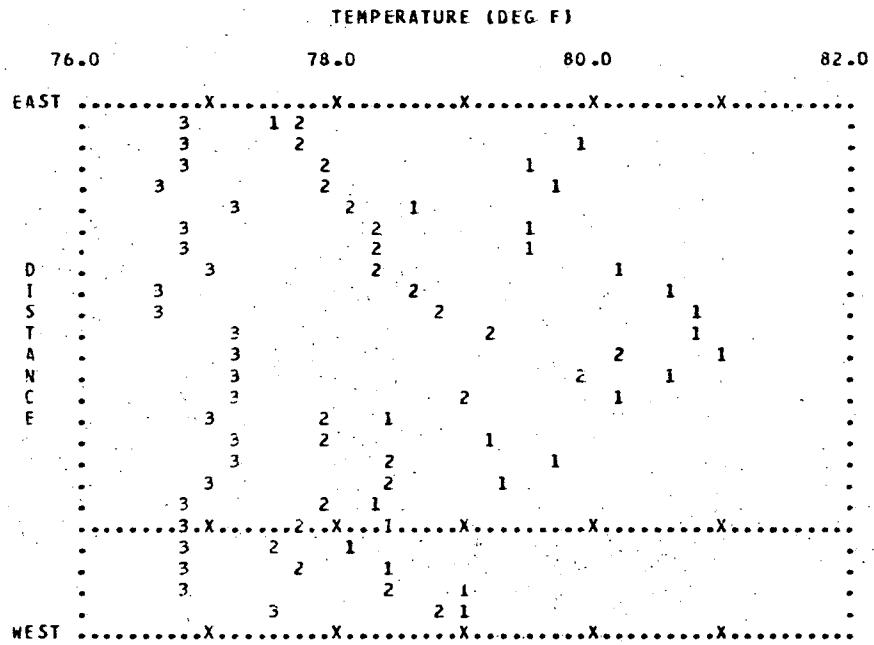
LATERAL TEMPERATURE SCAN AT HAVERSTRAW -
9, 12 AND 15 FOOT DEPTHS: HWS



LEGEND
1: 9 FOOT DEPTH TEMPERATURE
2: 12 FOOT DEPTH TEMPERATURE
3: 15 FOOT DEPTH TEMPERATURE
A: 9 AND 12 FOOT DEPTH TEMPERATURE
B: 9 AND 15 FOOT DEPTH TEMPERATURE
C: 12 AND 15 FOOT DEPTH TEMPERATURE
D: 9,12 AND 15 FOOT DEPTH TEMPERATURES

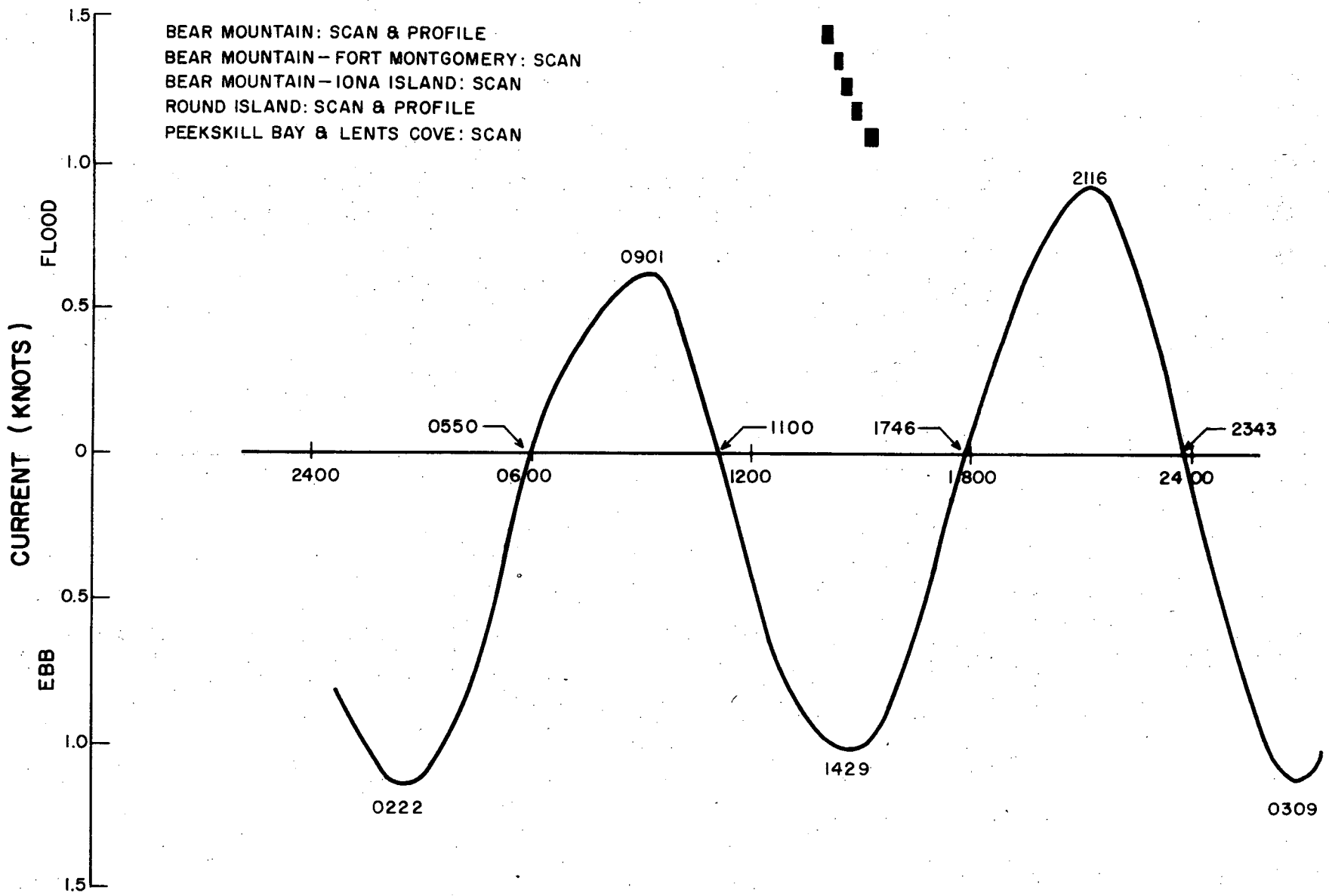
FIGURE 13.5

LATERAL TEMPERATURE SCAN AT VERPLANCK - SURFACE, 3 AND 6 FOOT DEPTHS: HWS



LEGEND
1: SURFACE TEMPERATURE
2: 3 FOOT DEPTH TEMPERATURE
3: 6 FOOT DEPTH TEMPERATURE
A: SURFACE AND 3 FOOT DEPTH TEMPERATURE
B: SURFACE AND 6 FOOT DEPTH TEMPERATURE
C: 3 AND 6 FOOT DEPTH TEMPERATURE
D: SURFACE, 3 AND 6 FOOT DEPTH TEMPERATURE

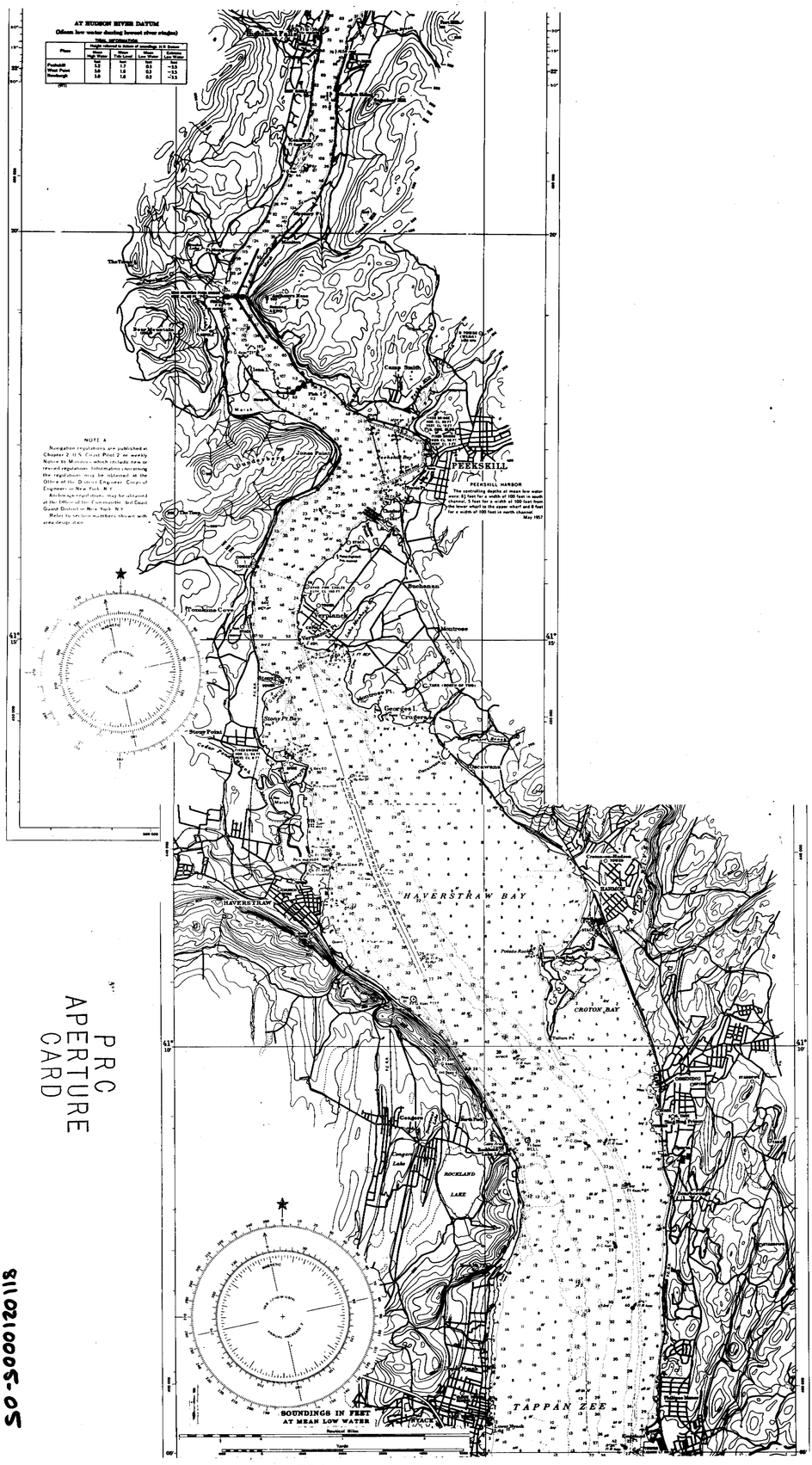
FIGURE 13.6



TIDAL CURRENT: JULY 30, 1974

TIDAL CURRENT – TIME SEQUENCE OF TEMPERATURE MEASUREMENTS: EBB

FIGURE 14.1



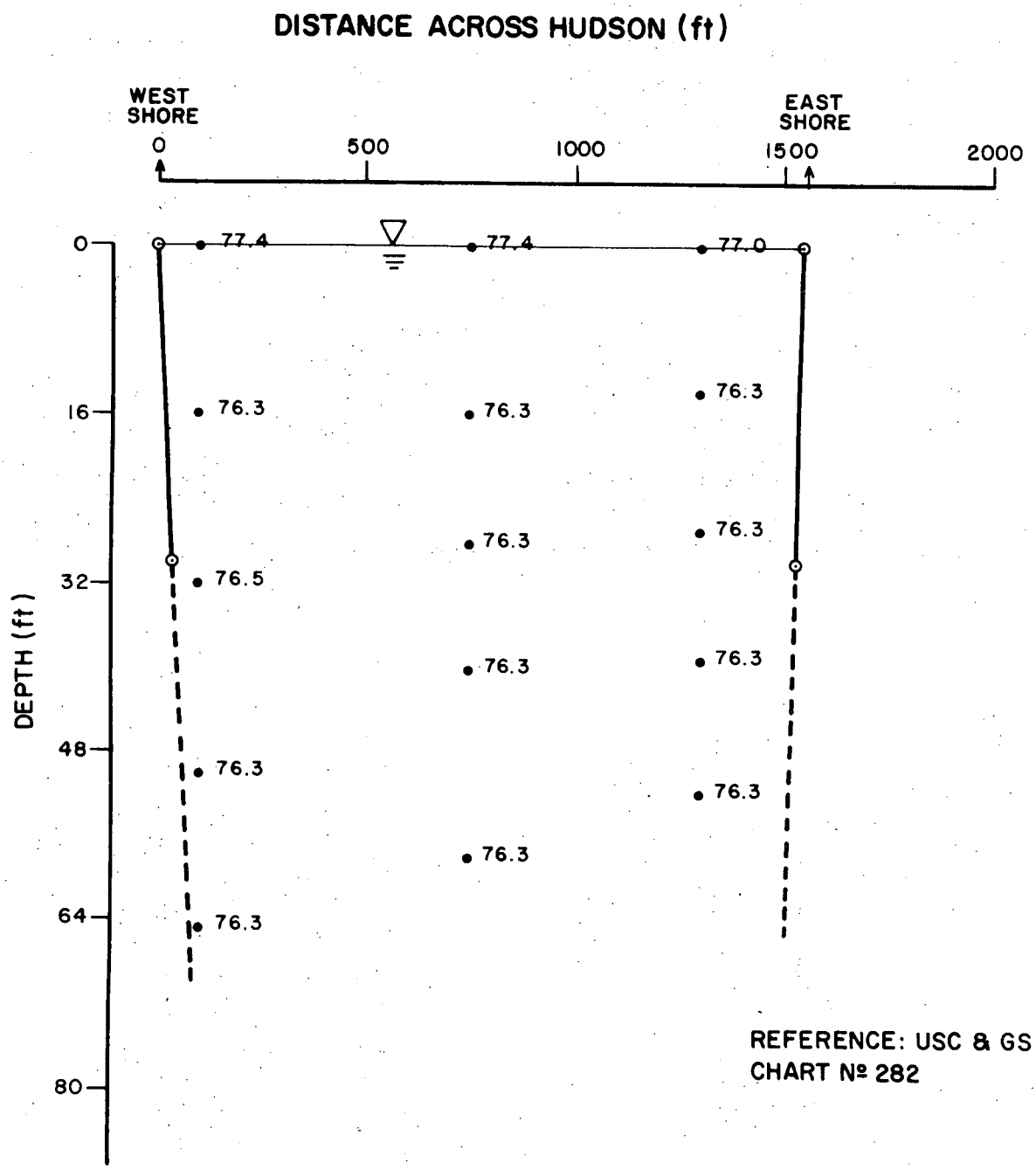
PRC APERTURE CARD

TERA APERTURE CARD

LOCATION OF TEMPERATURE MEASUREMENTS: EBB

FIGURE 14.2

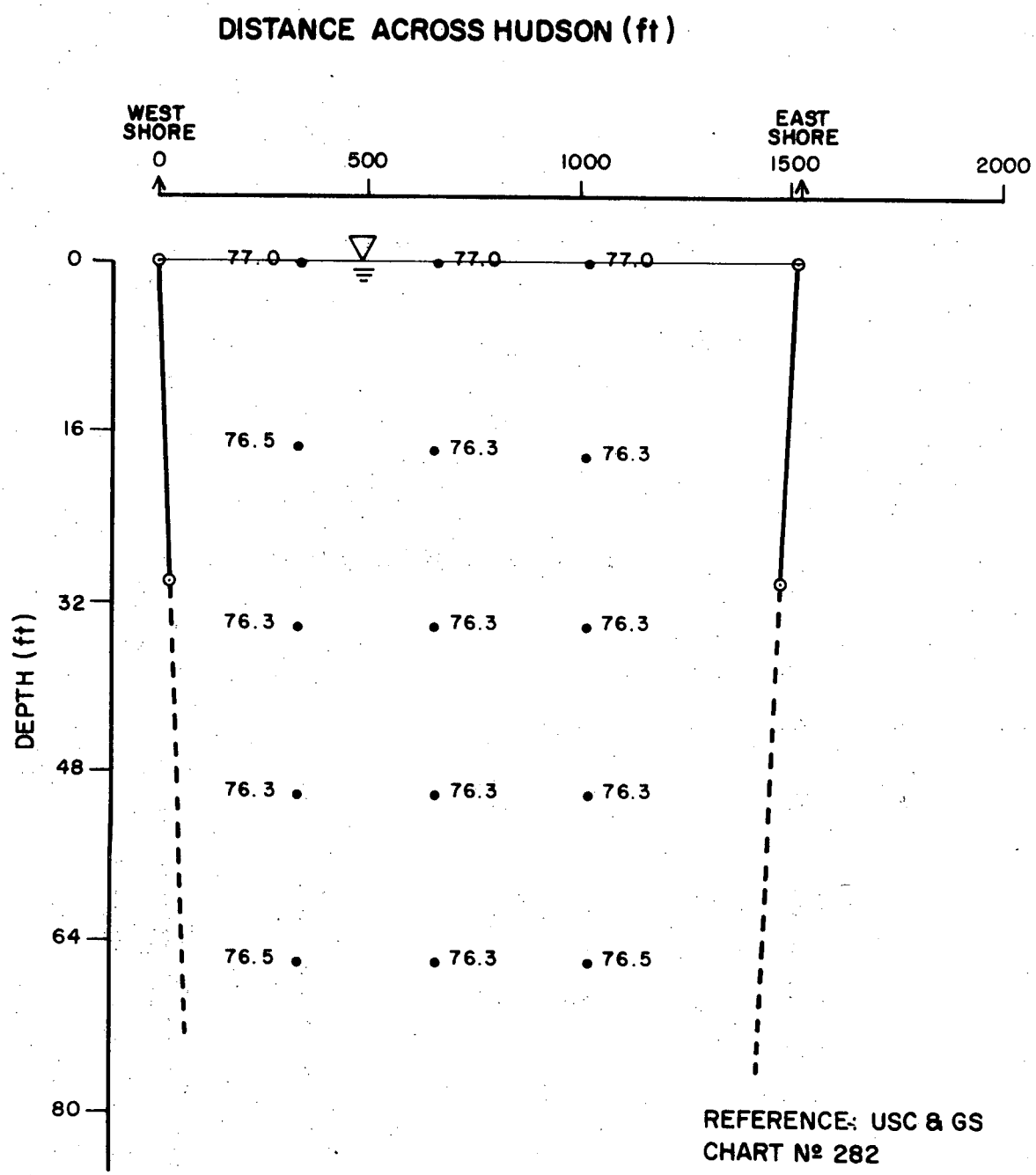
50-5000120118



TRANSECT: BEAR MOUNTAIN BRIDGE
DATE: JULY 30, 1974
TIME: 1400-1410
TIDAL STAGE: EBB
TEMPERATURE (°F)

TEMPERATURE PROFILE AT
BEAR MOUNTAIN BRIDGE: EBB

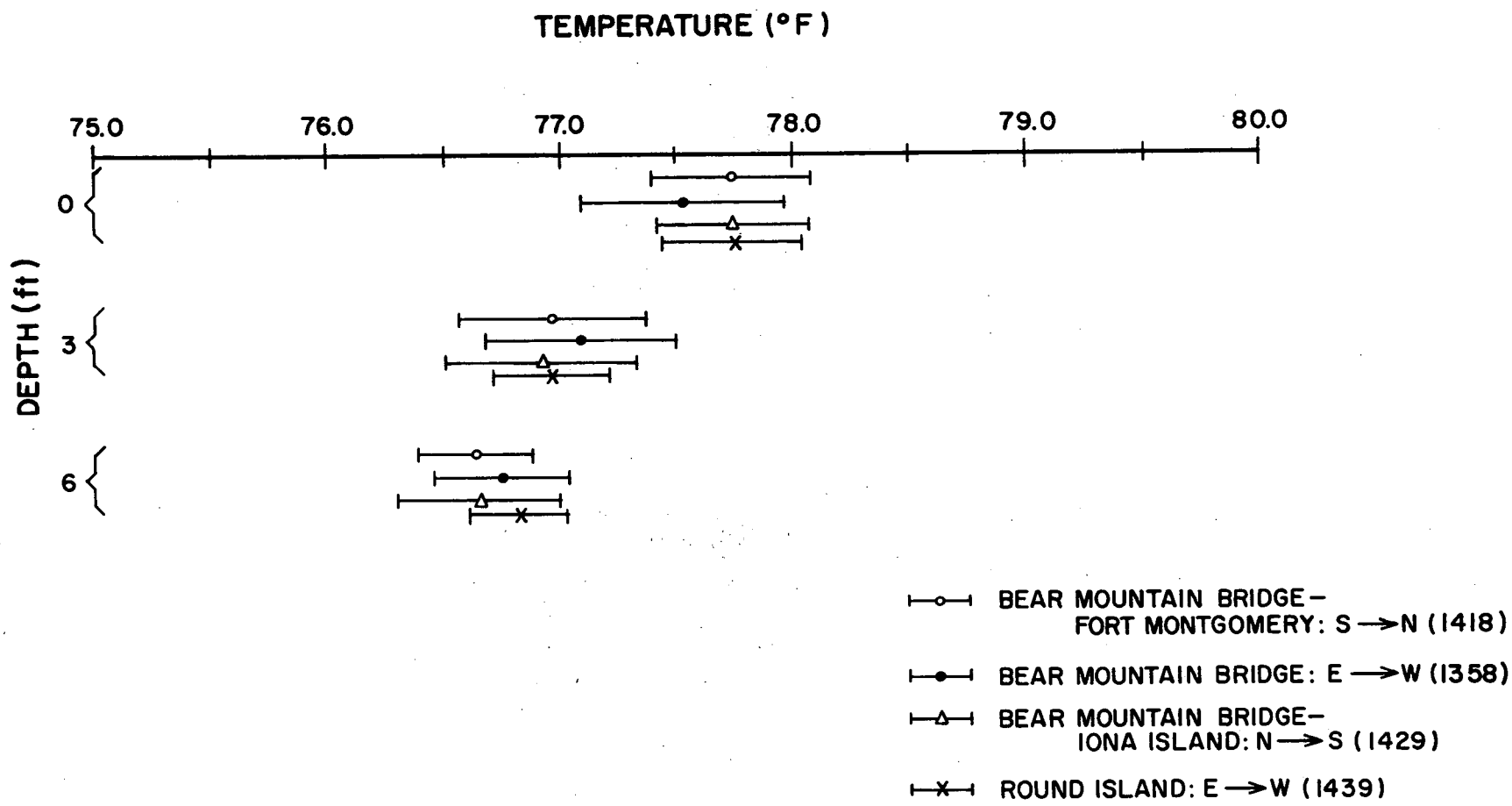
FIGURE 15.1



TRANSECT: ROUND ISLAND TO HOLE
DATE: JULY 30, 1974
TIME: 1440-1452
TIDAL STAGE: EBB
TEMPERATURE (°F)

TEMPERATURE PROFILE AT
ROUND ISLAND: EBB

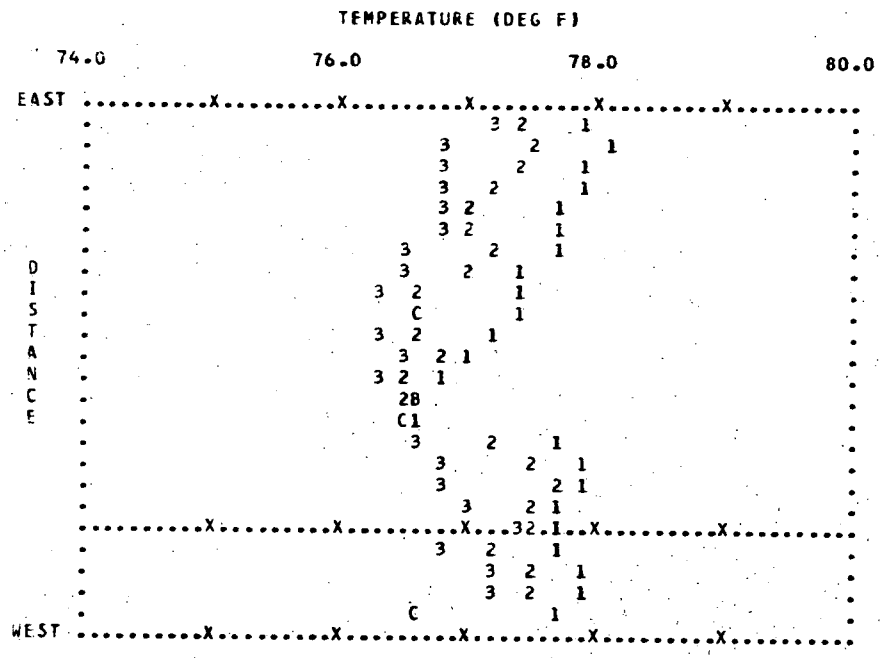
FIGURE 15.2



SCAN TEMPERATURES VS DEPTH: EBB

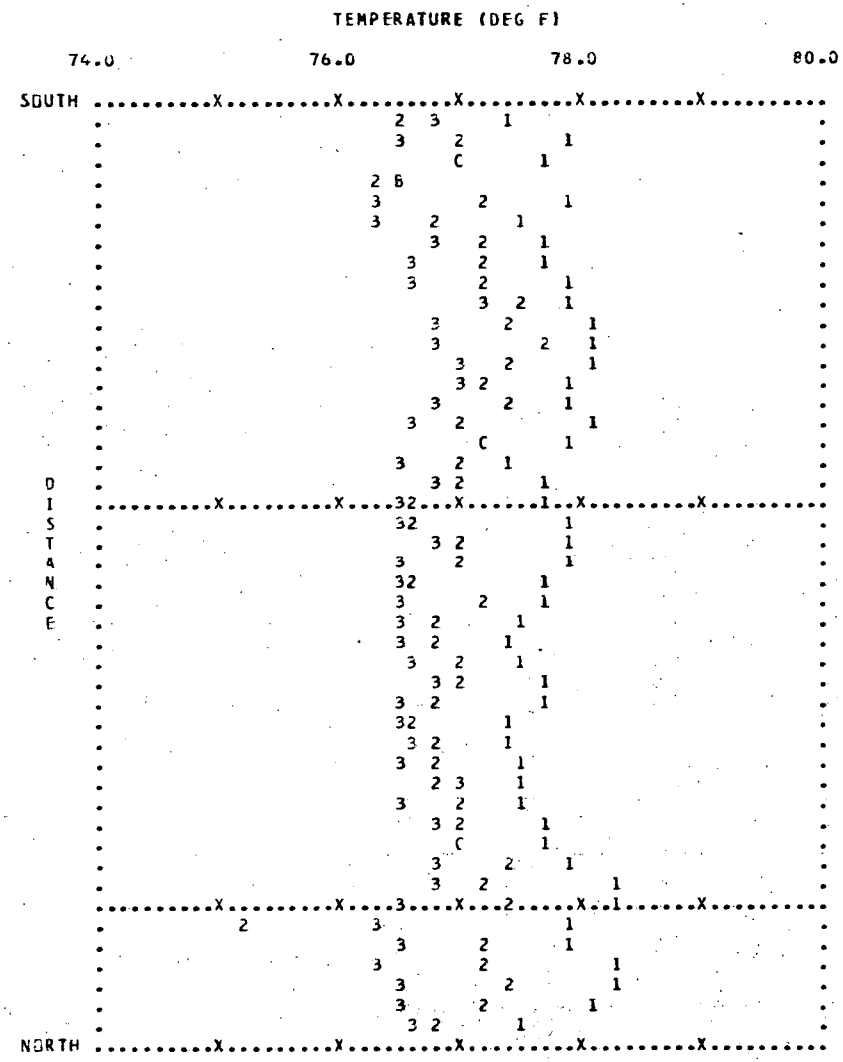
FIGURE 16.1

LATERAL TEMPERATURE SCAN AT BEAR MOUNTAIN
BRIDGE - SURFACE, 3 AND
6 FOOT DEPTHS: EBB



LEGEND
1: SURFACE TEMPERATURE
2: 3 FOOT DEPTH TEMPERATURE
3: 6 FOOT DEPTH TEMPERATURE
A: SURFACE AND 3 FOOT DEPTH TEMPERATURE
B: SURFACE AND 6 FOOT DEPTH TEMPERATURE
C: 3 AND 6 FOOT DEPTH TEMPERATURE
D: SURFACE, 3 AND 6 FOOT DEPTH TEMPERATURE

FIGURE 16.2

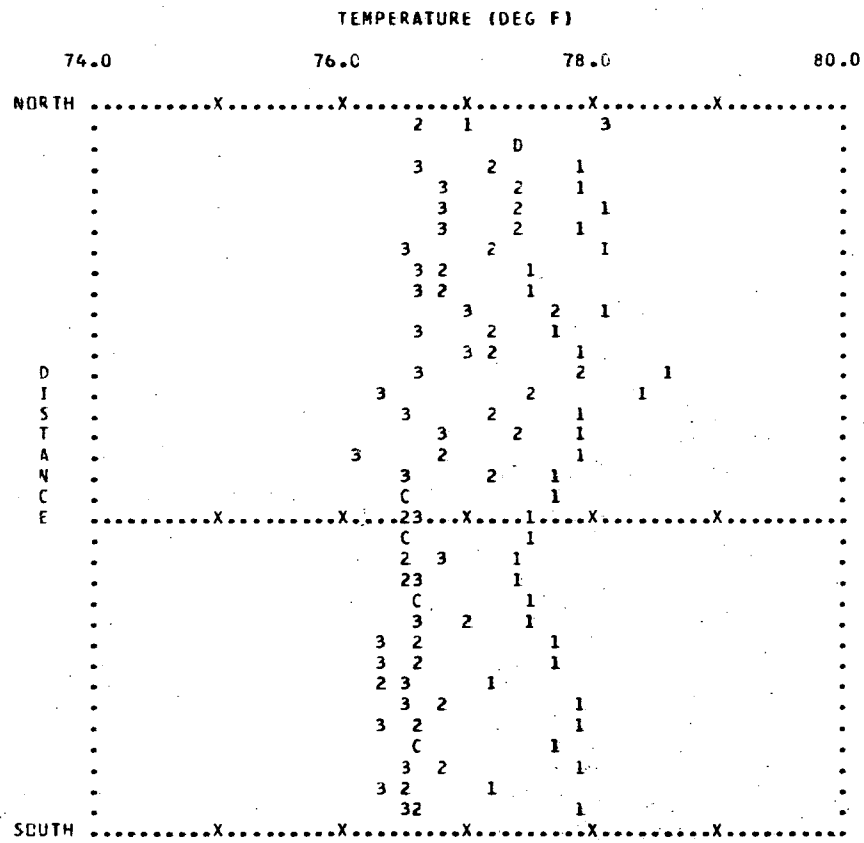


LEGEND
1: SURFACE TEMPERATURE
2: 3 FOOT DEPTH TEMPERATURE
3: 6 FOOT DEPTH TEMPERATURE
A: SURFACE AND 3 FOOT DEPTH TEMPERATURE
B: SURFACE AND 6 FOOT DEPTH TEMPERATURE
C: 3 AND 6 FOOT DEPTH TEMPERATURE
D: SURFACE, 3 AND 6 FOOT DEPTH TEMPERATURE

LONGITUDINAL TEMPERATURE SCAN, BEAR MOUNTAIN BRIDGE TO FORT MONTGOMERY - SURFACE, 3 AND 6 FOOT DEPTHS: EBB

FIGURE 16.3

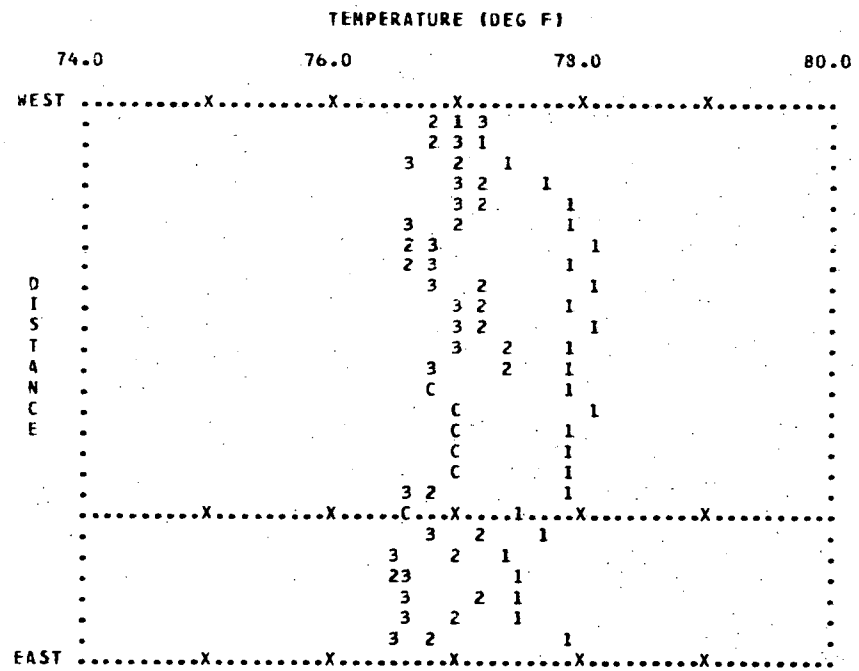
LONGITUDINAL TEMPERATURE SCAN, BEAR MOUNTAIN
BRIDGE TO IONA ISLAND - SURFACE,
3 AND 6 FOOT DEPTHS: EBB



LEGEND
1: SURFACE TEMPERATURE
2: 3 FOOT DEPTH TEMPERATURE
3: 6 FOOT DEPTH TEMPERATURE
A: SURFACE AND 3 FOOT DEPTH TEMPERATURE
B: SURFACE AND 6 FOOT DEPTH TEMPERATURE
C: 3 AND 6 FOOT DEPTH TEMPERATURE
D: SURFACE, 3 AND 6 FOOT DEPTH TEMPERATURE

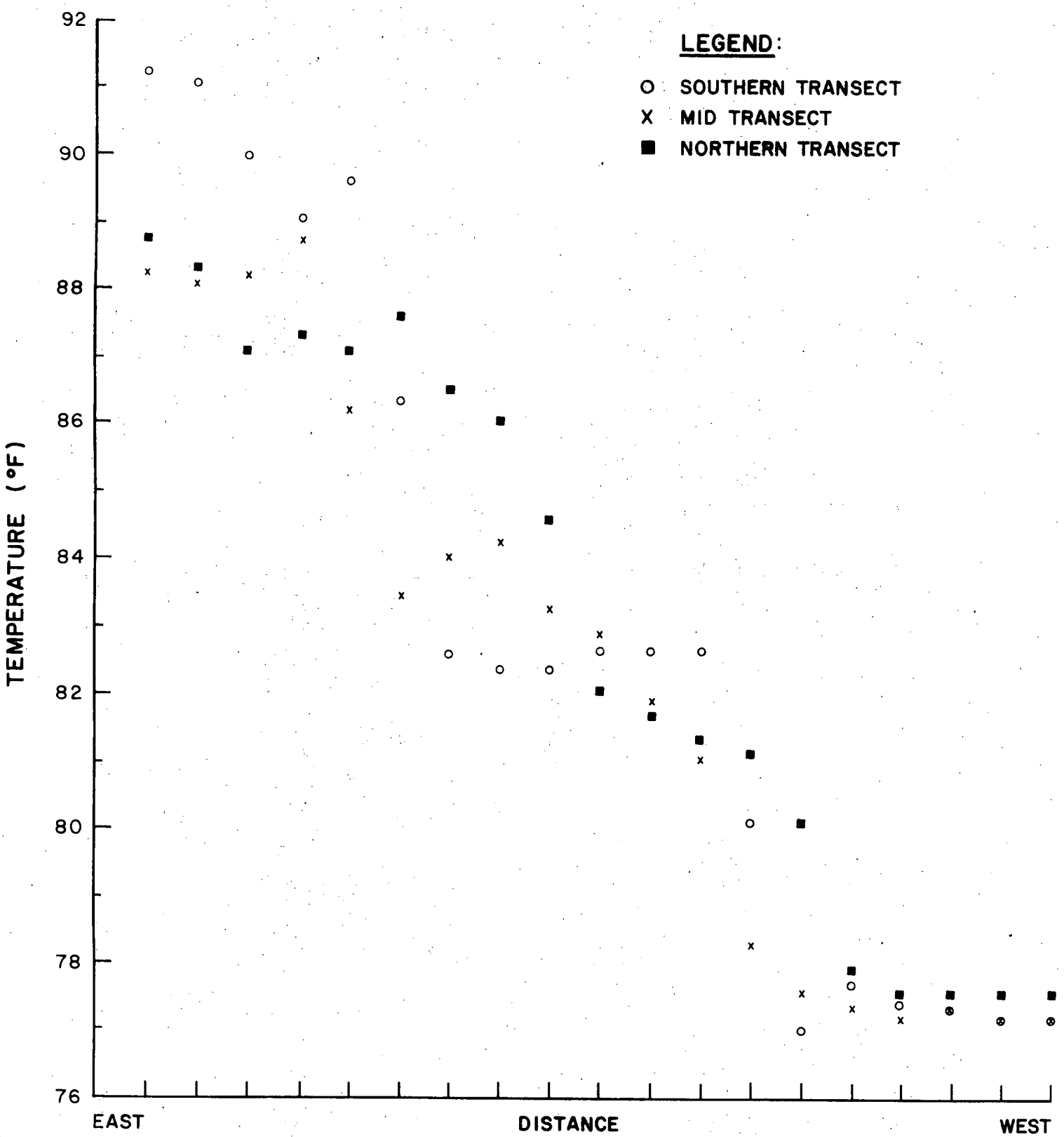
FIGURE 16.4

LATERAL TEMPERATURE SCAN AT ROUND ISLAND -
SURFACE, 3 AND 6 FOOT DEPTHS: EBB



LEGEND
1: SURFACE TEMPERATURE
2: 3 FOOT DEPTH TEMPERATURE
3: 6 FOOT DEPTH TEMPERATURE
A: SURFACE AND 3 FOOT DEPTH TEMPERATURE
B: SURFACE AND 6 FOOT DEPTH TEMPERATURE
C: 3 AND 6 FOOT DEPTH TEMPERATURE
D: SURFACE, 3 AND 6 FOOT DEPTH TEMPERATURE

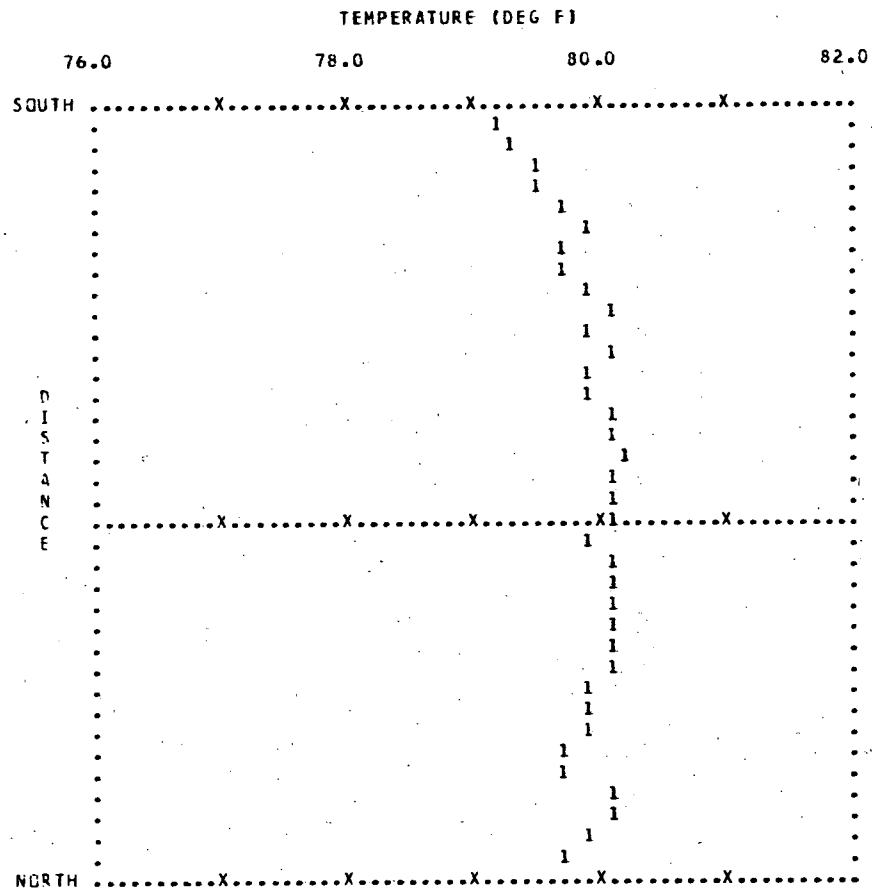
FIGURE 16.5



TEMPERATURE SCAN AT
LENTS COVE — SURFACE: EBB

FIGURE 16.6

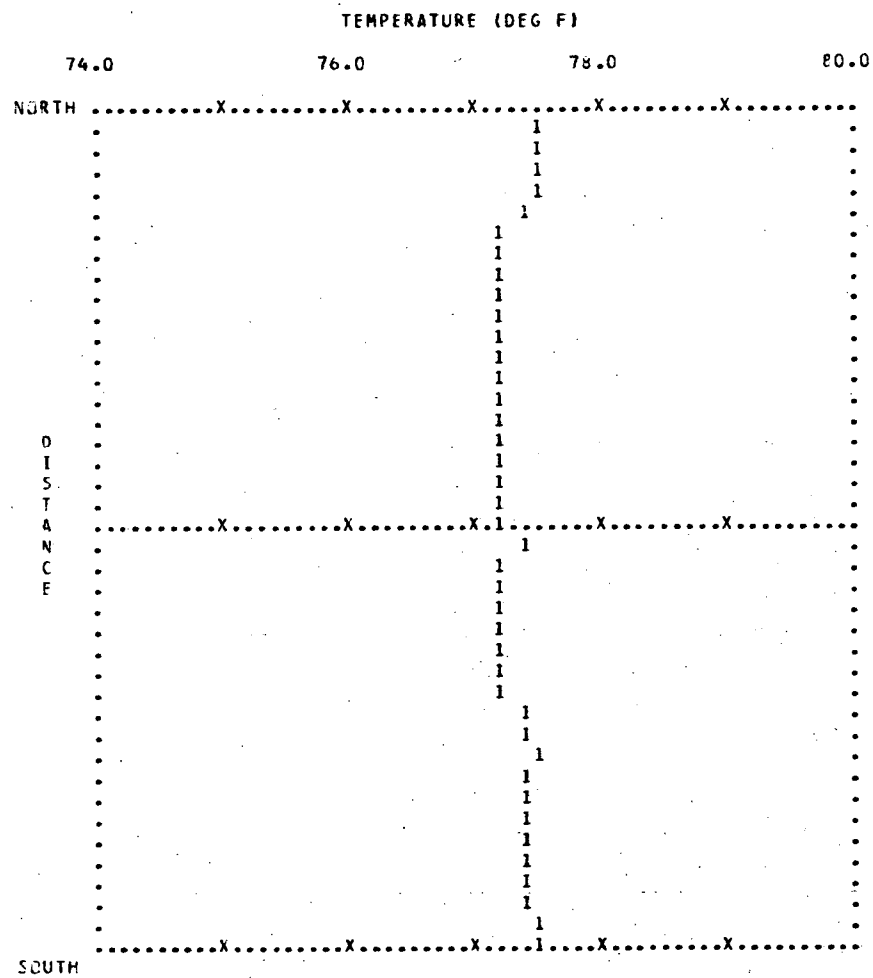
TEMPERATURE SCAN AT PEEKSKILL
BAY - SURFACE: EBB



LEGEND
1: SURFACE TEMPERATURE

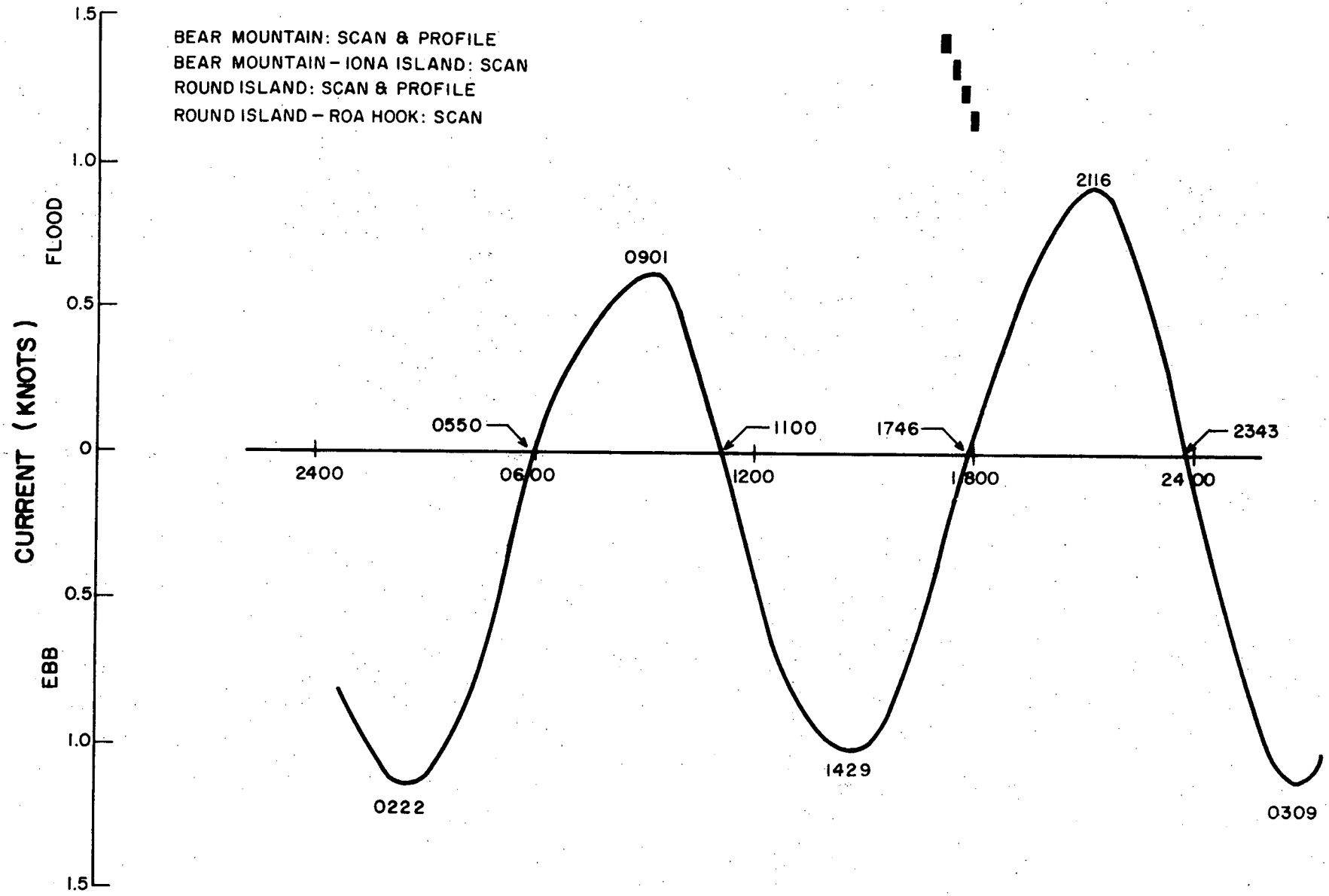
FIGURE 16.7a

TEMPERATURE SCAN AT PEEKSKILL
BAY - SURFACE: EBB



LEGEND
1: SURFACE TEMPERATURE

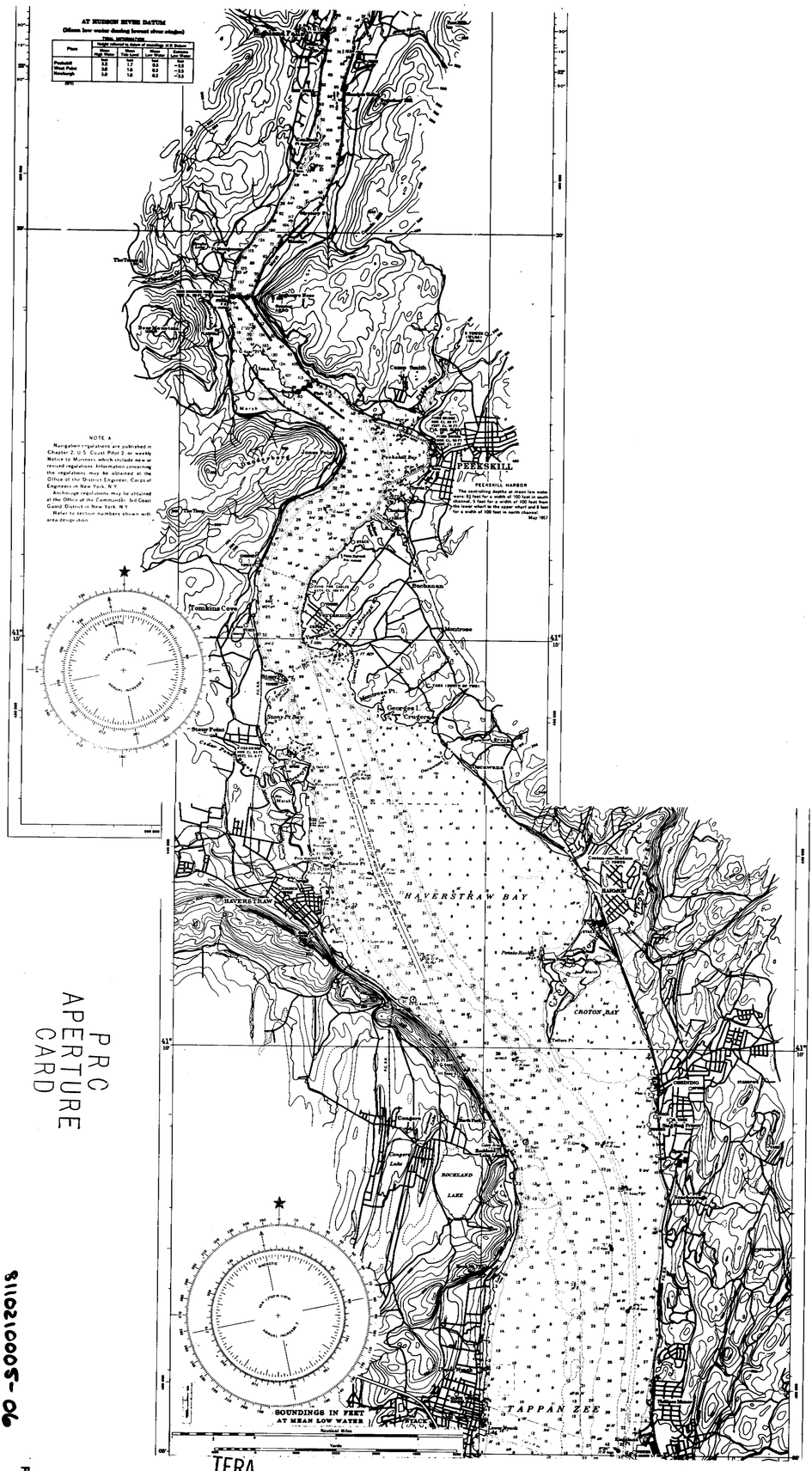
FIGURE 16.7b



TIDAL CURRENT: JULY 30, 1974

TIDAL CURRENT – TIME SEQUENCE OF TEMPERATURE MEASUREMENTS: LOW WATER SLACK

FIGURE 17.1



PRC APERTURE CARD

TERA APERTURE CARD

LOCATION OF TEMPERATURE MEASUREMENTS: LOW WATER SLACK

FIGURE 17.2

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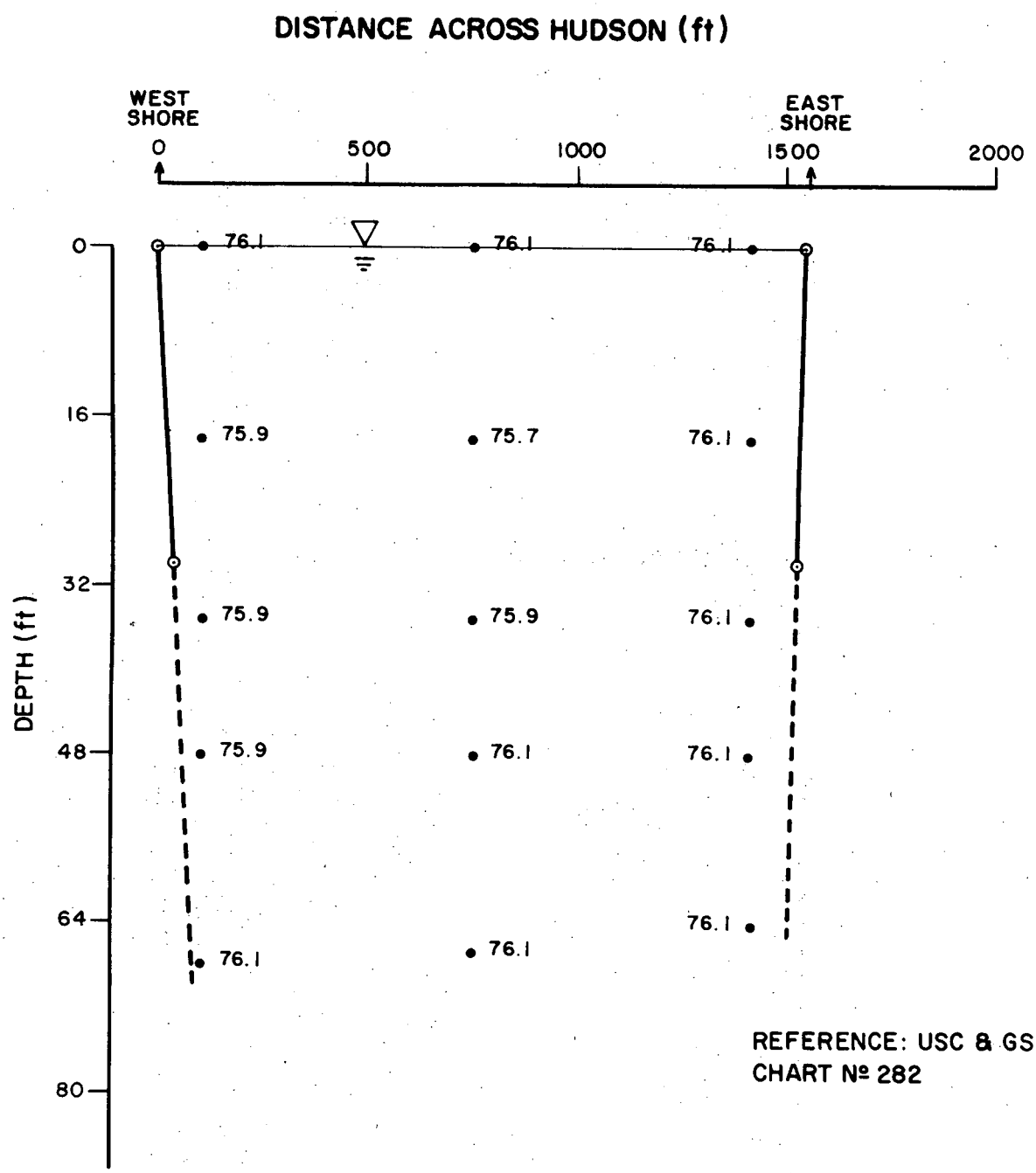
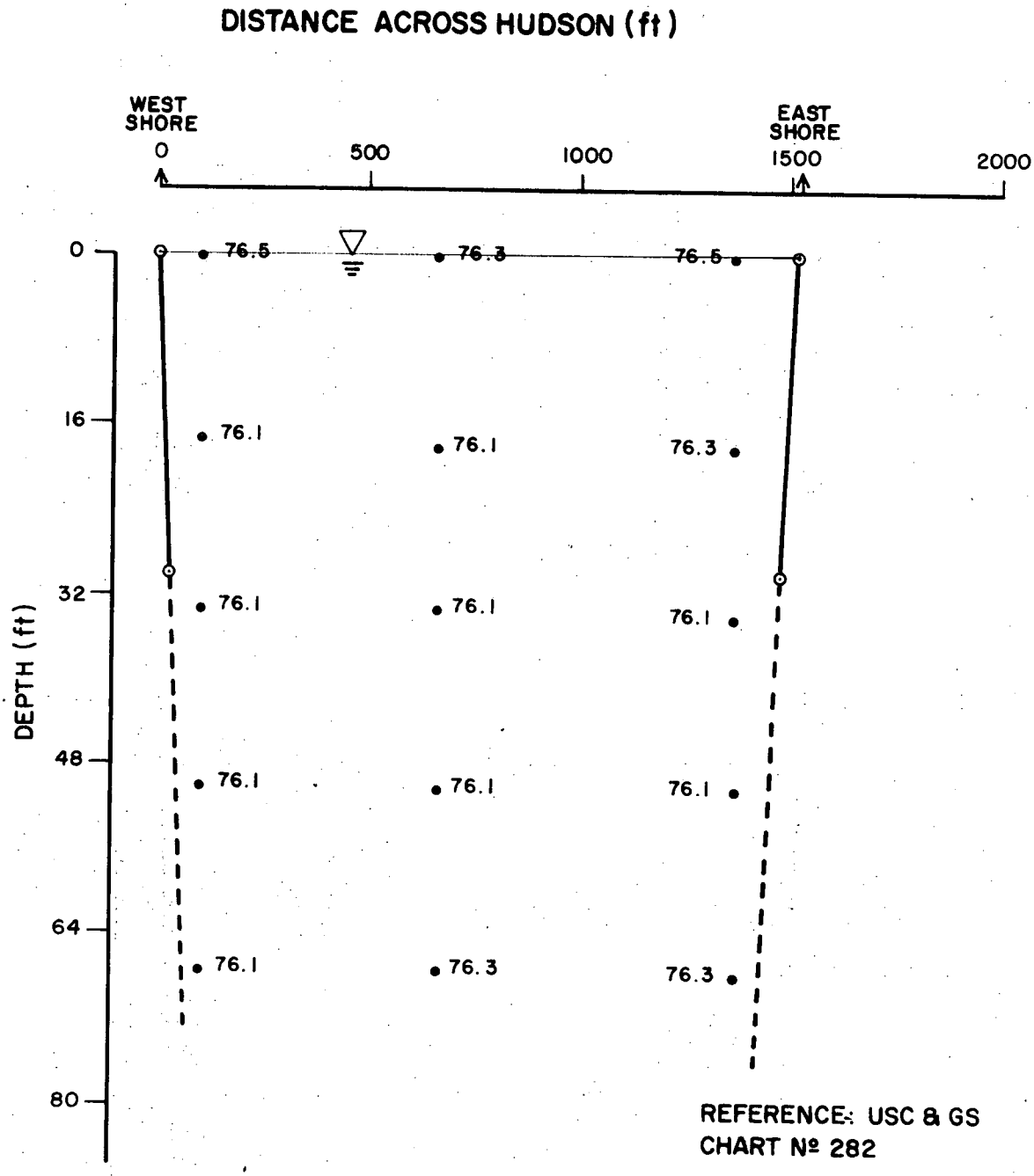


TRANSECT: BEAR MOUNTAIN BRIDGE
DATE: JULY 30, 1974
TIME: 1712-1720
TIDAL STAGE: LOW WATER SLACK
TEMPERATURE (°F)

TEMPERATURE PROFILE AT
BEAR MOUNTAIN BRIDGE: LWS

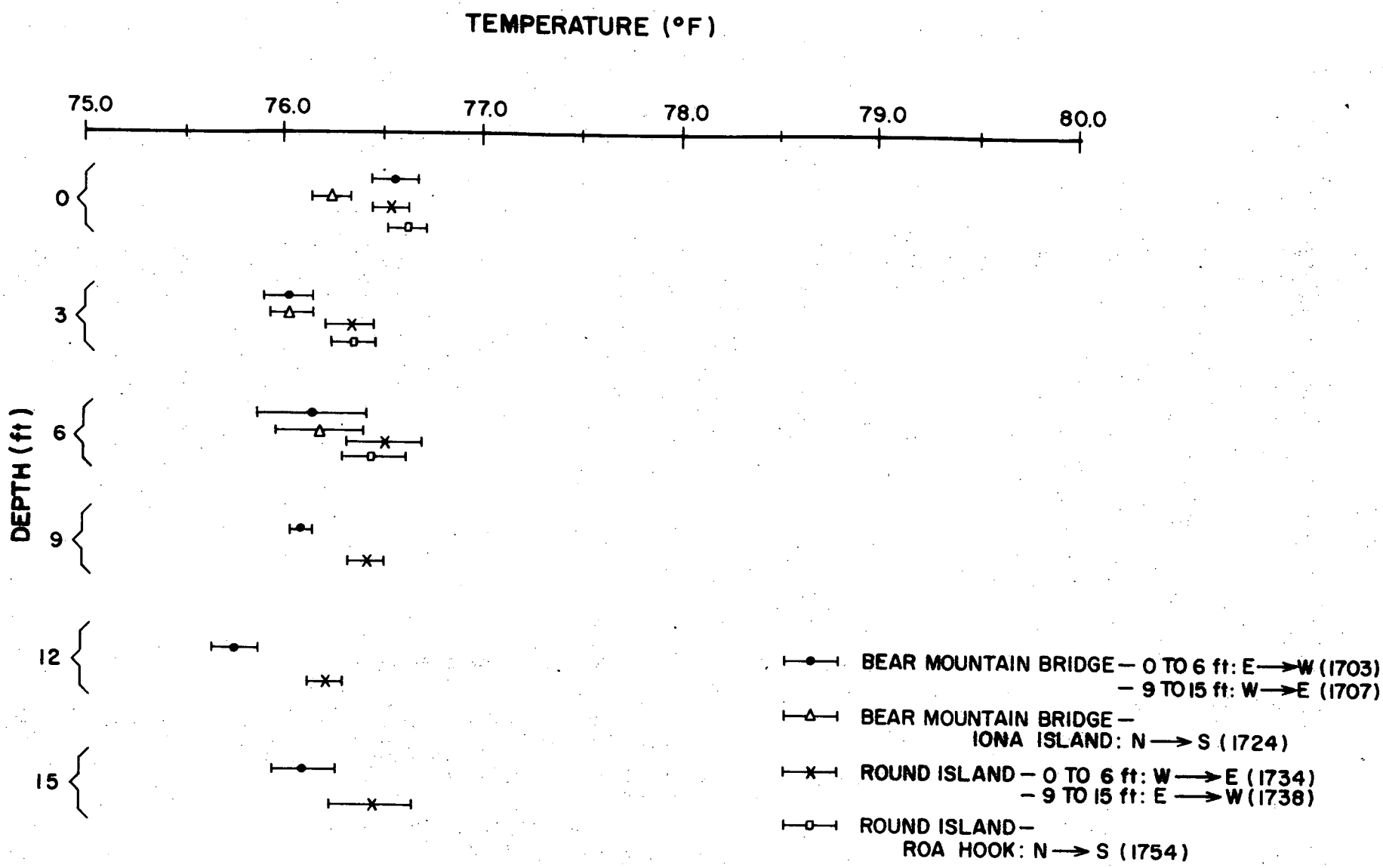
FIGURE 18.1



TRANSECT: ROUND ISLAND TO HOLE
DATE: JULY 30, 1974
TIME: 1744 - 1752
TIDAL STAGE: LOW WATER SLACK
TEMPERATURE (°F)

TEMPERATURE PROFILE AT ROUND ISLAND: LWS

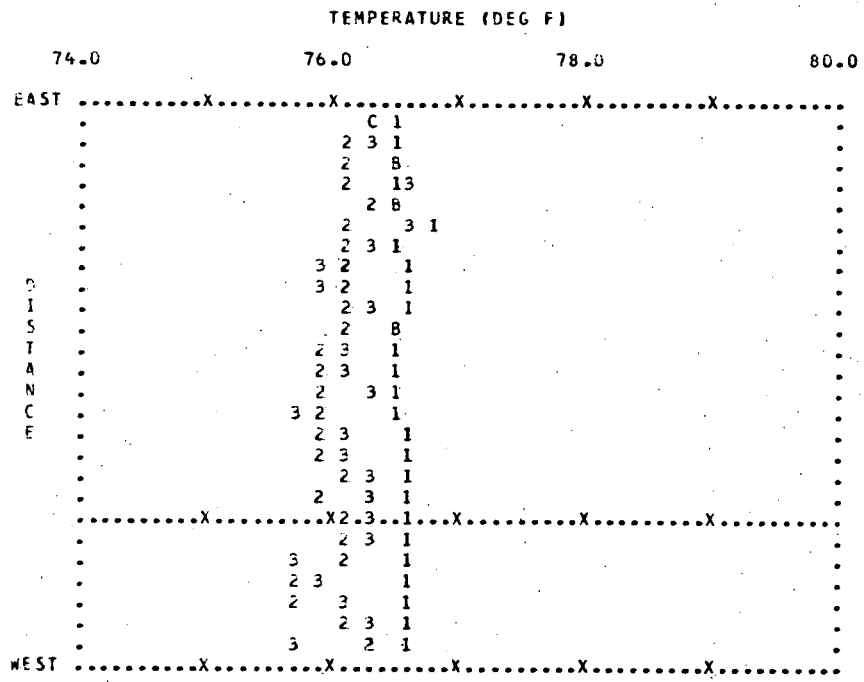
FIGURE 18.2



SCAN TEMPERATURES VS DEPTH: LWS

FIGURE 19.1

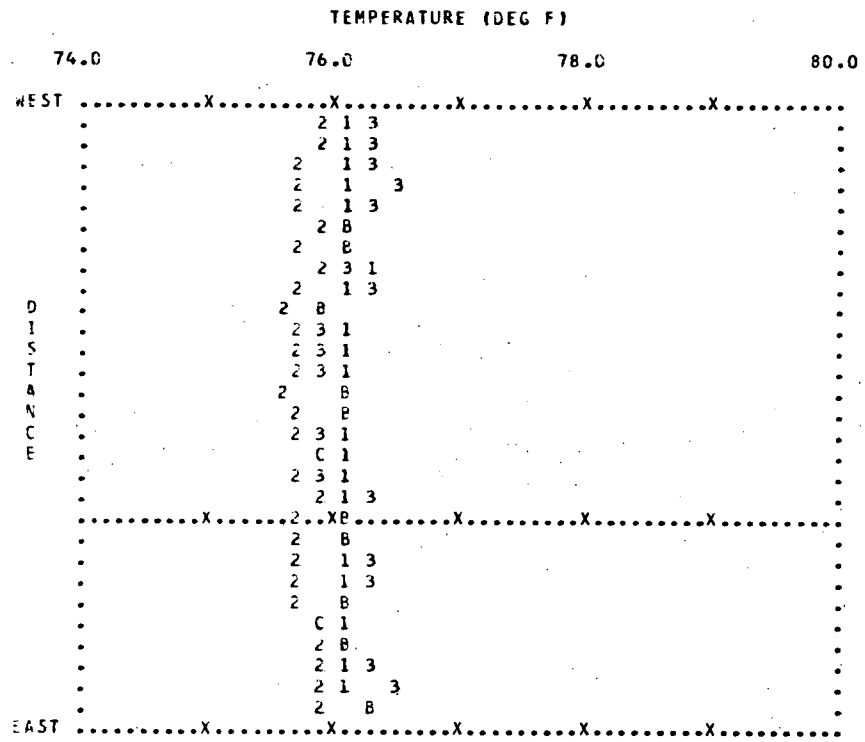
LATERAL TEMPERATURE SCAN AT BEAR MOUNTAIN
BRIDGE - SURFACE, 3 AND
6 FOOT DEPTHS: LWS



LEGEND
1: SURFACE TEMPERATURE
2: 3 FOOT DEPTH TEMPERATURE
3: 6 FOOT DEPTH TEMPERATURE
A: SURFACE AND 3 FOOT DEPTH TEMPERATURE
B: SURFACE AND 6 FOOT DEPTH TEMPERATURE
C: 3 AND 6 FOOT DEPTH TEMPERATURE
D: SURFACE, 3 AND 6 FOOT DEPTH TEMPERATURE

FIGURE 19.2

TUESDAY JULY 30, 1974 SURVEY - AMBIENT LWS 1707
BEAR MOUNTAIN BRIDGE - WEST TO EAST
9,12,15 FEET - 10 SEC INTERVAL

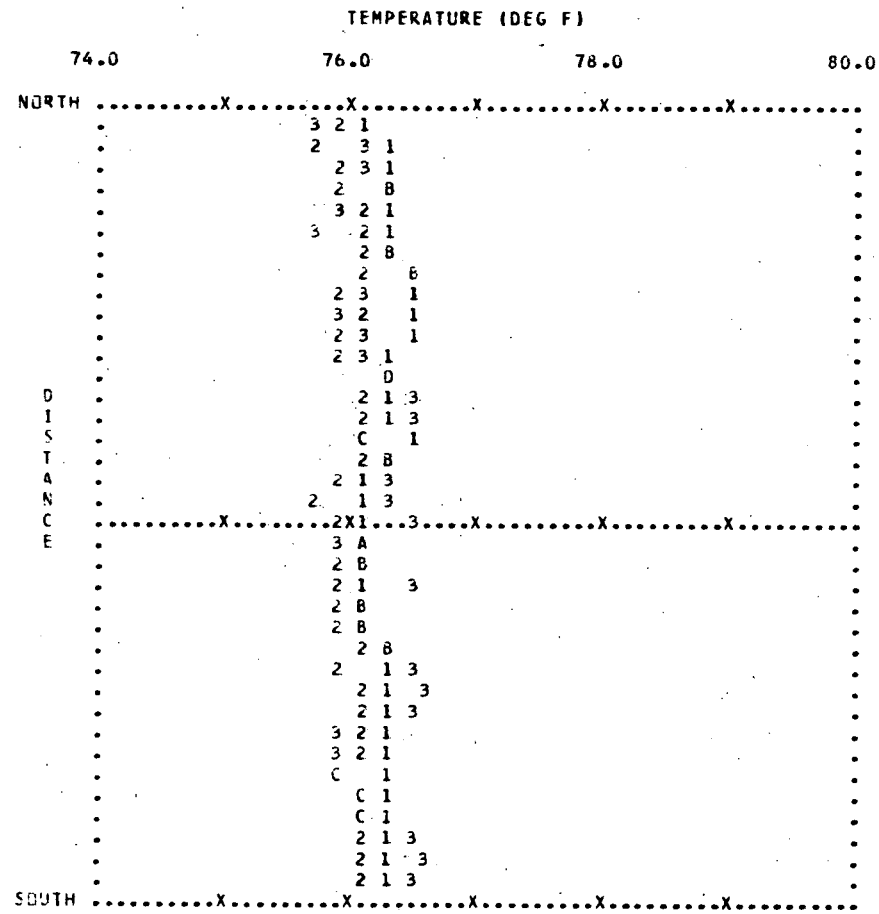


LEGEND
1: 9 FOOT DEPTH TEMPERATURE
2: 12 FOOT DEPTH TEMPERATURE
3: 15 FOOT DEPTH TEMPERATURE
A: 9 AND 12 FOOT DEPTH TEMPERATURE
B: 9 AND 15 FOOT DEPTH TEMPERATURE
C: 12 AND 15 FOOT DEPTH TEMPERATURE
D: 9,12 AND 15 FOOT DEPTH TEMPERATURES

LATERAL TEMPERATURE SCAN AT BEAR MOUNTAIN BRIDGE - 9, 12 AND 15 FOOT DEPTHS: LWS

FIGURE 19.3

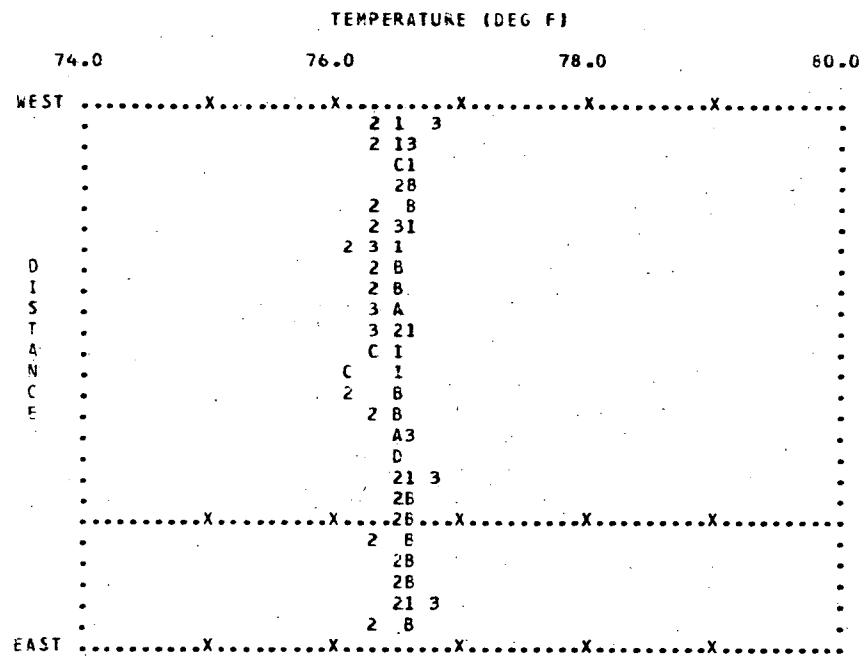
LONGITUDINAL TEMPERATURE SCAN, BEAR MOUNTAIN BRIDGE TO IONA ISLAND - SURFACE, 3 AND 6 FOOT DEPTHS: LWS



LEGEND
1: SURFACE TEMPERATURE
2: 3 FOOT DEPTH TEMPERATURE
3: 6 FOOT DEPTH TEMPERATURE
A: SURFACE AND 3 FOOT DEPTH TEMPERATURE
B: SURFACE AND 6 FOOT DEPTH TEMPERATURE
C: 3 AND 6 FOOT DEPTH TEMPERATURE
D: SURFACE, 3 AND 6 FOOT DEPTH TEMPERATURE

FIGURE 19.4

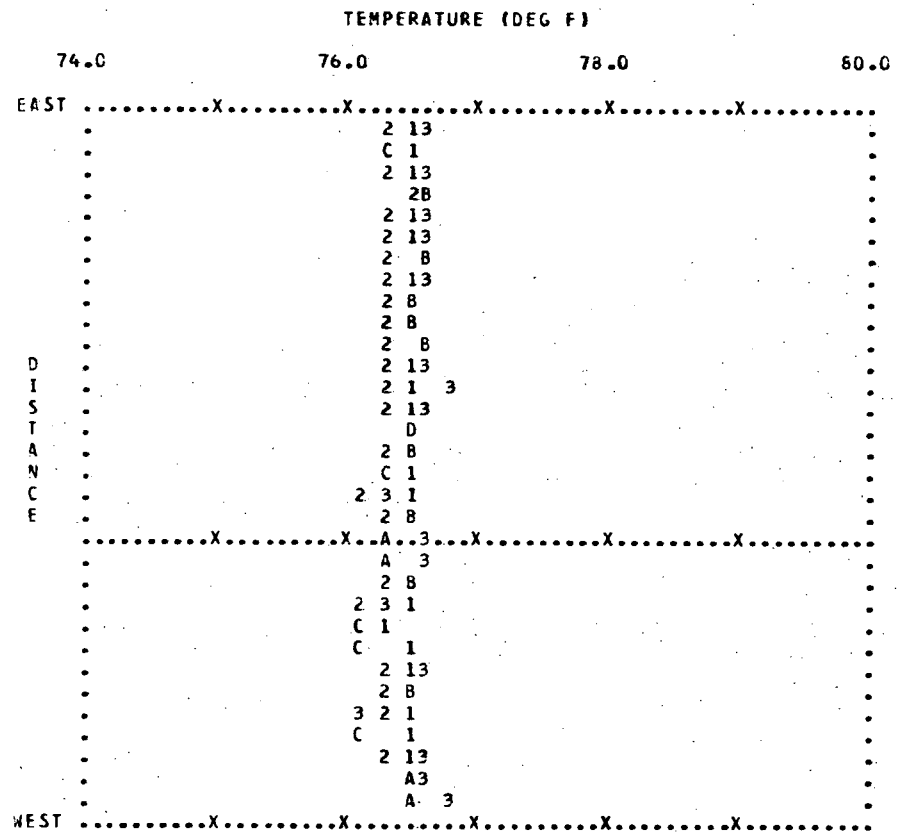
LATERAL TEMPERATURE SCAN AT ROUND ISLAND - SURFACE, 3 AND 6 FOOT DEPTHS: LWS



LEGEND
1: SURFACE TEMPERATURE
2: 3 FOOT DEPTH TEMPERATURE
3: 6 FOOT DEPTH TEMPERATURE
A: SURFACE AND 3 FOOT DEPTH TEMPERATURE
B: SURFACE AND 6 FOOT DEPTH TEMPERATURE
C: 3 AND 6 FOOT DEPTH TEMPERATURE
D: SURFACE, 3 AND 6 FOOT DEPTH TEMPERATURE

FIGURE 19.5

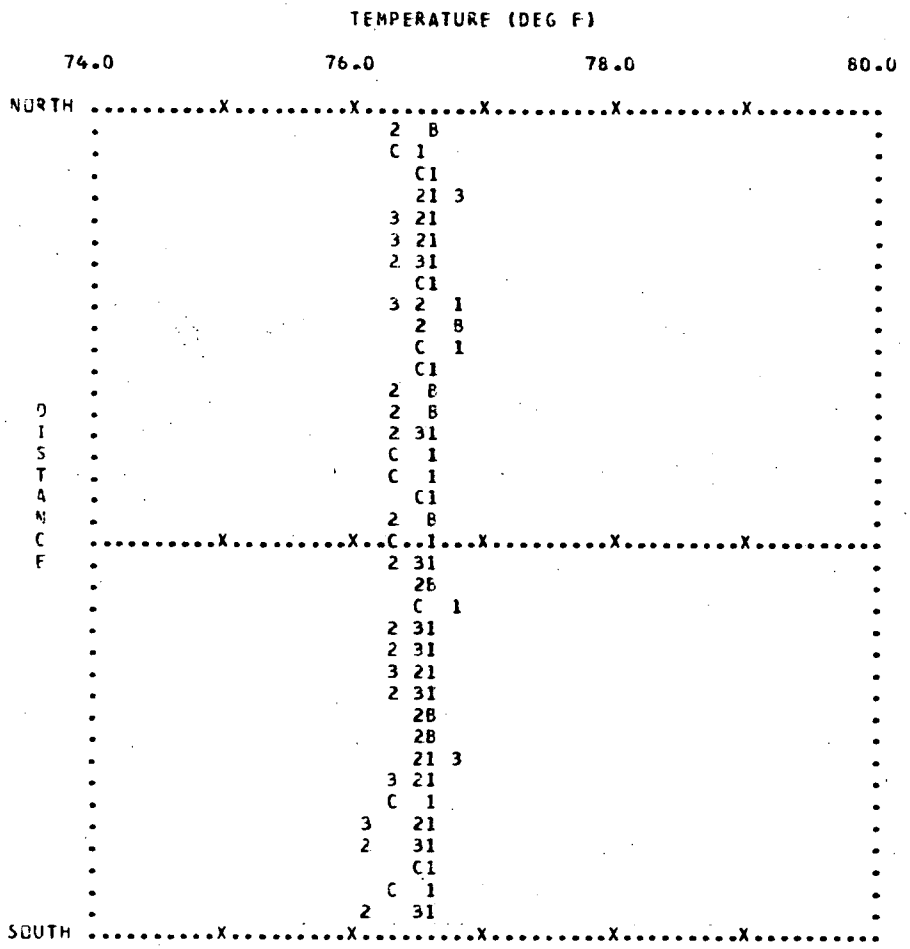
LATERAL TEMPERATURE SCAN AT ROUND ISLAND -
9, 12 AND 15 FOOT DEPTHS: LWS



LEGEND
1: 9 FOOT DEPTH TEMPERATURE
2: 12 FOOT DEPTH TEMPERATURE
3: 15 FOOT DEPTH TEMPERATURE
A: 9 AND 12 FOOT DEPTH TEMPERATURE
B: 9 AND 15 FOOT DEPTH TEMPERATURE
C: 12 AND 15 FOOT DEPTH TEMPERATURE
D: 9,12 AND 15 FOOT DEPTH TEMPERATURES

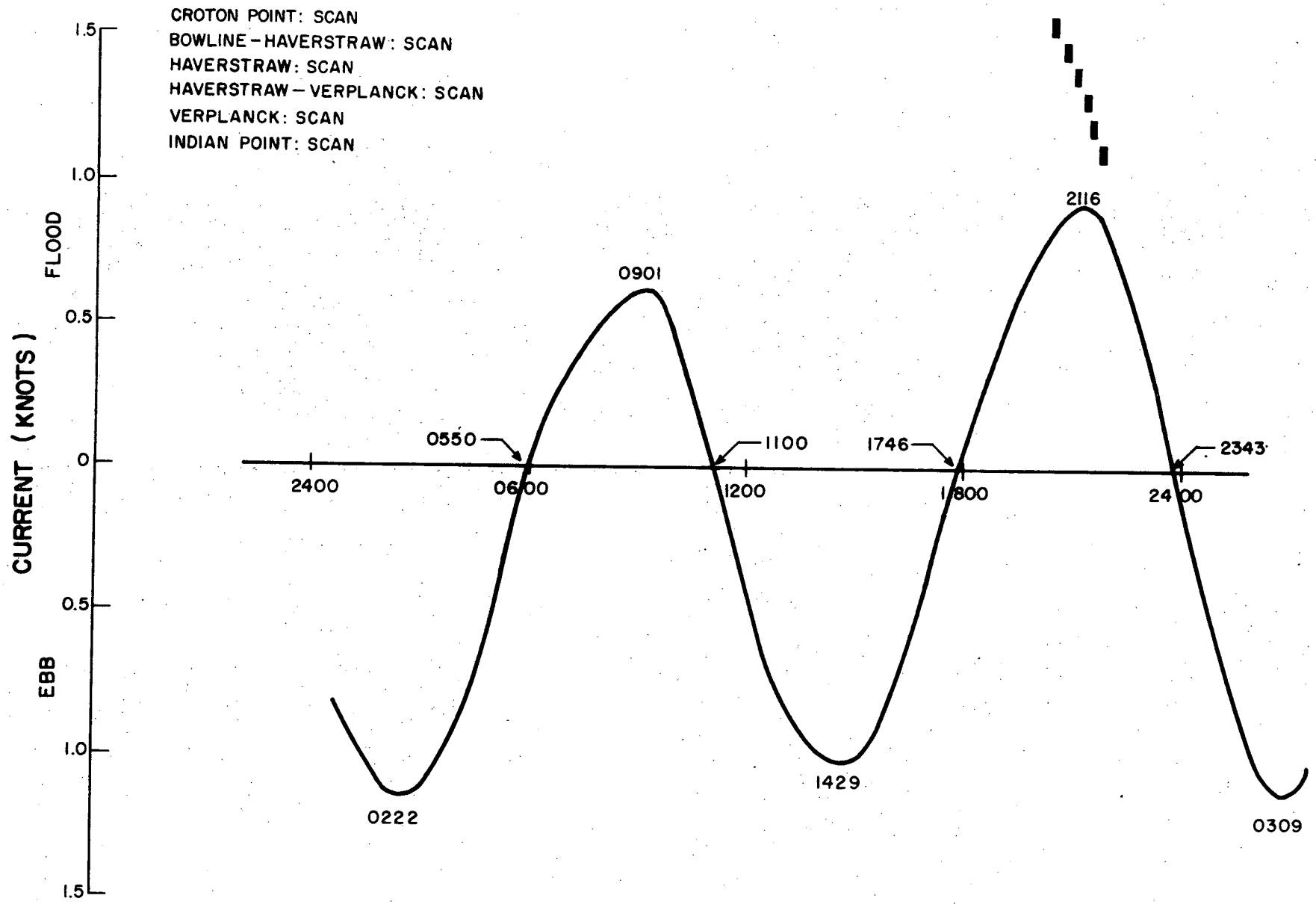
FIGURE 19.6

LONGITUDINAL TEMPERATURE SCAN, ROUND ISLAND
TO ROA HOOK - SURFACE, 3 AND
6 FOOT DEPTHS: LWS



LEGEND
1: SURFACE TEMPERATURE
2: 3 FOOT DEPTH TEMPERATURE
3: 6 FOOT DEPTH TEMPERATURE
A: SURFACE AND 3 FOOT DEPTH TEMPERATURE
B: SURFACE AND 6 FOOT DEPTH TEMPERATURE
C: 3 AND 6 FOOT DEPTH TEMPERATURE
D: SURFACE, 3 AND 6 FOOT DEPTH TEMPERATURE

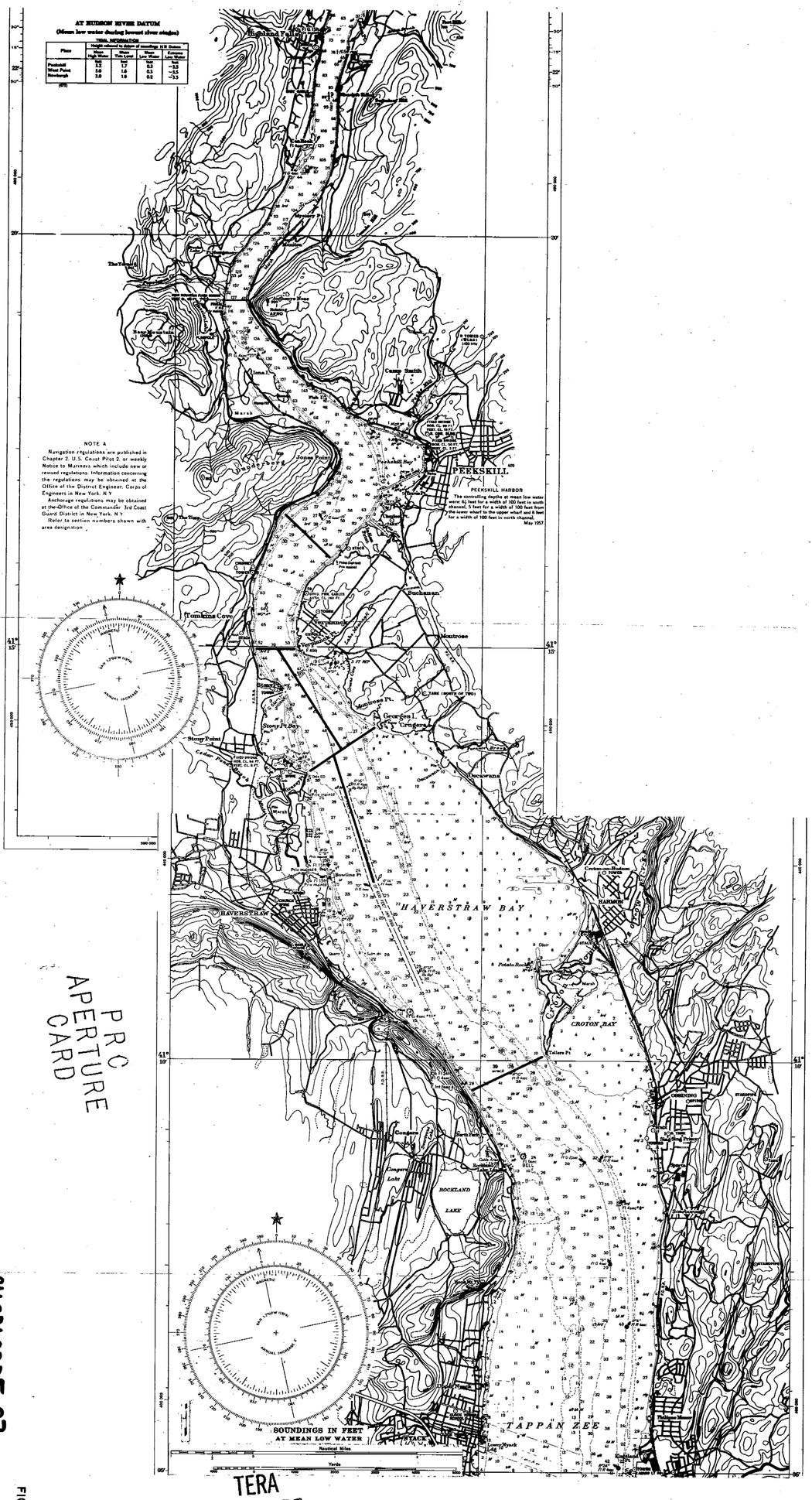
FIGURE 19.7



TIDAL CURRENT: JULY 30, 1974

TIDAL CURRENT – TIME SEQUENCE OF TEMPERATURE MEASUREMENTS: SECOND FLOOD

FIGURE 20.1



PRC APERTURE CARD

TERA APERTURE CARD

LOCATION OF TEMPERATURE MEASUREMENTS: SECOND FLOOD

FIGURE 20.2

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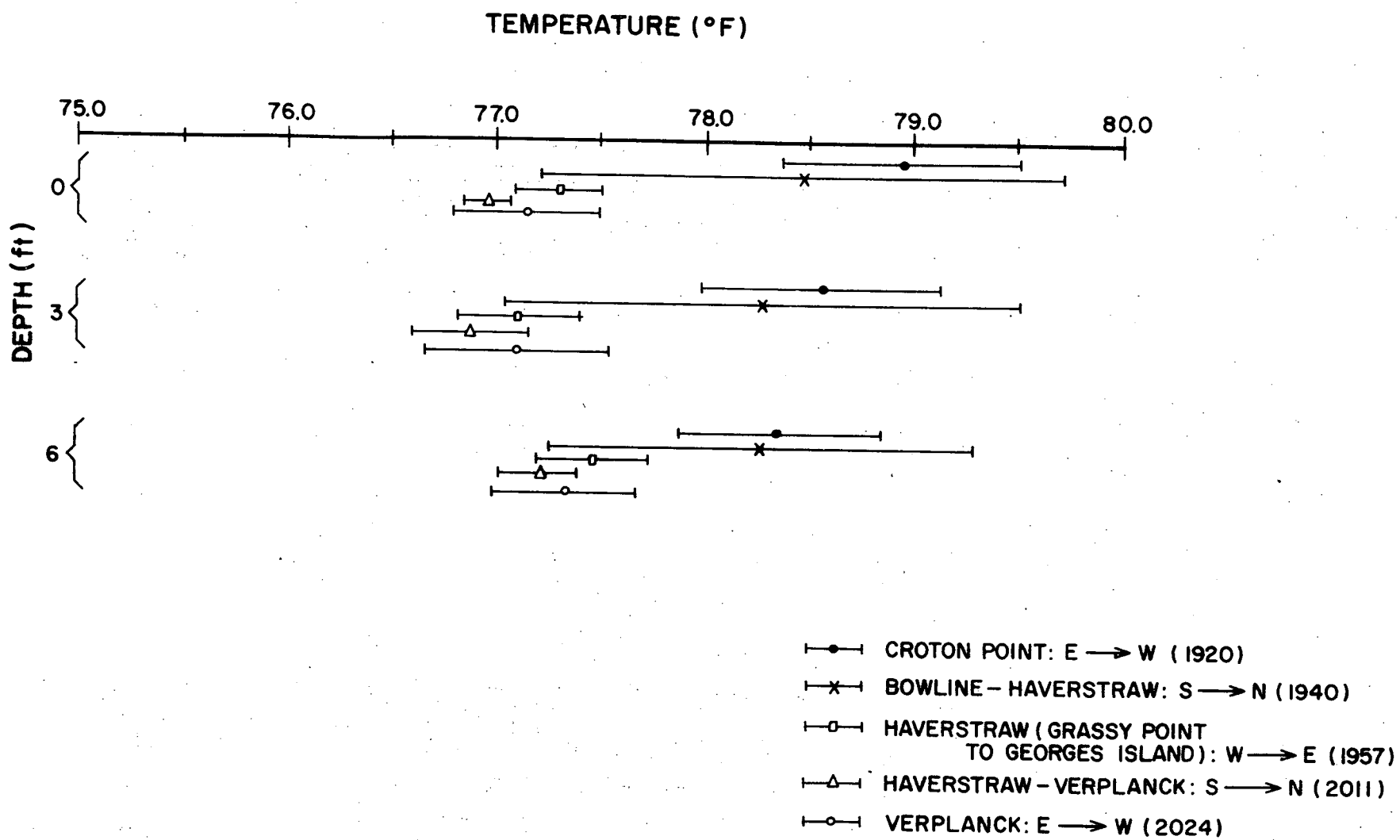
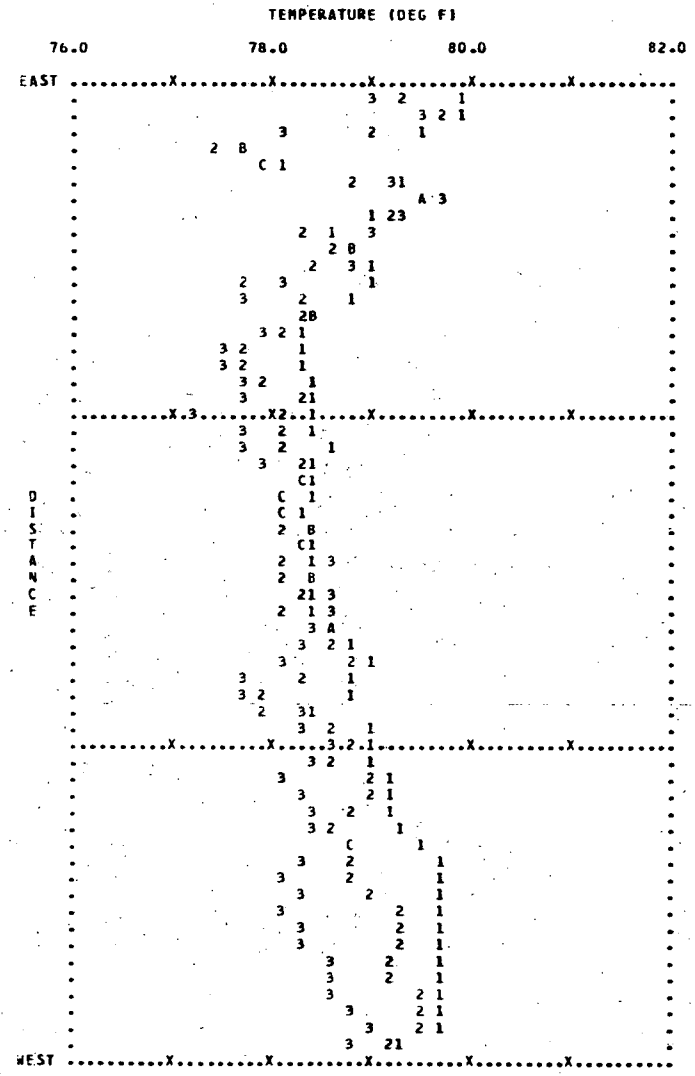


SCAN TEMPERATURES VS DEPTH: SECOND FLOOD

FIGURE 21.1



LEGEND
1: SURFACE TEMPERATURE
2: 3 FOOT DEPTH TEMPERATURE
3: 6 FOOT DEPTH TEMPERATURE
A: SURFACE AND 3 FOOT DEPTH TEMPERATURE
B: SURFACE AND 6 FOOT DEPTH TEMPERATURE
C: 3 AND 6 FOOT DEPTH TEMPERATURE
D: SURFACE, 3 AND 6 FOOT DEPTH TEMPERATURE

LATERAL TEMPERATURE SCAN AT CROTON POINT - SURFACE, 3 AND 6 FOOT DEPTHS: SECOND FLOOD

FIGURE 21.2

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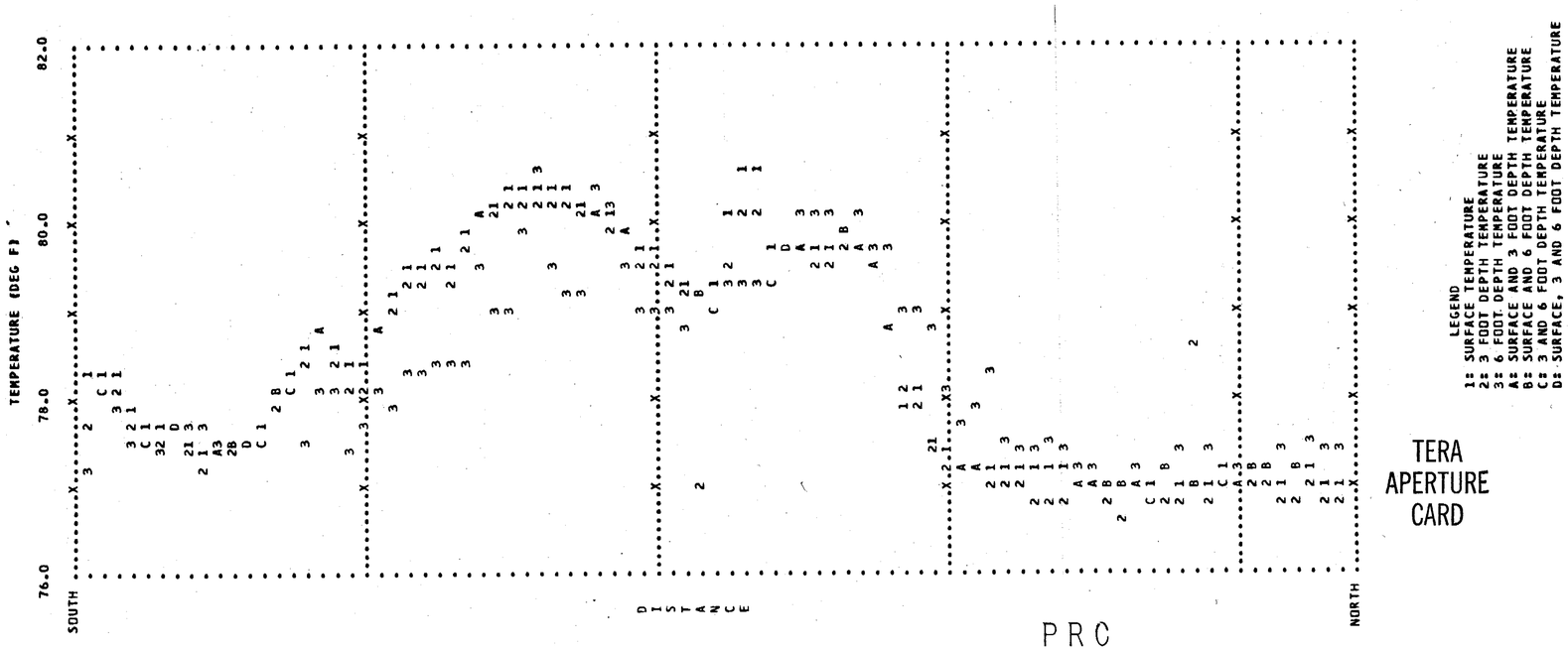
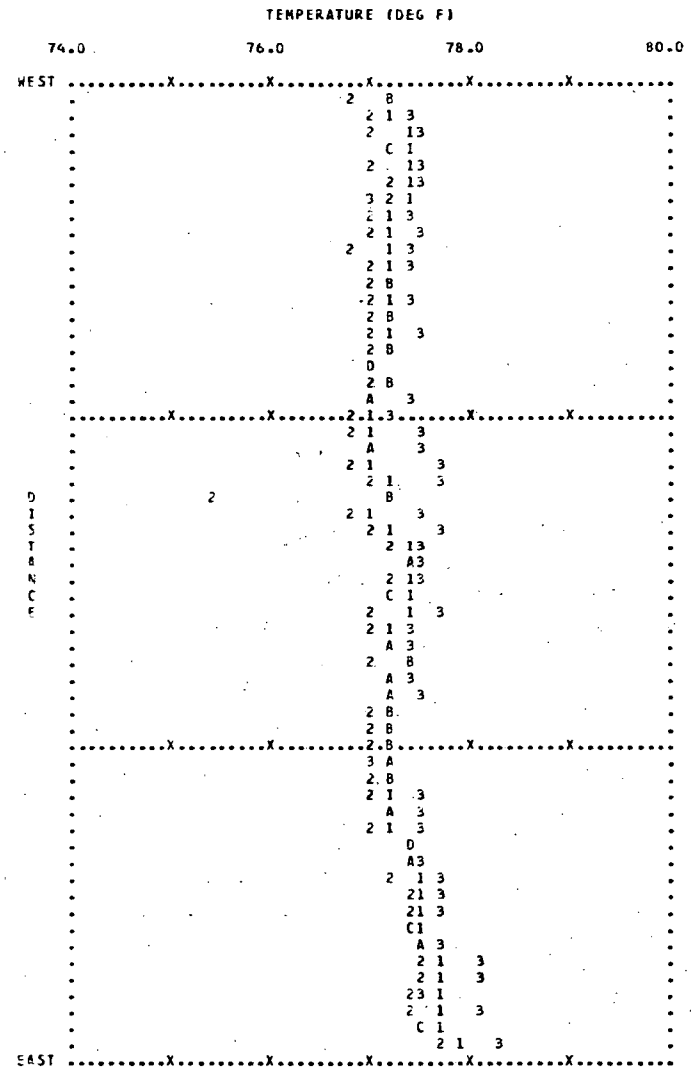
LONGITUDINAL TEMPERATURE SCAN, BOWLINE
POINT TO HAVERSTRAW - SURFACE, 3 AND
6 FOOT DEPTHS: SECOND FLOOD



TERA
APERTURE
CARD

PRC
APERTURE
CARD

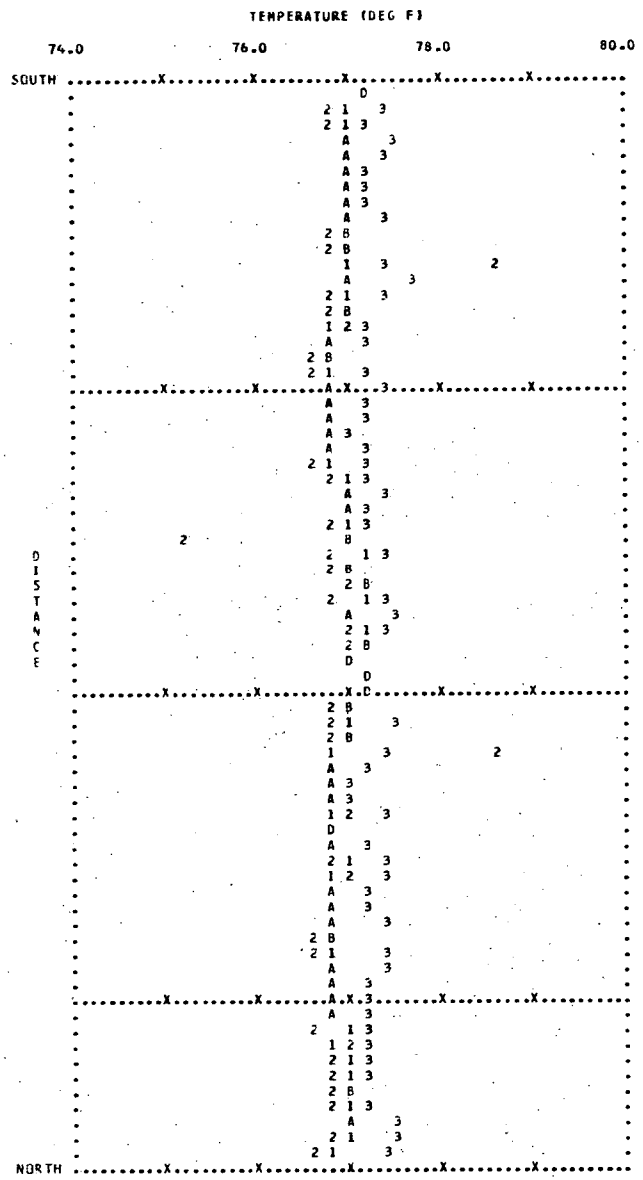
FIGURE 21.3



LEGEND
1: SURFACE TEMPERATURE
2: 3 FOOT DEPTH TEMPERATURE
3: 6 FOOT DEPTH TEMPERATURE
A: SURFACE AND 3 FOOT DEPTH TEMPERATURE
B: SURFACE AND 6 FOOT DEPTH TEMPERATURE
C: 3 AND 6 FOOT DEPTH TEMPERATURE
D: SURFACE, 3 AND 6 FOOT DEPTH TEMPERATURE

LATERAL TEMPERATURE SCAN AT
HAVERSTRAW - SURFACE, 3 AND
6 FOOT DEPTHS: SECOND FLOOD

FIGURE 21.4

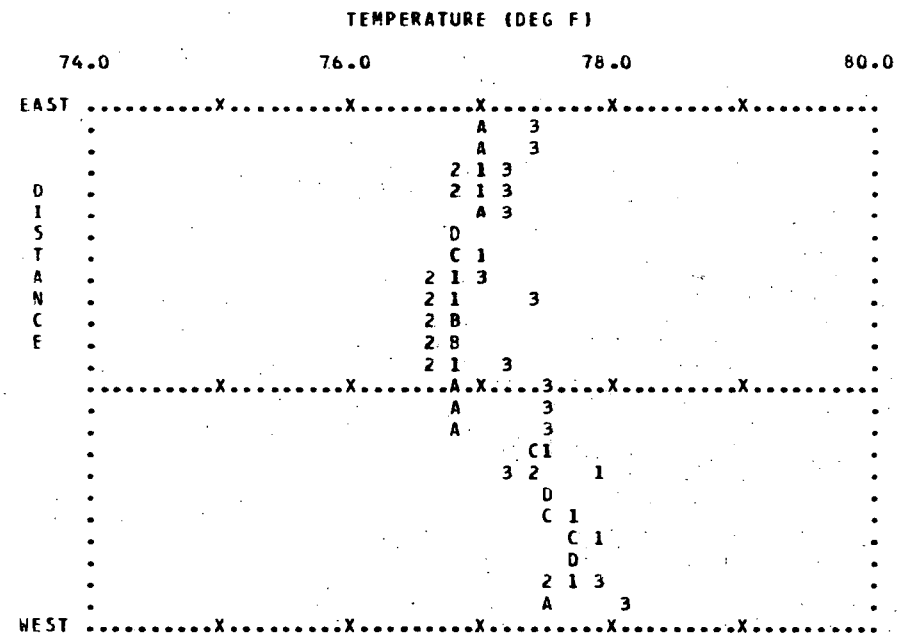


LEGEND
1= SURFACE TEMPERATURE
2= 3 FOOT DEPTH TEMPERATURE
3= 6 FOOT DEPTH TEMPERATURE
A= SURFACE AND 3 FOOT DEPTH TEMPERATURE
B= SURFACE AND 6 FOOT DEPTH TEMPERATURE
C= 3 AND 6 FOOT DEPTH TEMPERATURE
D= SURFACE, 3 AND 6 FOOT DEPTH TEMPERATURE

LONGITUDINAL TEMPERATURE SCAN, HAVERSTRAW TO VERPLANCK - SURFACE, 3 AND 6 FOOT DEPTHS: SECOND FLOOD

FIGURE 21.5

LATERAL TEMPERATURE SCAN AT VERPLANCK -
SURFACE, 3 AND 6 FOOT
DEPTHS: SECOND FLOOD



LEGEND
1: SURFACE TEMPERATURE
2: 3 FOOT DEPTH TEMPERATURE
3: 6 FOOT DEPTH TEMPERATURE
A: SURFACE AND 3 FOOT DEPTH TEMPERATURE
B: SURFACE AND 6 FOOT DEPTH TEMPERATURE
C: 3 AND 6 FOOT DEPTH TEMPERATURE
D: SURFACE, 3 AND 6 FOOT DEPTH TEMPERATURE

FIGURE 21.6

LATERAL TEMPERATURE SCAN AT INDIAN POINT -
SURFACE: SECOND FLOOD

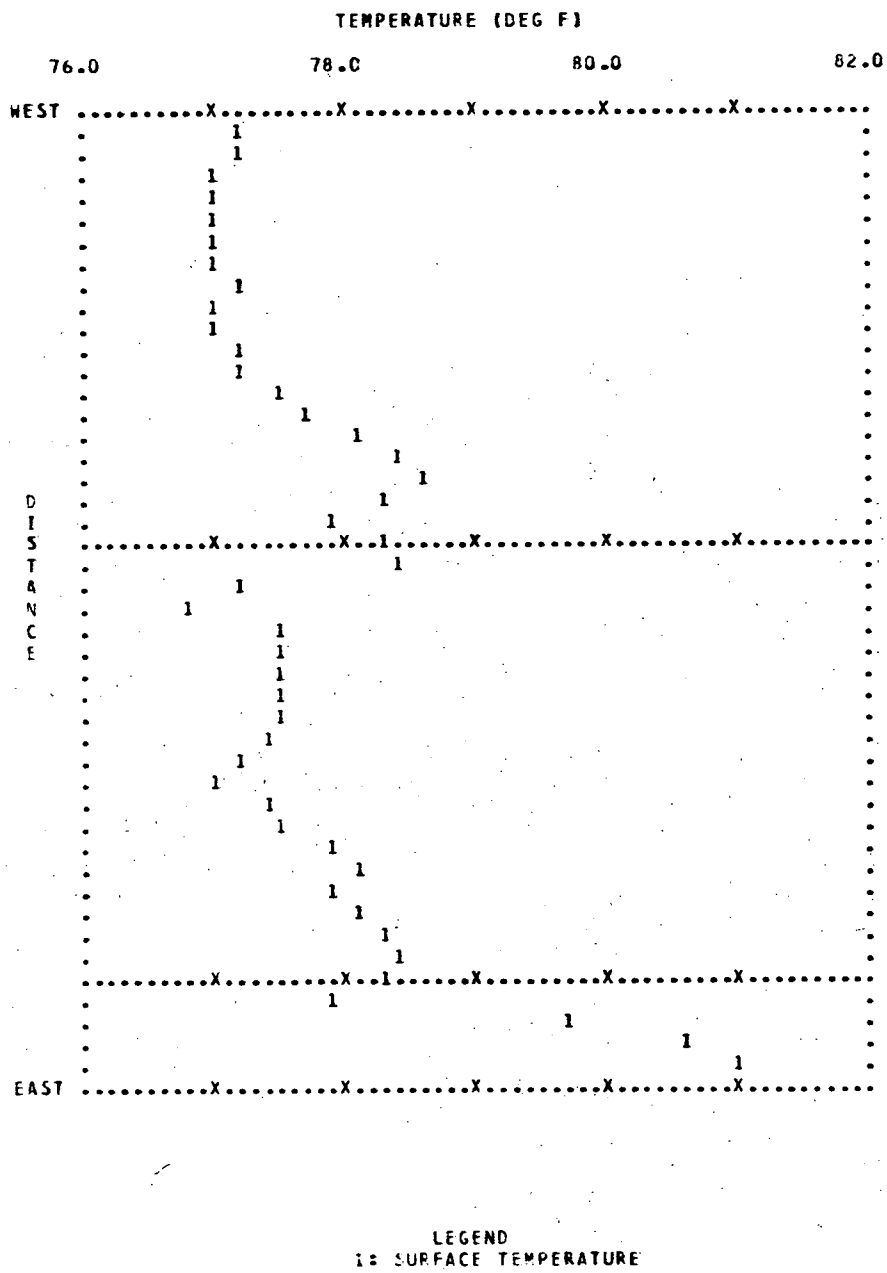
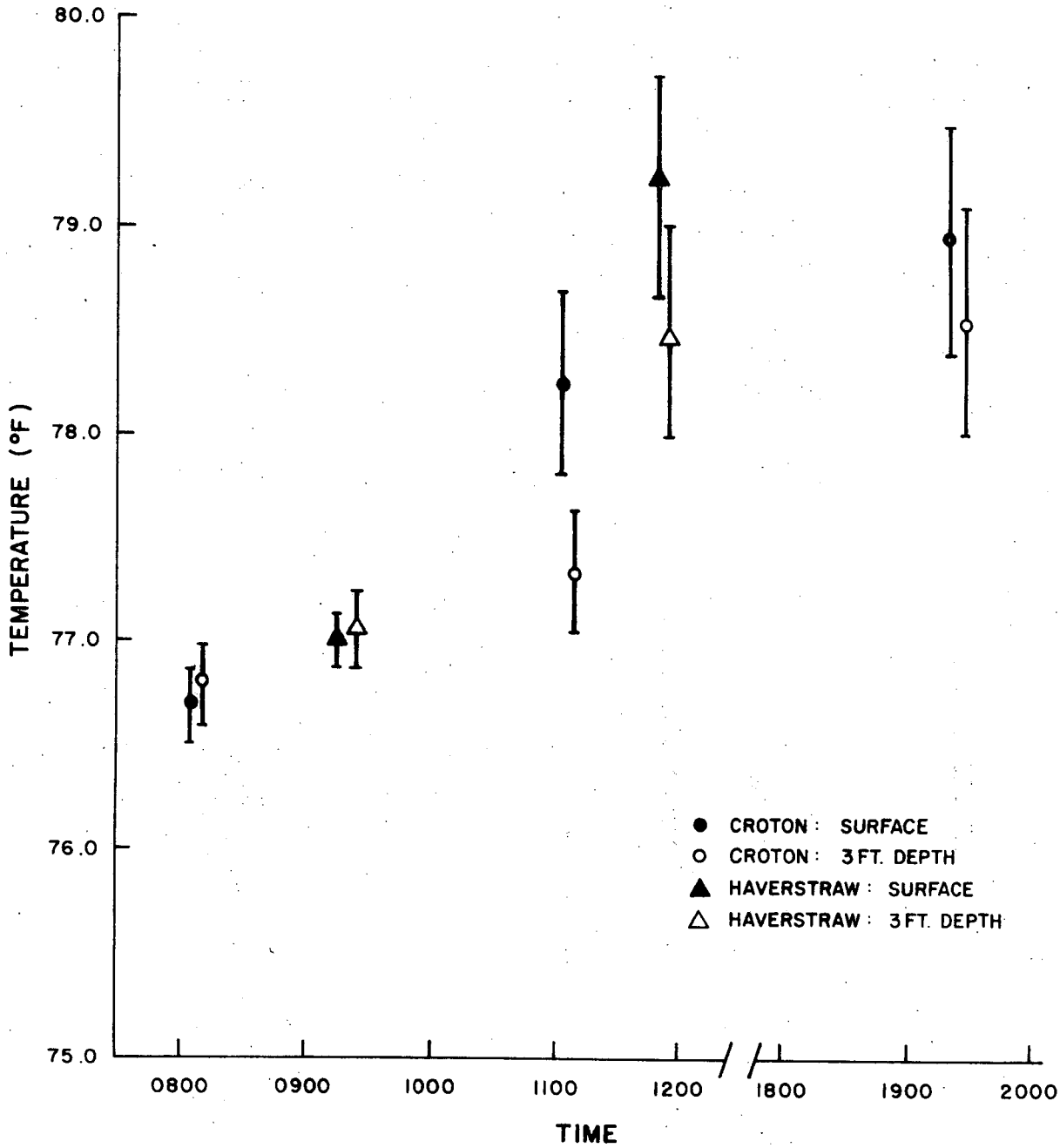
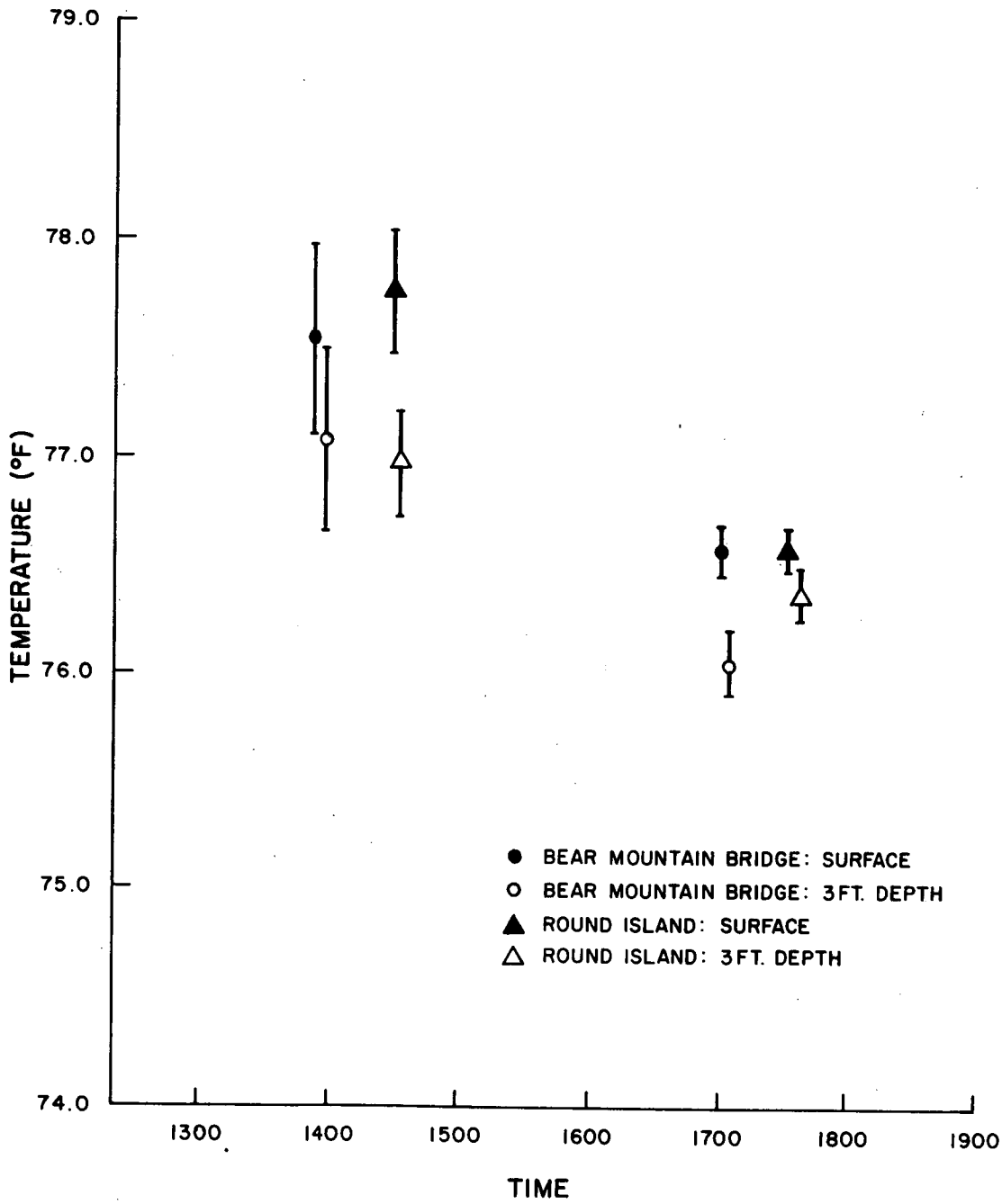


FIGURE 21.7



TIME VARIATION OF SURFACE
AND 3 FOOT DEPTH TEMPERATURES:
SOUTH REACH

FIGURE 22.1



TIME VARIATION OF SURFACE
AND 3 FOOT DEPTH TEMPERATURES:
NORTH REACH

FIGURE 22.2

17-1D