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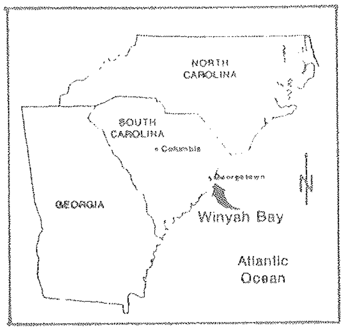

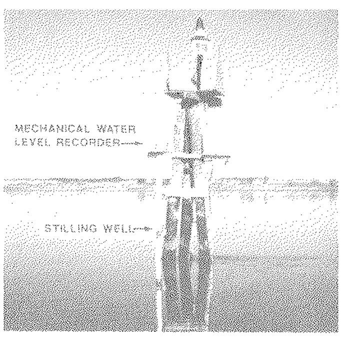

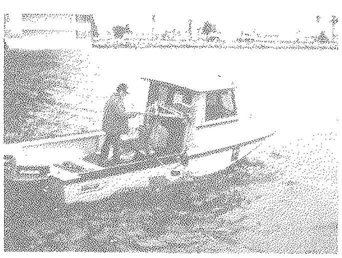

HYDRAULICS LABORATORY

TECHNICAL REPORT HL-89-23

WINYAH BAY, GEORGETOWN, SOUTH CAROLINA, DATA COLLECTION SURVEY REPORT

by

Timothy L. Fagerburg

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DEPARTMENT OF THE ARMY
Waterways Experiment Station, Corps of Engineers
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U.S. ARMY ENGINEER WATERWAYS EXPERIMENT STATION

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Water levels, current speeds and directions, salinities, suspended sediment concentrations, bed sediment characteristics, and densities were measured in Winyah Bay, SC, in January 1989. The prototype data were collected as part of a study to evaluate the effects of a dredged material placement operation to create a wetland marsh in the bay. The report describes the equipment and procedures used in the data acquisition and presents tables, plots, and summaries of all the data collected.

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PREFACE

The field investigation reported herein was conducted by the US Army Engineer Waterways Experiment Station (WES), Vicksburg, MS, during the period 1 October 1988 through 8 March 1989 to provide the necessary data for support of the Georgetown Harbor Channel Project, Georgetown, SC. This effort was funded by the US Army Engineer District, Charleston, under the project management of Messrs. Braxton Kyzer and Steve Morrison.

Personnel of the WES Hydraulics Laboratory (HL) performed the work under the general supervision of Messrs. F. A. Herrmann, Jr., Chief, HL; R. A. Sager, Assistant Chief, HL; W. H. McAnally, Jr., Chief, Estuaries Division; and G. M. Fisackerly, Chief, Estuarine Processes Branch (EPB). The data collection program was designed by Messrs. G. M. Fisackerly, T. L. Fagerburg, H. A. Benson, and J. W. Parman, EPB. Data reduction was performed by Mr. Fagerburg and Ms. C. J. Coleman, EPB. Laboratory analyses of water samples were performed by Mr. L. G. Caviness, EPB. The in situ sediment density profiles presented in Appendix A were prepared by Dr. Andrew P. Salkield, Sediment Instrumentation Research and Development, Moline, IL, for WES under Contract No. DACW 3989 M0913. This report was prepared by Mr. Fagerburg and edited by Mrs. M. C. Gay, Information Technology Laboratory, WES.

Commander and Director of WES during preparation of this report was COL Larry B. Fulton, EN. Technical Director was Dr. Robert W. Whalin.

CONTENTS

CONVERSION FACTORS, NON-SI TO SI (METRIC) UNITS OF MEASUREMENT

Non-SI units of measurement used in this report can be converted to SI (metric) units as follows:

Multiply	By	To Obtain
cubic feet	0.02831685	cubic metres
feet	0.3048	metres
gallons (US liquid)	3.785412	cubic decimetres
inches	25.4	millimetres
miles (US statute)	1.609347	kilometres
ounces (US fluid)	0.02957353	cubic decimetres

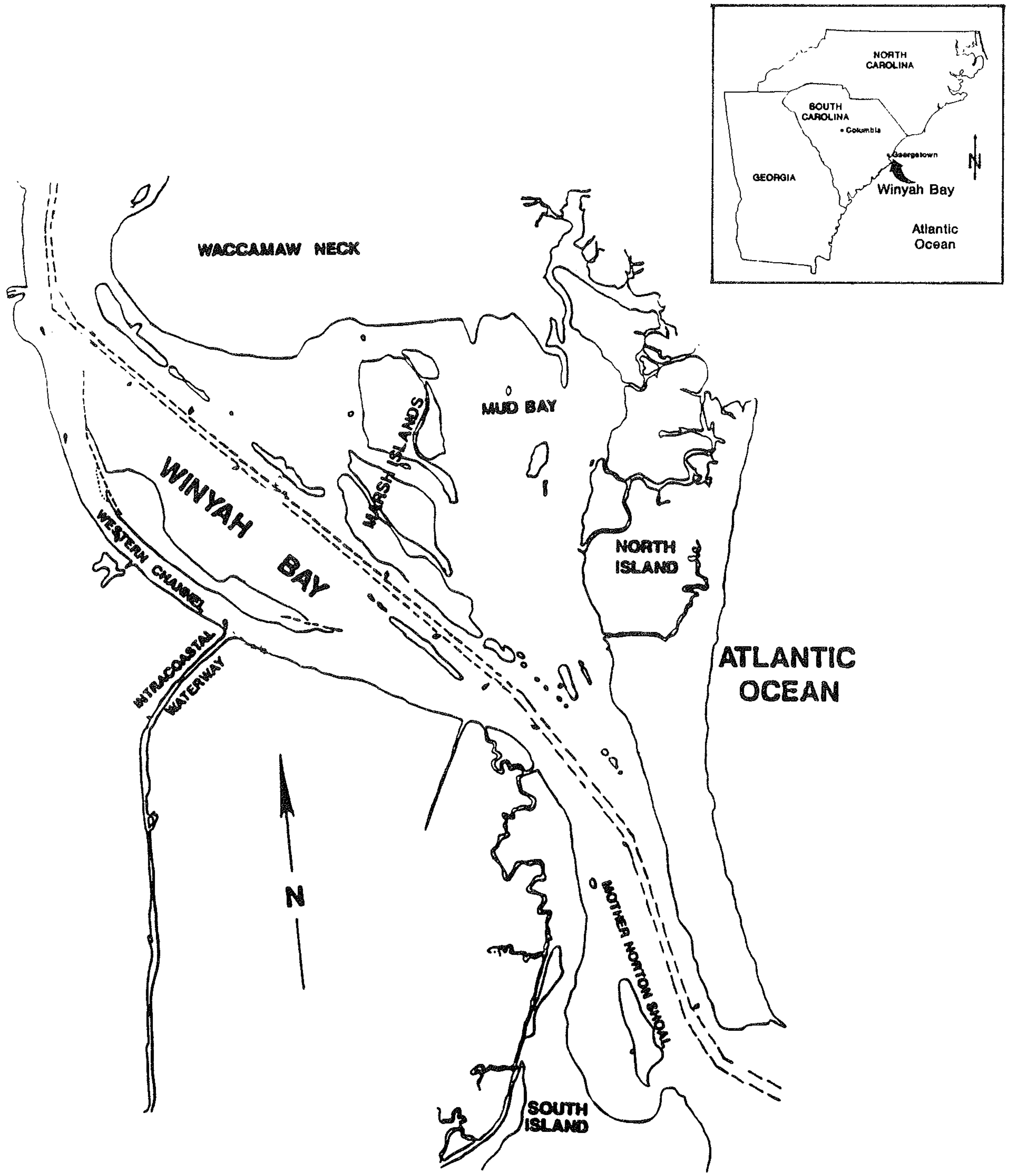

Figure 1. Project location map

WINYAH BAY, GEORGETOWN, SOUTH CAROLINA
DATA COLLECTION SURVEY REPORT

PART I: INTRODUCTION

Project Description

1. Winyah Bay is an irregularly shaped tidal estuary extending about 16 miles* from the ocean to the confluence of the Pee Dee and Waccamaw Rivers near Georgetown, SC, as shown in Figure 1. The bay width is about 0.75 mile at the entrance between the North and South Islands, 4.5 miles in the middle section as it widens into a shallow expanse known as Mud Bay, and 1.25 miles in the upper section. Freshwater inflow into the bay is contributed by the Pee Dee, Waccamaw, Black, and Sampit Rivers. The total mean freshwater inflow into the bay is approximately 13,000 cfs. The existing navigation project provides a 27-ft-deep channel from the Atlantic Ocean to the turning basin in the Sampit River near Georgetown. The route of the Atlantic Intracoastal Waterway also passes through Winyah Bay. Over the past 14 years, the material from annual maintenance of the channel has been disposed at locations along the northern side of the Western Channel Island in an attempt to create marsh lands for habitat development.

Purpose and Scope of Work

Purpose

2. The US Army Engineer District, Charleston, was concerned about the loss of sediment material from the marsh-creation site and needed a means of quantifying the transport pathways of the material. The purpose of this report is to present the data that were collected during a comprehensive field survey for the Charleston District. The data from this report are to be used by the District to support the Georgetown Harbor Channel Project.

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* A table of factors for converting non-SI units of measurement to SI (metric) units is found on page 3.

Scope

3. One 13-hr (tidal cycle) survey was conducted to collect synoptic field data during peak tidal flow periods within the Winyah Bay study area. Data were also collected for longer term conditions that covered the period prior to the start of dredging operations, during dredging, and for several weeks following the completion of the dredging. Measurements consisted of the following:

- a. Current speed and direction at three ranges.
- b. Tide levels recorded at three locations.
- c. Suspended sediment and salinity samples at each range.
- d. Automatic water samplers at three locations.
- e. Core samples of bottom material at 13 locations for material classification.
- f. Wind speed and direction in the study area.
- g. Postsurvey deployment of a SIRAD B.S.G. 1 Gamma Backscatter Density Gage. Density profiles are shown in Appendix A.
- h. Postsurvey deployment of a Boundary Layer Automated Profiling System.

4. This report describes the field investigation methods used to collect the field data and presents the results of the data reduction efforts.

PART II: EQUIPMENT DESCRIPTION, PROCEDURES, MEASUREMENT LOCATIONS, AND CONDITIONS

Data Collection Equipment

Current speed and direction

5. Each boat used in the survey was equipped to deploy instruments over the side using the portable equipment setup shown in Figure 2. Collapsible aluminum frames were used to support the equipment, and winches (with 1/8-in. wire rope) were used to raise and lower the velocity and direction equipment. An indicator on the winch displayed the depth of the instruments below the water surface. A Gurley Model 665 velocity meter with vertical axis cup-type impeller and direct velocity readout capabilities was used to measure the current speeds. These meters have a threshold speed of less than 0.2 fps and an accuracy of ±0.1 fps for velocities less than 1 fps. Current directions were monitored with a magnetic directional indicator mounted above the velocity meter on a solid suspension bar. This entire assembly was connected to a streamlined lead weight that held the sensors in a vertical position and oriented them into the direction of the flow. The signal cables from each instrument were raised and lowered with the equipment and connected to the display units located on the deck of the boat. A more detailed display of the system is shown in Figure 3.

Suspended sediment and salinity water samples

6. Water samples for analyses of salinities and total suspended solids were obtained at each depth at which a velocity reading was taken by pumping the sample from the depth to the surface collection point. The pumping system consisted of a 1/4-in.-ID plastic tubing attached to the current meter signal cables for support. The opening of the sampling tubing was attached to the solid suspension bar at the same elevation as the current meter and was pointed into the flow. A 12-v d-c pump was used to pump the water through 50 ft of the tubing to the deck of the boat where each sample was then collected in individual 8-oz plastic bottles. The pumps and tubing were flushed for approximately 1 min at each depth before the sample was collected.

Automatic water samplers

7. Water samples were taken automatically during the survey period and

Figure 2. Field deployment of velocity measuring equipment

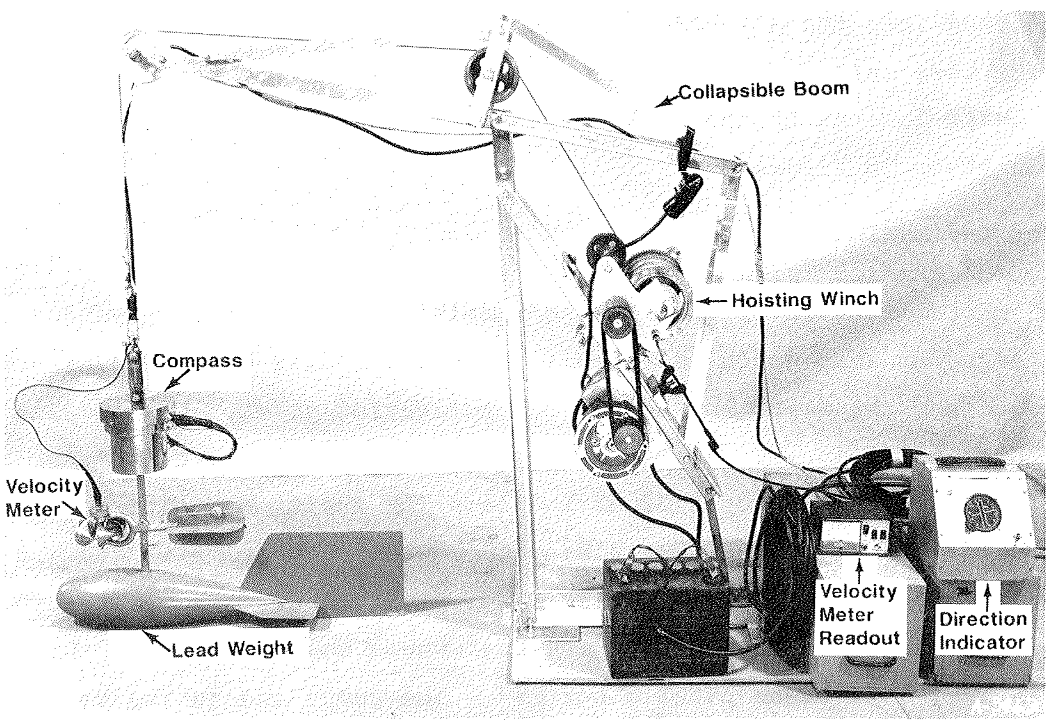


Figure 3. Components of the field instrument assembly

during the periods before and after the survey using ISCO Model 2700 automatic water samplers, as shown in Figure 4. A typical field installation of these water samplers is shown in Figure 5. The samplers operated from a 12-v d-c battery power source. Samples were collected in 1-ℓ plastic bottles located inside the sampler. The samplers are fully programmable for obtaining any volume of sample desired up to the maximum size of the bottle, for obtaining composite samples, for setting different intervals between samples, and for setting times to begin the sampling routine. When the sampling period was complete, the sample bottles were replaced with empty bottles to begin a new sampling period.

8. Five samplers were used in this study to obtain water samples at different locations in Winyah Bay, as shown in Figure 6. Two samplers (AWS-1 and AWS-1A) were located on the entrance marker near the southern end of the bay. One sampler (AWS-2) was located at channel marker No. 24 (CM 24) in the middle portion of the bay. The remaining two samplers (AWS-3 and AWS-3A) were located at the entrance range marker near the Belle Isle Marina. At the locations where two automatic samplers were installed, stations AWS-1 and AWS-3, one sampler was set up to collect samples at 2 ft above the bottom and the other to collect samples at middepth at the time of low water. The samplers were programmed to collect four samples per bottle every 373 min during the peak flood and ebb tides and the slack-water periods. The samples were collected for time periods prior to the dredging operations (October-November), during the dredging operations (December-January), and following the dredging operations (February).

<u>Tide level recorders</u>

9. Water-surface elevations for tide level determination were measured by a system consisting of a stilling well containing a float and connected to a recording device by a wire rope. The recorders used were Fisher-Porter model 1550 punched-tape mechanical water level recorders similar to those shown in Figure 7. These instruments record elevations to the nearest 0.01 ft and have a range of up to 100 ft. A timer activated the recording mechanism every 15 min, and the float elevation at the time was punched on 16-channel, foil-backed paper tape. The float was a 3-in.-diam aluminum cylinder, and the stilling well was a vertical 4-in.-diam polyvinyl chloride (PVC) pipe. A typical field installation is shown in Figure 8. Water in the stilling well responded to water levels outside the well by flow through a 15-ft-long,

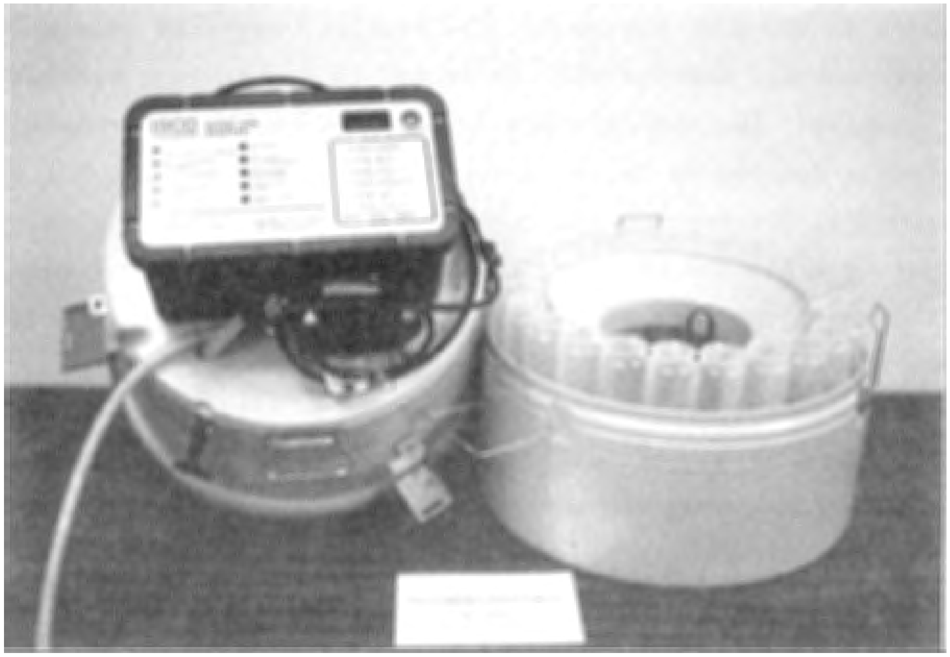


Figure 4. Automatic water samplers

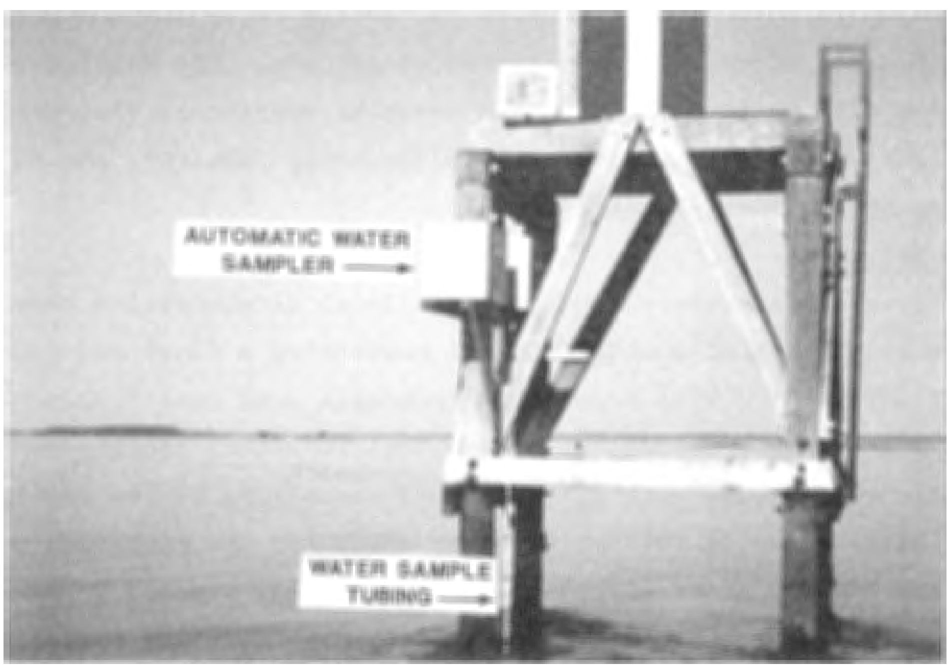


Figure 5. Typical field installation of the automatic water samplers

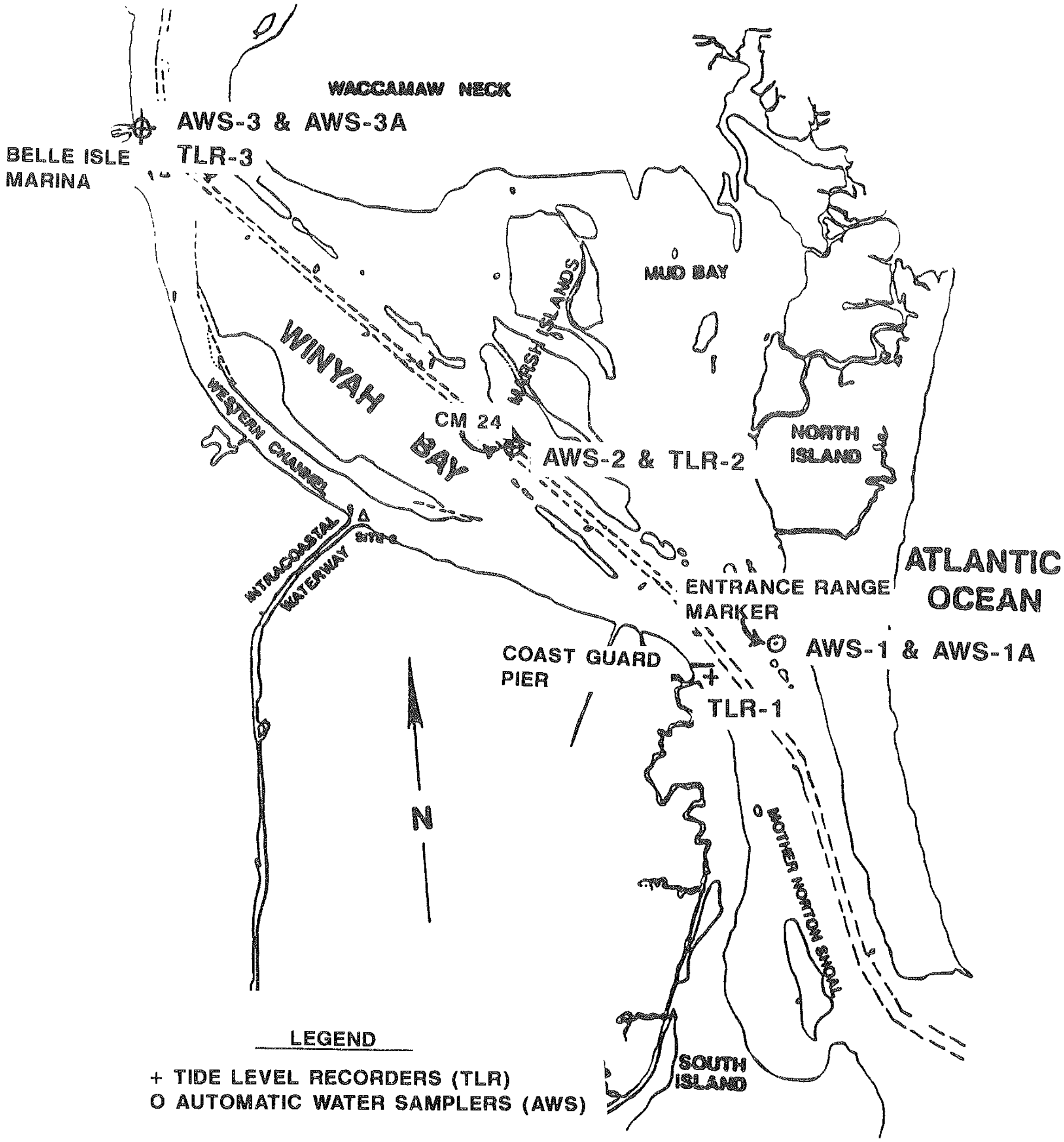


Figure 6. Site locations for tide level recorders and automatic water samplers

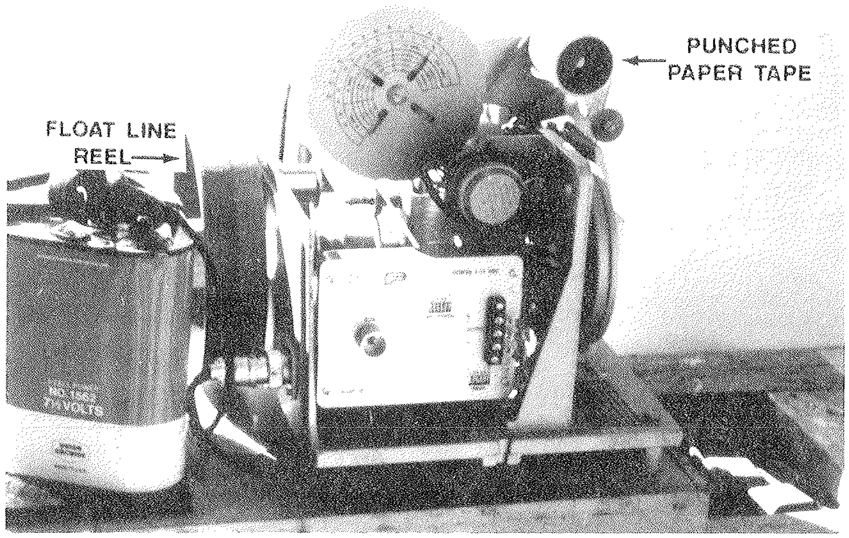


Figure 7. Punched paper mechanical water level recorders

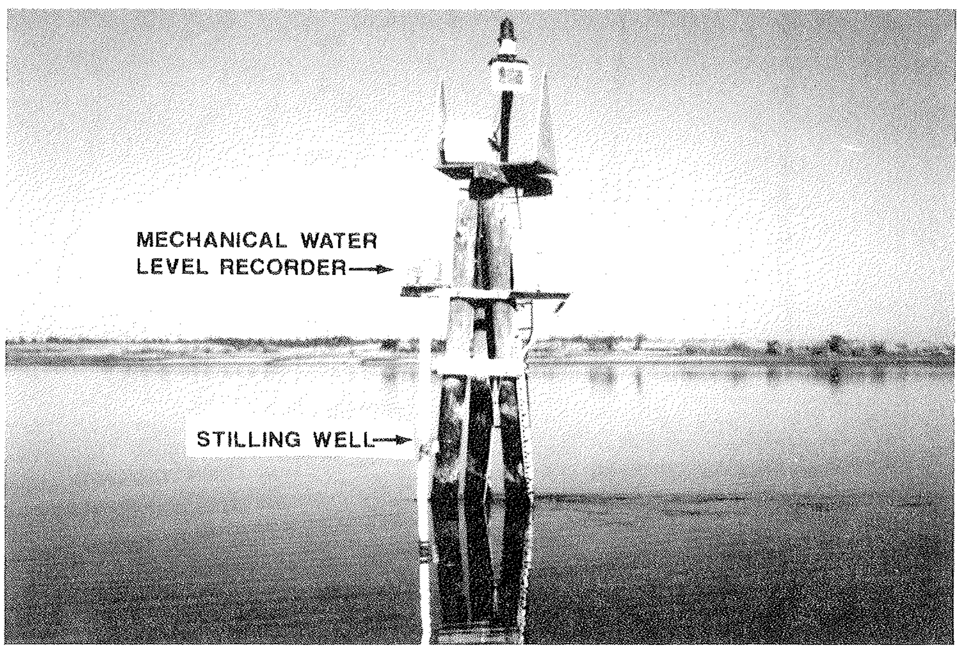


Figure 8. Typical field installation of mechanical water level recorders

3/8-in.-diam copper tube. The outer end of the tube was protected against clogging by a cylindrical copper filter as shown in Figure 9.

10. Vertical control for the tide level recorder assemblies was arbitrary. The 15-ft-long copper tubing used as the stilling well filling port was designed to minimize short-period oscillations and to cause the well to respond linearly to fluctuations in the outside water level. Response characteristics of the stilling wells have been determined by drainage tests.* Initial synchronization of the tide recorder timer was within ±5 sec of the National Bureau of Standards (NBS) time standard. The gage time is generally accurate to ±2 min per month, except for occasional malfunctions that can cause large time errors. In practice, recorder and NBS times were recorded when tapes were removed so that timing errors could be identified. The relative accuracy of the water level recorders is affected by temperature of the water, float, and wire, plus salinity changes of the water inside the well. Relative accuracy is considered to be within 0.1 ft.

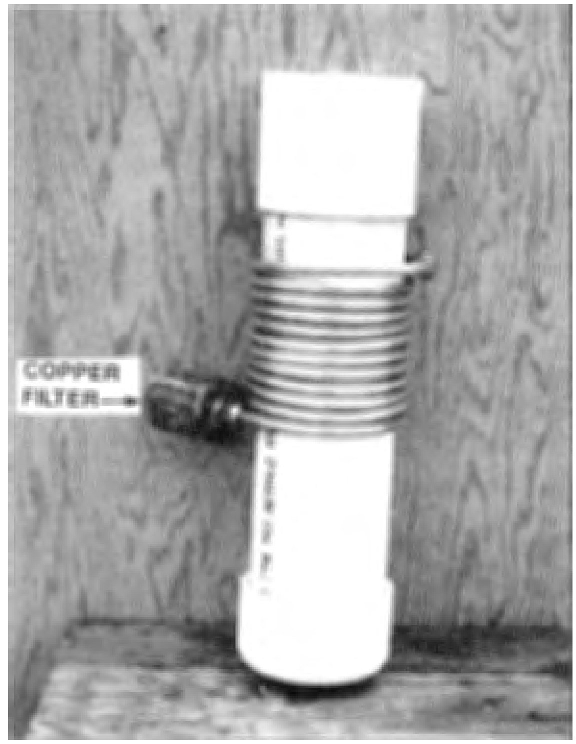


Figure 9. Lower section of tide level recorder stilling well

11. Three recorders were used in this study to obtain water-surface elevation measurements at different locations in Winyah Bay as shown in Figure 6. One water level recorder (TLR-1) was located on the piling immediately downstream of the Coast Guard pier on the right descending bank at the southern end of the bay. Another recorder (TLR-2) was located on channel marker No. 24 in the middle portion of the bay next to the automatic water sampler. The remaining water level recorder (TLR-3) was located at the entrance range marker near the Belle Island Marina. The recorders were set to

* W. A. McAnally, Jr. 1979. "Water Level Measuring by Estuaries Division, Hydraulics Laboratory," Memorandum for Record, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

record water-surface elevation every 15 min. The recorders were operated for time periods prior to the dredging operations (October-November), during the dredging operations (December-January), and following the dredging operations (February).

Bottom sediment samples

12. The samples of the bottom sediment were obtained using a push core type sampler. The sampler consisted of a PVC pipe 1-1/2 in. in diameter and 18 in. in length. Attached to this was a smaller section of pipe with a valve attached at the upper end. The purpose of the valve was to create a reduced pressure to hold the sampler in the larger diameter pipe. The samples were then brought to the surface and classified by visual inspection. The bottom sampling locations in the study area are shown in Figure 10.

Wind speed and direction

13. The wind conditions at the time of the 13-hr survey were recorded using a WeatherMaster Model No. 132 hand-held anemometer. The directions of the prevailing winds were determined from compass heading of the anemometer giving the highest speed. Periodic maximum wind speeds were recorded at various times throughout the survey.

Procedures

14. For the 13-hr data collection period in the Winyah Bay study area, a total of three ranges were selected to yield the information most applicable to the problem statement. The general location of these ranges is shown in Figure 11. Range 1, located at the southern end of the bay just above channel marker No. 16, had four stations equally spaced across the channel. Stations 1-B and 1-C were located at the edges of the channel, and stations 1-A and 1-D were located at positions outside of the navigation channel. Range 2, located at the midsection of the bay, also had four stations equally spaced across the range. Station 2-C was located at the west edge of the channel prism line. Station 2-A was located approximately 300 ft to the east of the Western Channel Island. Station 2-B was located midway between stations 2-A and 2-C. Station 2-D was located approximately 100 ft from the west edge of Marsh Island. Range 3, located midway between the south end of Hare Island and Frazier Point Bend at Belle Isle, had four stations equally spaced across the range. Station 3-B was located at the western edge of the channel prism

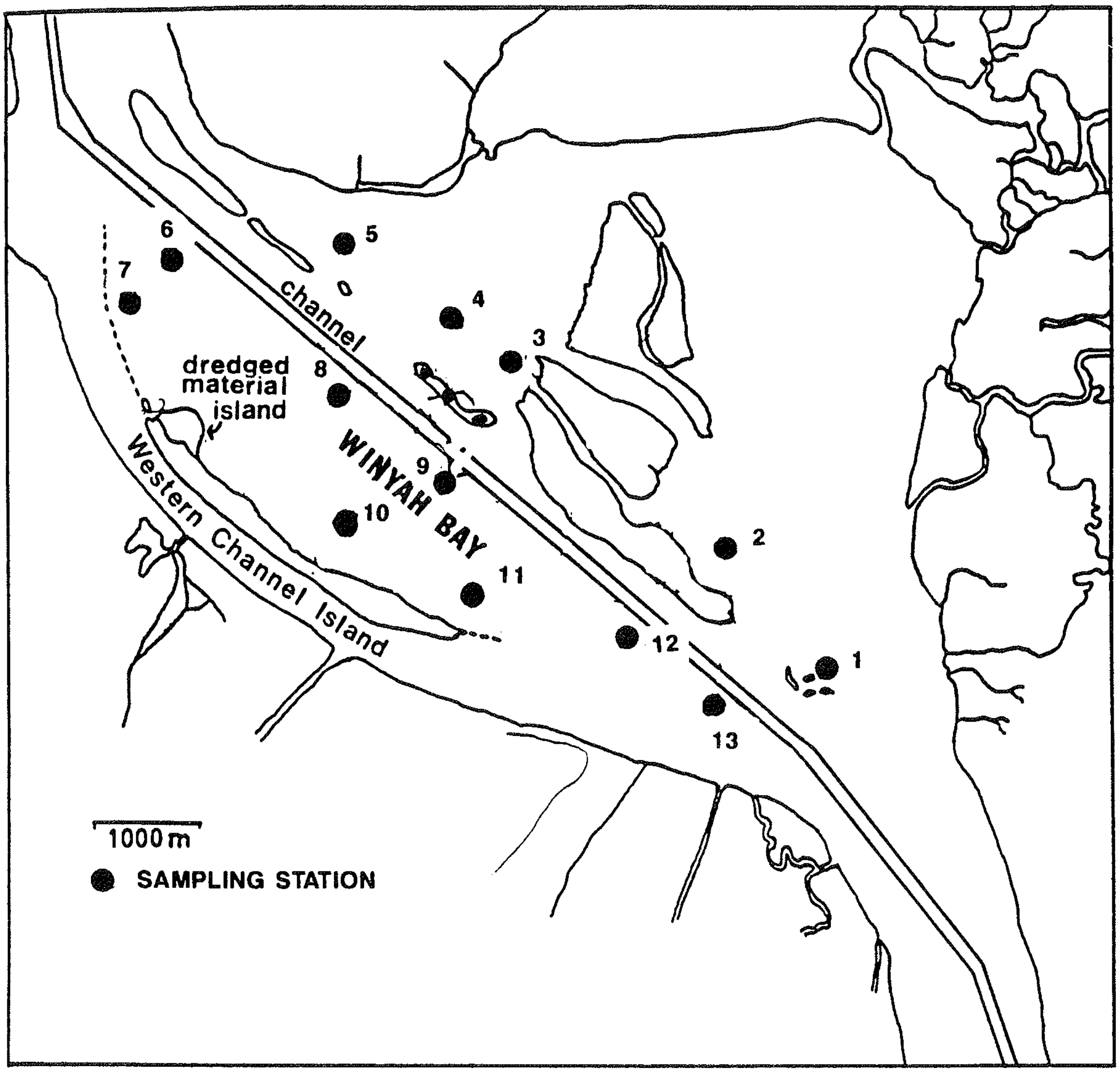


Figure 10. Bottom sampling and density monitoring locations

line, and station 3-A was located approximately 150 ft from the western shore. The remaining stations, 3-C and 3-D, were located in the mud flats to the east of the channel and equally spaced.

15. Prior to the beginning of the survey, the boats assigned to each range deployed anchors and mooring lines at each of the stations. The mooring lines were attached to large inflated buoys for retrieving the lines during each sampling period. The boat moved into position at each of the buoys and used the anchored line to hold a steady position in the current while data collection was being performed. At each of the stations, the velocity data and water samples were collected at three depths: bottom, middepth, and surface. The bottom measurement was made at a distance of 2 ft from the

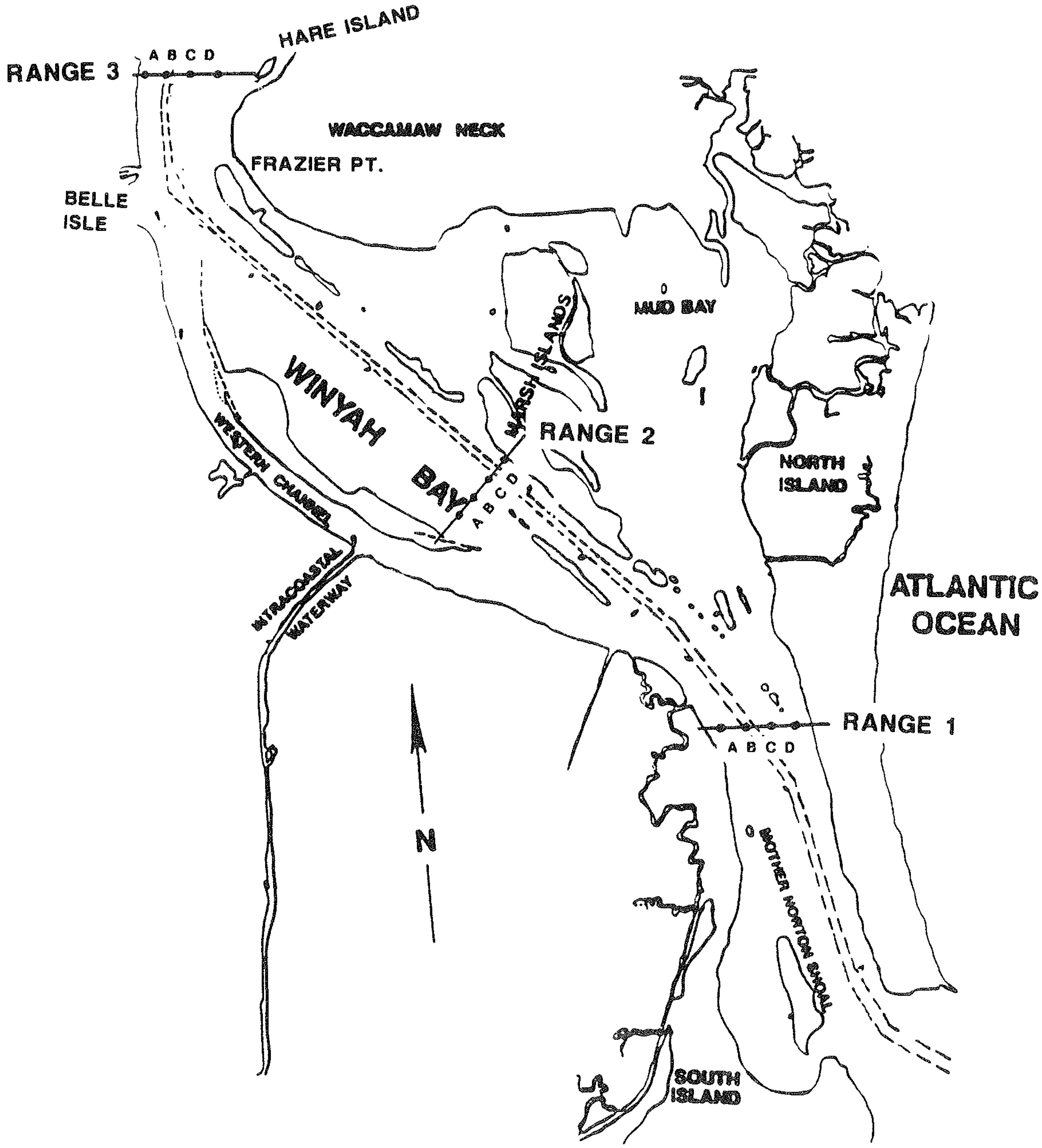


Figure 11. Location of data collection ranges

actual bottom. The middepth measurement was obtained at the actual middepth measurement. The surface measurement was obtained at a distance of 2 ft below the water surface. Data collected at each depth included current speed, current direction, and a pumped water sample. The data at each station were obtained once per hour.

Laboratory analysis of water samples

16. The samples collected by the automatic water samplers and those obtained at the individual sampling stations during the survey were analyzed in the laboratory at the US Army Engineer Waterways Experiment Station. Total suspended materials were determined by filtration of the samples. Nuclepore polycarbonate filters with 0.4-μ pore size were used. They were desiccated and preweighed, then a vacuum system was used to draw the sample through the filter. After the filters and holders were washed with distilled water, the filters were dried at 105° C for 1 hr and reweighed. The total suspended materials were calculated based on the weight of the filter and the volume of the filtered sample.

17. The water samples obtained at each range during the strength of ebb and flood tide periods at the time of the survey were measured for salinities in the laboratory. A Beckman Model RA5 salinometer with automatic temperature compensation was used for these analyses. The salinometer was calibrated with standard seawater and was accurate to within ±0.2 ppt.

Conditions of the survey

18. The 12.42-hr data collection survey encompassed an entire tide cycle. The maximum tidal range measured during the survey was 3.88 ft in the upper reaches of the bay and 3.98 ft near the south end of the bay. Calm and clear weather conditions prevailed during the survey. Mostly clear skies existed at the time of the survey. The wind conditions during the survey ranged from a slight breeze to light winds of 5-6 mph. No significant freshwater runoff into the bay was observed during the survey period.

Postsurvey Measurements

19. Following the data collection survey, another series of measurements was made to monitor the density profiles of the sediments. It was anticipated that sufficient amounts of low-density sediment commonly referred to as "fluid mud" would be present. This next series of measurements consisted of the deployment of two different types of instruments for the purposes of determining the distribution of the fluid mud and the vertical density profiles of the sediment layer. The density profiles of the sediment were monitored using a gamma backscatter density gage and a Boundary Layer Automated Profiling System (BLAPS).

Gamma backscatter density gage

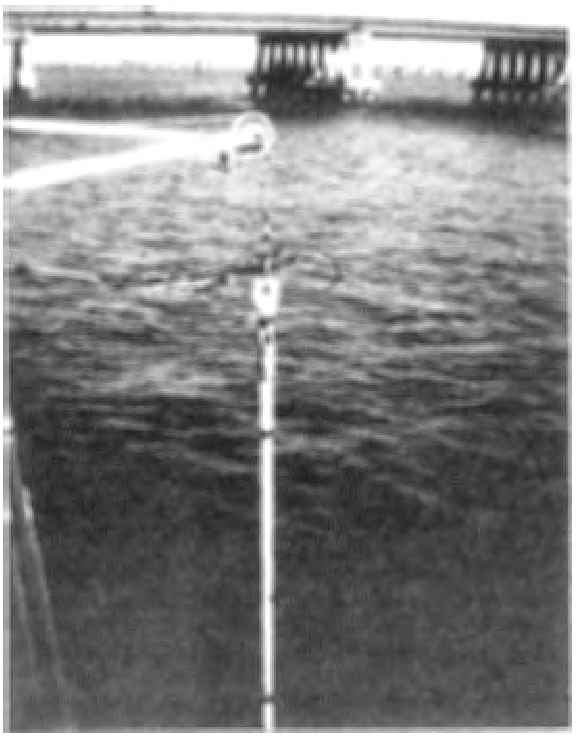


Figure 12. Deployment of the gamma backscatter density gage

20. The gamma backscatter density gage uses radioactive material and its reflective properties to measure the density of a suspended material based upon the amount of radiation that is reflected. The gage is a long slender rod that is lowered by controlled descent to the bottom and penetrates the low-density sediment layer. Figure 12 depicts the deployment of the gage. The rate of backscatter of the gamma particles from the gage is then correlated to the density or specific gravity of the material. To supplement these data, physical samples of the bottom material in the location of the gage were obtained using a vacuum sediment sampler as shown in Figure 13. A brief description of and results of the data

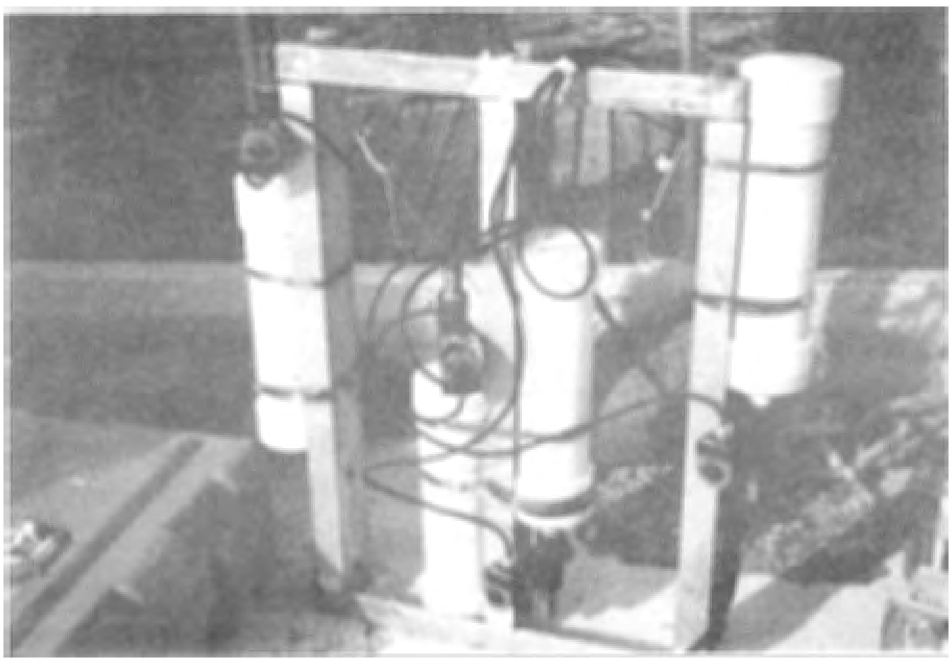


Figure 13. Vacuum sediment sampler

obtained from this study are presented in Appendix A.

Boundary Layer
<u>Automated Profiling System</u>

21. A second method of profiling the depth of the low-density sediment layer was used following the survey. BLAPS is an array of instrumentation designed to monitor the dynamic factors of parameters that exist in the near-bed environment.* The system is capable of monitoring velocity, depth, temperature, conductivity, turbidity, and density of bottom sediments. The instrument array is attached to a motorized ram for raising and lowering through the near-bed layer to be profiled. Figure 14 shows the system being

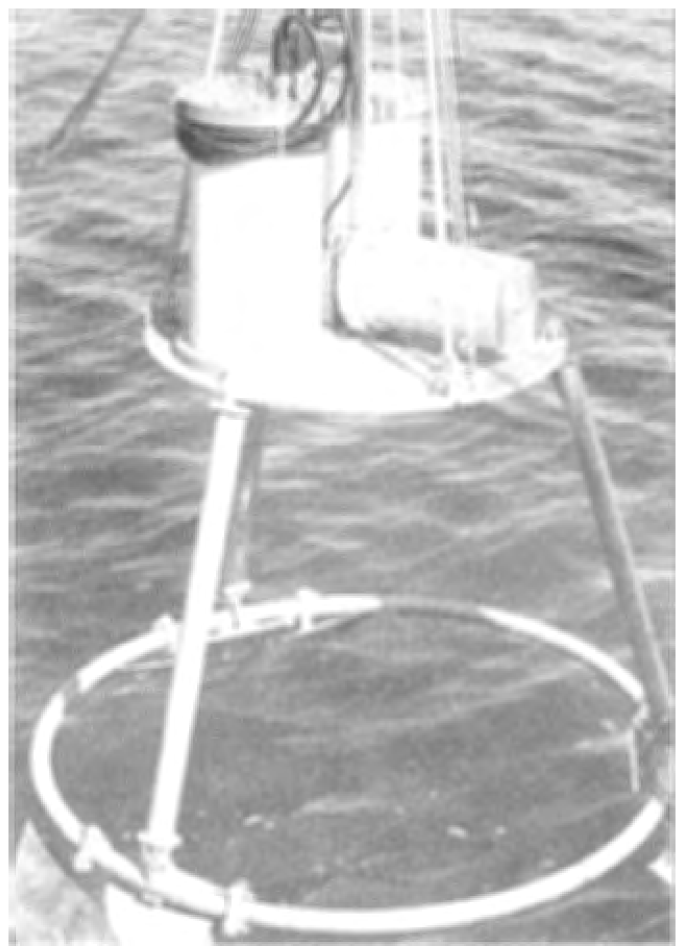


Figure 14. Deployment of BLAPS at sampling location

* T. C. Pratt and G. M. Fisackerly. "Boundary Layer Automated Profiling System Field Evaluation" (in preparation), US Army Engineer Waterways Experiment Station, Vicksburg, MS.

readied for deployment. Special hoisting facilities are currently required due to the size and weight of the system. However, design changes are currently being initiated to reduce the bulkiness of the equipment.

22. Inclinometers were mounted on the support frame of the array to measure the tilt of the entire system for determination of the proper operating position during deployment procedures. Turbidity was measured using an optical backscatter sensing probe (OBS probe). This probe monitors the amount of light reflected from the suspended sediment in the water column. The OBS probe also has a built-in temperature sensor to give the temperature of the surrounding water. Detector plates mounted on the profiling ram were used to determine the bottom. The plates, which are still in the experimental stage, are designed to allow for detection of different bottom densities.

23. The BLAPS is equipped with an onboard data acquisition system. The data logging capabilities include 11 analog input channels and unlimited digital channels. The system currently has 1 megabyte of internal memory with expansion capabilities of up to 20 megabytes by addition of a hard drive.

PART III: DATA PRESENTATION

Tide Data

24. The tidal variation of the water-surface elevation data observed during the survey is tabulated in Table 1. The plots of the water-surface data for periods of 12 hr prior to and following the survey period dates are shown in Plates 1-3. Data from all three gages are compared in Plate 4. Tide level recorders TLR-1, TLR-2, and TLR-3 appeared to function properly during the 12 hr prior to and following the survey.

25. The data from TLR-1 were used as a reference for comparison with the data from the other stations to estimate tidal phase and range differences between the lower and the upper reaches of Winyah Bay. This comparison illustrated that tide ranges observed were essentially equal with the maximum tidal range of 4.63 ft observed at TLR-1 and 4.48 ft at TLR-3 on 20 January 1989. The comparison also reflected the tide phase difference of 0.50 hr between TLR-1 and TLR-3 which occurred on 20 January 1989 between the hours of 0730 and 0800 at the time of high water.

Velocity Data

26. Tables 2-13 are time-series listings of the velocity data obtained at the three ranges as described in paragraph 14. Plates 5-16 are plots of the velocity data for each cycle of the tide (ebb and flood) during the survey period. If sufficient water depth existed at each station, the current speed and direction were measured at three depths: near bottom, middepth, and near surface. At stations located in shallow areas, such as station 2-A, only near-surface velocities were measured. The maximum velocity observed at the lower range, at station 1-B, in the channel was 5.5 fps at the surface. The maximum velocity observed in the channel at station 2-C was 3.4 fps at the surface. The maximum velocity in the channel at station 3-B was 2.8 fps at the surface.

27. The majority of the flow within the navigation channel, particularly at the middle and lower ranges (Ranges 1 and 2), was in a southeast direction during ebb flow and in a northwest direction during flood flow. The freshwater inflow from the rivers local to this area contributed to the flow

in the channel. As a result, there were no large variations, other than tidal, in the magnitude and direction of the currents. Eddies and unusual flow circulation patterns created by change in the tidal periods were observed; however, the changes within the system were not always detectable using hourly observation periods representative of this study.

Salinity Data

28. The results of the sample analysis for salinities at each sample station during the peak ebb and flood periods of the survey are listed in Table 14. No salinities were measured for the samples obtained from the automatic water samples. The salinity values at the sampling locations within Winyah Bay indicate that the upper ranges (Ranges 2 and 3) represent a partly to well mixed flow system while Range 1 is a generally well-mixed system.

Suspended Sediment Data

29. The results of the sample analysis for suspended sediment concentrations at each sample station monitored during the survey are shown in Tables 15-17 and Plates 17-19. The suspended sediment concentrations shown in Plates 17-19 can be compared with water-surface elevation changes for representative stations within Winyah Bay in Plate 20. The majority of the samples containing the greatest concentrations of suspended sediment are generally found near the bottom of the channel at the time of the strength of flood period. The maximum concentration observed during the survey period sampling was 420 mg/ℓ. The suspended sediment concentrations near the bottom within the shallow areas tended to be lower than those observed in the channel during the peak velocity periods of the strengths of ebb and flood tides. However, a slight increase was seen in the surface concentrations within the shallow areas during the strengths of ebb and flood.

30. The results of the suspended sediment concentration analyses performed on samples obtained from the automatic samplers are listed in Tables 18-21 and are also plotted in Plates 21-30. The concentrations were found to vary from 140 mg/ℓ at the lower portion of the bay, sampling location AWS-1, to a minimum of 6 mg/ℓ at sampling location AWS-3. As previously stated, these samplers were used primarily to monitor changes in the suspended

sediment concentrations in the water column for periods prior to, during, and following the dredging operations within the bay. Prior to the dredging, 18 October-12 November 1988, the concentrations, with a few exceptions, were generally low. The maximum sediment concentration observed during this period was 140 mg/ℓ at sampling locations AWS-1 and AWS-3. During the dredging operations, which began on 1 December 1988 and continued to 19 February 1989, no significant increases in suspended sediment concentrations were detected from the sample analyses. The maximum concentration observed during this period was 86 mg/ℓ at location AWS-3 on 6 February 1989. The maximum concentration observed during the period immediately following dredging was 103 mg/ℓ at location AWS-1. The data do not indicate any increases in suspended sediment concentrations during the dredging operation. The largest suspended sediment concentrations appear during the periods before and after dredging operations. It was observed that suspended sediment concentrations were dependent upon the surface wave conditions within the bay. If the water surface was relatively calm, then the sediment concentrations were generally low throughout the depth profile. If the water surface was rough, with a wind blowing toward the southern end of the bay, the suspended sediment concentrations were noticeably greater. For example, concentrations shown in Plates 28 and 29 were obtained during a storm in the area.

Bottom Sediment Classification

31. The bottom sediment samples collected by means of the push core sampler described in paragraph 12 were classified by visual inspection in the field. The results of the visual inspection of the 18-in. samples are shown graphically in Plates 31 and 32. Plate 31 represents the classification of samples obtained prior to the initiation of dredging operations. Plate 32 represents the classification of the samples taken 2 weeks following completion of the dredging operations. As evident in the plates, there are some differences in the bottom sediment composition at most of the sampling locations that occurred over a 5-month period. In general, these changes reflect the movement of the very fine bottom materials out of the sample areas by the natural circulation of the bay. These changes may also reflect variations in boat locations during the two separate sampling periods and the discrepancies that are inherent in this type of sampling technique.

Gamma Backscatter Density Gage Measurements

32. A total of 12 locations were sampled using the gamma backscatter density gage in an attempt to detect fluid mud layers in the bay. The locations are listed in Table A1 and shown in Figure A1 in Appendix A. These sampling stations were located above and below the marsh-building dredged material disposal site to determine if erodible material from the marsh is leaving the disposal site and depositing in the bay in fluid mud layers. Of the 12 stations sampled, only 4 indicated minimal evidence of a fluid mud layer. The thickness of the layer varied from only a few inches to 1 ft and the specific gravity readings ranged from 1.25 to 1.4. The results of these sampling procedures do not indicate that any of the erodible material that may be leaving the marsh site is being retained within the bay; therefore, the fine sediment appears to be leaving the bay through natural processes. The results of the sampling using this method are presented in Appendix A.

Boundary Layer Automated Profiling System

33. The results of the deployment efforts of the BLAPS were found to be similar to that observed for the gamma backscatter density gage. A total of three test locations, as shown in Figure 15, were sampled using the BLAPS in an attempt to detect fluid mud layers in the bay. These sampling stations were also located above and below the marsh-building dredge placement site to determine if erodible material from the marsh is leaving the disposal site and depositing in the bay in fluid mud layers. Table 22 presents the time-series listing of the velocity data obtained at the three test sites during the deployment of the BLAPS. The velocities near the bottom were measured for determination of the boundary conditions that would affect the thickness of a low-density sediment layer. No indication of a fluid mud layer was found at any of the three test locations. The results of these sampling procedures did not indicate any evidence of erodible material leaving the marsh site during the period of deployment. Plots of the densities of the locations indicating minimal evidence of fluid mud layers are shown in Plates 33-35.

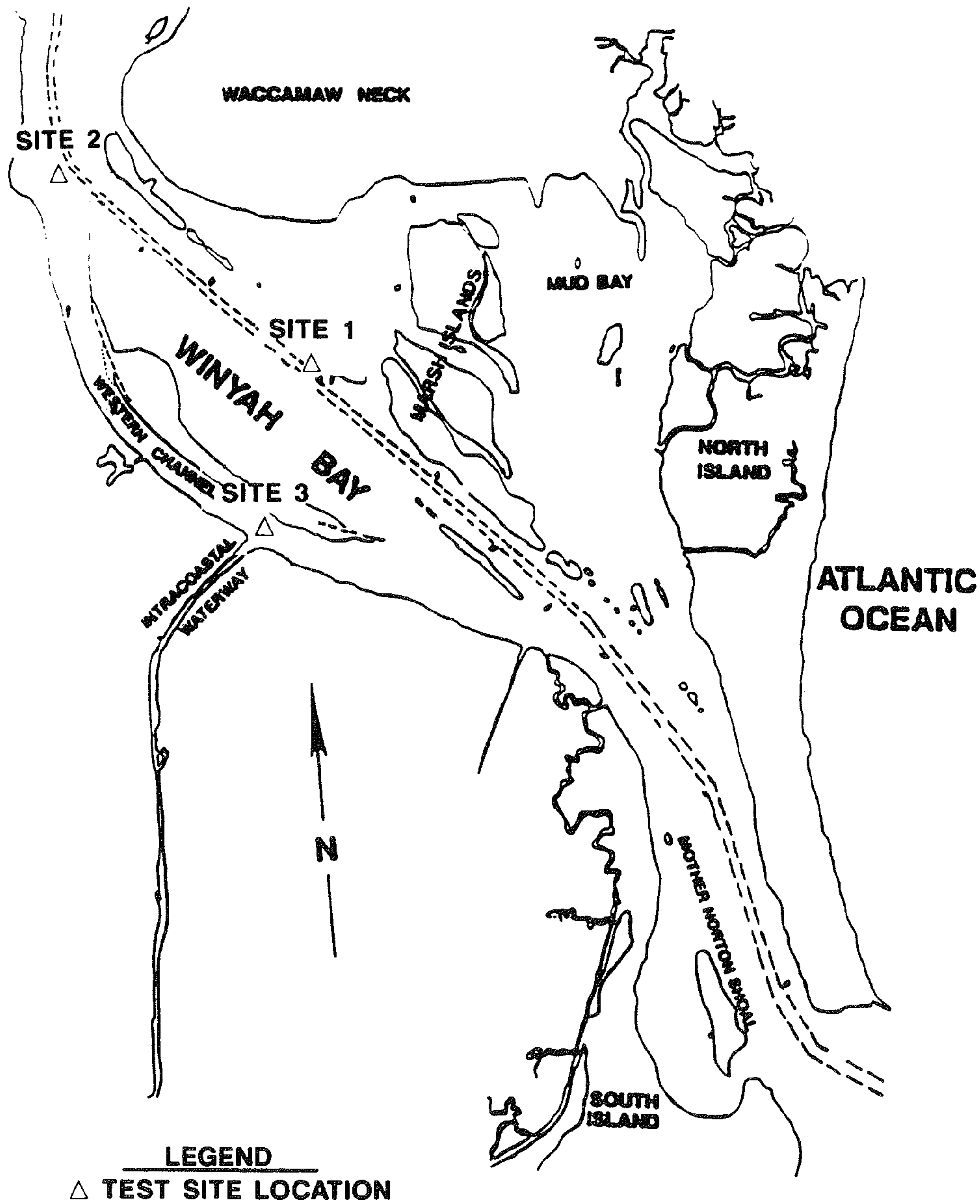


Figure 15. BLAPS test sites

PART IV: SUMMARY

34. The data presented herein were collected from the intensive survey and longer term sampling efforts within Winyah Bay. The following observations were made of the data:

a. There appears to be a slight decrease in the maximum range of water-surface elevation (tide) (0.15 ft) from the lower bay water level recorder, TLR-1, to the upper bay water level recorder, TLR-3.

b. The maximum velocities observed during the survey occurred at the strength of ebb of the tidal cycle. The maximum recorded velocity was 5.5 fps at station 1-B.

c. Suspended sediment concentrations in the channel were found to be generally greater near the bottom. The greatest suspended sediment concentration observed during the survey period was 420 mg/ℓ at station 3-B.

d. Long-term sampling of the suspended sediment recorded a maximum concentration of 140 mg/ℓ. This concentration occurred during the predredging period (October-November 1988). The long-term suspended sediment sampling indicated no significant changes in concentrations resulting from dredging operations.

e. Changes in the bottom material composition over time indicate that most of the very fine sediments are not retained within the majority of the sampling areas but appear to be displaced by the natural circulation patterns within the bay.

f. Salinity values indicated that the lower portion of the bay could be described as being well mixed, while the upper portions could be described as being partly to well mixed.

Table 1

Water-Surface Elevations* Observed During Survey Period, 18-20 January 1989

Time CST	TLR-1 Coast Guard Pier ft	TLR-2 CM 24 ft	TLR-3 Belle Isle ft
		January 18	
1900	1.30	1.50	1.54
1915	1.15	1.34	1.43
1930	0.95	1.17	1.28
1945	0.72	0.97	1.12
2000	0.47	0.76	0.91
2015	0.23	0.54	0.68
2030	0.01	0.34	0.46
2045	-0.21	0.16	0.23
2100	-0.42	-0.06	0.06
2115	-0.64	-0.28	-0.12
2130	-0.84	-0.56	-0.30
2145	-1.03	-0.69	-0.48
2200	-1.22	-0.90	-0.67
2215	-1.41	-1.09	-0.84
2230	-1.58	-1.27	-1.06
2245	-1.75	-1.44	-1.22
2300	-1.90	-1.62	-1.37
2315	-2.01	-1.77	-1.52
2330	-2.09	-1.90	-1.69
2345	-2.16	-2.00	-1.79
2400	-2.19	-2.09	-1.91
		January 19	
0015	-2.19	-2.14	-2.01
0030	-2.15	-2.14	-2.05
0045	-2.08	-2.11	-2.14
0100	-1.96	-2.06	-2.15
0115	-1.78	-1.95	-2.15
0130	-1.56	-1.75	-2.10
0145	-1.35	-1.54	-1.95
0200	-1.11	-1.32	-1.73
0215	-0.87	-1.08	-1.49
0230	-0.65	-0.88	-1.20
0245	-0.42	-0.69	-0.93
0300	-0.18	-0.50	-0.67
0315	0.06	-0.30	-0.44
0330	0.32	-0.07	-0.21
0345	0.57	0.31	0.03
0400	0.79	0.25	0.28
0415	0.97	0.62	0.50
0430	1.17	0.86	0.75

(Continued)

* Mean water level reading used as datum.

Table 1 (Continued)

Time CST	TLR-1 Coast Guard Pier ft	TLR-2 CM 24 ft	TLR-3 Belle Isle ft
	January 19 (Continued)		
0445	1.35	1.11	0.94
0500	1.52	1.29	1.15
0515	1.66	1.47	1.36
0530	1.79	1.60	1.53
0545	1.90	1.77	1.66
0600	1.96	1.85	1.77
0615	2.00	1.96	1.87
0630	2.02	1.99	1.94
0645	2.02	2.03	1.98
0700	1.99	2.03	1.99
0715	1.92	2.01	1.99
0730	1.83	1.94	1.95
0745	1.69	1.82	1.87
0800	1.56	1.66	1.76
0815	1.40	1.49	1.63
0830	1.22	1.33	1.49
0845	1.03	1.16	1.32
0900	0.84	0.99	1.15
0915	0.67	0.82	0.97
0930	0.48	0.66	0.79
0945	0.28	0.49	0.58
1000	0.06	0.30	0.41
1015	-0.14	0.09	0.22
1030	-0.34	-0.09	0.03
1045	-0.54	-0.27	-0.16
1100	-0.73	-0.46	-0.33
1115	-0.92	-0.63	-0.48
1130	-1.09	-0.83	-0.64
1145	-1.24	-1.02	-0.84
1200	-1.38	-1.18	-1.01
1215	-1.52	-1.31	-1.14
1230	-1.64	-1.46	-1.34
1245	-1.72	-1.60	-1.47
1300	-1.77	-1.70	-1.60
1315	-1.80	-1.76	-1.68
1330	-1.81	-1.80	-1.78
1345	-1.79	-1.82	-1.83
1400	-1.72	-1.81	-1.87
1415	-1.59	-1.74	-1.89
1430	-1.43	-1.62	-1.86
1445	-1.27	-1.44	-1.78
1500	-1.08	-1.26	-1.61
1515	-0.89	-1.05	-1.38
1530	-0.67	-0.85	-1.17

(Continued)

Table 1 (Continued)

Time CST	TLR-1 Coast Guard Pier ft	TLR-2 CM 24 ft	TLR-3 Belle Isle ft
	January 19 (Continued)		
1545	-0.45	-0.63	-0.93
1600	-0.23	-0.41	-0.66
1615	-0.02	-0.20	-0.40
1630	0.20	-0.02	-0.15
1645	0.41	0.17	0.09
1700	0.64	0.36	0.29
1715	0.85	0.49	0.50
1730	1.02	0.66	0.71
1745	1.15	0.89	0.91
1800	1.27	1.06	1.08
1815	1.38	1.21	1.20
1830	1.46	1.34	1.36
1845	1.52	1.47	1.45
1900	1.55	1.55	1.53
1915	1.51	1.61	1.59
1930	1.46	1.59	1.59
1945	1.34	1.51	1.55
2000	1.19	1.39	1.47
2015	0.99	1.18	1.33
2030	0.77	0.98	1.15
2045	0.52	0.75	0.95
2100	0.27	0.53	0.73
2115	-0.02	0.32	0.50
2130	-0.25	0.10	0.28
2145	-0.47	-0.12	-0.02
2200	-0.68	-0.31	-0.16
2215	-0.87	-0.54	-0.34
2230	-1.06	-0.70	-0.55
2245	-1.25	-0.90	-0.71
2300	-1.42	-1.11	-0.87
2315	-1.59	-1.29	-1.08
2330	-1.74	-1.47	-1.24
2345	-1.87	-1.63	-1.39
2400	-1.98	-1.75	-1.52
	January 20		
0015	-2.06	-1.88	-1.68
0030	-2.10	-1.99	-1.79
0045	-2.12	-2.05	-1.93
0100	-2.11	-2.08	-1.99
0115	-2.04	-2.08	-2.03
0130	-1.93	-2.02	-2.05
0145	-1.79	-1.92	-2.08
0200	-1.62	-1.78	-2.03
0215	-1.42	-1.60	-1.93

(Continued)

Table 1 (Concluded)

Time CST	TLR-1 Coast Guard Pier ft	TLR-2 CM 24 ft	TLR-3 Belle Isle ft
	January 20 (Continued)		
0230	-1.21	-1.49	-1.76
0245	-0.98	-1.18	-1.55
0300	-0.73	-0.94	-1.31
0315	-0.50	-0.73	-1.03
0330	-0.27	-0.53	-0.74
0345	-0.04	-0.32	-0.49
0400	0.22	-0.13	-0.26
0415	0.49	0.08	-0.03
0430	0.73	0.26	0.21
0445	0.96	0.53	0.44
0500	1.18	0.79	0.68
0515	1.38	1.03	0.92
0530	1.58	1.29	1.15
0545	1.77	1.49	1.37
0600	1.96	1.68	1.58
0615	2.13	1.88	1.76
0630	2.24	2.06	1.94
0645	2.35	2.23	2.07
0700	2.43	2.31	2.20
0715	2.49	2.37	2.29
0730	2.51	2.45	2.36
0745	2.48	2.48	2.40
0800	2.39	2.46	2.41
0815	2.32	2.39	2.35
0830	2.19	2.26	2.27
0845	2.03	2.10	2.15
0900	1.82	1.92	2.01

Table 2

Current Data Observed at Station 1-A

19 January 1989

Hour CST	Depth ft	Speed fps	Direction deg*
		Surface**	
0752	3.0	1.0	321
0902	3.0	3.6	340
1011	3.0	5.4	343
1102	3.0	4.9	340
1202	3.0	2.7	345
1302	3.0	2.1	1
1402	3.0	1.7	8
1502	3.0	0.3	112
1602	3.0	2.5	144
1706	3.0	2.6	156
1802	3.0	2.2	160
1857	3.0	1.5	160
2002	3.0	1.0	305
2052	3.0	3.4	330
		Middepth	
0751	9.9	0.8	358
0901	8.9	2.1	343
1010	9.1	4.1	333
1101	8.4	2.3	337
1201	8.1	2.2	346
1301	8.0	1.8	350
1401	8.4	0.5	22
1501	8.8	0.7	140
1601	9.0	2.2	152
1705	8.9	2.2	149
1801	10.2	1.8	138
1856	10.1	1.2	130
2001	9.4	0.7	350
2051	9.0	2.5	342
		Bottom	
0750	17.8	0.5	26
0900	15.8	1.4	1
1009	16.2	1.6	292
1100	14.8	1.1	338
1200	14.2	1.6	335
1300	14.0	0.9	306
1400	14.8	0.2	50
1500	15.5	0.7	152
1600	16.0	1.3	130

(Continued)

* deg = direction from true north from which the current is flowing.

** Surface measurement obtained 3 ft below the water surface. Bottom measurement obtained 2 ft above the bed.

Table 2 (Concluded)

Hour CST	Depth ft	Speed fps	Direction deg
		Bottom (Continued)	
1704	15.8	1.8	140
1800	18.3	1.0	125
1855	18.2	0.7	122
2000	16.8	0.8	20
2050	16.0	1.3	6

Table 3

Current Data Observed at Station 1-B

19 January 1989

Hour CST	Depth ft	Speed fps	Direction deg*
		Surface**	
0804	3.0	1.0	332
0914	3.0	3.7	340
1019	3.0	5.3	341
1112	3.0	5.5	333
1211	3.0	5.5	335
1310	3.0	4.1	336
1410	3.0	2.0	342
1511	3.0	0.9	136
1611	3.0	3.9	143
1716	3.0	2.7	152
1812	3.0	2.6	160
1906	3.0	1.4	162
2010	3.0	1.2	313
2107	3.0	4.1	330
		Middepth	
0803	17.2	0.7	1
0913	16.9	2.4	330
1018	16.3	3.2	343
1111	16.6	3.1	332
1210	16.1	3.5	356
1309	15.5	2.1	340
1409	14.8	1.0	339
1510	15.5	1.8	140
1610	15.8	2.5	142
1714	16.7	2.8	143
1811	16.6	2.5	140
1905	16.4	2.0	134
2009	17.0	0.5	350
2106	16.5	2.7	338
		Bottom†	
0802	32.4	0.5	10
0912	31.8	1.0	345
1017	30.5	1.5	12
1110	31.2	1.5	341
1209	30.2	1.4	312
1308	29.0	0.5	342
1408	27.6	0.2	240
1509	29.0	0.7	120

(Continued)

* deg = direction from true north from which the current is flowing.
** Surface measurement obtained 3 ft below the water surface.
† Bottom measurement obtained 2 ft above the bed.

Table 3 (Concluded)

Hour CST	Depth ft	Speed fps	Direction deg
	Bottom (Continued)		
1609	29.5	1.6	128
1713	31.3	1.6	120
1810	31.2	2.0	120
1904	30.8	2.0	130
2008	32.0	0.9	359
2105	31.0	1.9	340

Table 4

Current Data Observed at Station 1-C

19 January 1989

Hour CST	Depth ft	Speed fps	Direction deg*
		Surface**	
0821	3.0	1.9	336
0923	3.0	2.8	330
1028	3.0	4.8	342
1120	3.0	3.9	342
1220	3.0	2.9	8
1318	3.0	1.8	343
1418	3.0	1.0	330
1520	3.0	1.2	149
1648	3.0	4.2	148
1725	3.0	5.1	150
1822	3.0	3.3	150
1915	3.0	1.2	145
2021	3.0	1.7	345
2121	3.0	3.4	340
		Middepth	
0820	13.0	1.5	349
0922	15.5	2.1	356
1027	13.3	2.6	354
1119	13.5	2.3	352
1219	14.4	2.6	341
1317	12.9	1.6	1
1417	12.9	0.3	166
1519	11.1	1.7	144
1647	9.8	3.5	148
1724	10.0	4.0	150
1821	10.2	2.8	144
1914	9.8	1.2	151
2020	9.9	1.3	350
2120	9.9	2.9	348
		Bottom†	
0819	24.0	0.8	29
0921	29.0	1.0	350
1026	24.5	0.6	350
1118	25.0	0.8	346
1218	26.7	1.2	340
1316	23.7	0.4	16
1416	23.8	0.4	212
1518	20.2	1.6	138
1646	17.6	2.4	150

(Continued)

* deg = direction from true north from which the current is flowing.
** Surface measurement obtained 3 ft below the water surface.
† Bottom measurement obtained 2 ft above the bed.

Table 4 (Concluded)

Hour CST	Depth ft	Speed fps	Direction deg
		Bottom (Continued)	
1723	18.0	2.3	156
1820	18.3	1.7	142
1913	17.6	1.1	156
2019	17.8	0.6	28
2119	17.7	1.4	355

Table 5

Current Data Observed at Station 1-D

19 January 1989

Hour CST	Depth ft	Speed fps	Direction deg*
		Surface**	
0832	3.0	1.9	346
0935	3.0	2.6	10
1035	3.0	2.0	352
1127	3.0	1.5	349
1227	3.0	1.0	351
1328	3.0	1.3	286
1426	3.0	0.4	355
1528	3.0	0.9	154
1656	3.0	1.7	160
1738	3.0	2.7	150
1831	3.0	1.7	148
1925	3.0	0.4	169
2031	3.0	1.8	346
2134	3.0	0.8	313
		Middepth	
0831	8.0	1.5	351
0934	8.0	1.4	351
1034	7.2	1.7	348
1126	6.8	1.4	340
1226	6.2	1.0	2
1327	4.8	0.9	280
1425	7.8	0.2	120
1527	5.5	1.1	154
1655	7.7	1.6	160
1737	8.0	1.8	158
1830	8.7	1.3	130
1924	6.4	0.3	173
2030	7.7	1.3	346
2133	7.8	0.4	210
		Bottom†	
0830	14.0	1.0	346
0933	14.0	1.0	341
1033	12.3	0.4	6
1125	11.6	0.8	341
1225	10.3	0.6	30
1326	7.6	0.3	225
1424	13.5	0.1	68
1526	9.0	0.1	210
1654	13.3	1.1	156

(Continued)

* deg = direction from true north from which the current is flowing.
** Surface measurement obtained 3 ft below the water surface.
† Bottom measurement obtained 2 ft above the bed.

Table 5 (Concluded)

Hour CST	Depth ft	Speed fps	Direction deg
	Bottom (Continued)		
1736	13.9	1.4	151
1829	15.3	1.1	200
1923	10.8	0.3	166
2029	13.3	0.8	345
2132	13.5	0.7	210

Table 6

Current Data Observed at Station 2-A

19 January 1989

Hour CST	Depth ft	Speed fps	Direction deg*
		Surface**	
0828	2.0	1.2	300
0906	2.9	1.3	295
1001	2.7	0.9	310
1102	2.0	1.0	315
1601	2.0	0.1	215
1701	2.8	0.5	125
1800	3.3	0.6	130
1900	3.7	0.4	130
2000	3.5	0.2	330
2100	3.3	0.8	250

* deg = direction from true north from which the current is flowing.

** Water depth too shallow for profiling. Only one depth measured at this velocity station.

Table 7

Current Data Observed at Station 2-B

19 January 1989

Hour CST	Depth ft	Speed fps	Direction deg*
		Surface**	
0841	3.0	1.6	290
0915	3.0	1.9	300
1009	3.0	2.9	305
1111	3.0	2.6	295
1205	3.0	2.0	295
1304	3.0	1.8	295
1404	3.0	1.1	295
1505	3.0	0.1	330
1612	3.0	2.1	130
1707	3.0	3.0	135
1810	3.0	1.8	130
1922	3.0	1.2	135
2008	3.0	0.0	360
2120	3.0	2.4	285
		Middepth	
0840	5.9	0.8	295
0913	5.6	1.7	300
1007	5.5	2.2	305
1110	4.9	2.4	290
1204	4.8	2.2	295
1302	4.6	1.4	290
1403	4.5	1.0	290
1503	5.0	0.1	300
1611	4.5	1.8	130
1706	5.1	2.2	135
1809	5.4	1.8	130
1921	5.5	1.0	130
2007	4.0	0.0	50
2119	5.3	1.6	300
		Bottom†	
0838	9.8	0.4	290
0912	9.1	1.3	310
1005	9.0	1.5	310
1108	7.9	1.5	295
1202	7.6	1.8	295
1300	7.1	1.4	290
1400	7.0	0.7	290
1502	8.0	0.2	270
1609	7.0	1.4	135

(Continued)

* deg = direction from true north from which the current is flowing.
** Surface measurement obtained 3 ft below the water surface.
† Bottom measurement obtained 2 ft above the bed.

Table 7 (Concluded)

Hour CST	Depth ft	Speed fps	Direction deg
		Bottom (Continued)	
1704	8.3	1.5	145
1807	8.9	1.0	130
1920	9.0	0.6	165
2006	6.0	0.1	75
2118	8.6	1.2	300

Table 8

Current Data Observed at Station 2-C

19 January 1989

Hour CST	Depth ft	Speed fps	Direction deg*
		Surface**	
0851	3.0	1.7	295
0929	3.0	2.2	300
1017	3.0	3.4	300
1120	3.0	3.3	300
1214	3.0	3.4	295
1312	3.0	3.2	290
1412	3.0	2.2	300
1512	3.0	0.1	250
1619	3.0	2.2	130
1713	3.0	3.6	125
1819	3.0	2.8	130
1929	3.0	1.0	155
2017	3.0	0.5	70
2112	3.0	2.2	300
		Middepth	
0848	14.9	0.1	245
0927	14.9	0.9	290
1016	14.8	2.2	300
1118	14.4	2.7	290
1212	14.3	2.8	295
1310	13.8	2.7	290
1410	13.8	1.9	290
1510	14.5	0.1	210
1617	15.2	2.6	130
1712	15.5	2.5	130
1818	16.1	2.0	110
1927	16.0	1.2	120
2015	15.5	0.6	160
2111	14.2	1.0	295
		Bottom†	
0846	27.8	0.0	240
0926	27.8	0.1	290
1014	27.5	1.9	310
1116	26.9	1.2	290
1210	26.5	1.0	295
1308	25.7	1.8	290
1408	25.5	0.5	290
1508	27.0	0.7	150
1615	28.3	1.2	130

(Continued)

* deg = direction from true north from which the current is flowing.

** Surface measurement obtained 3 ft below the water surface.

† Bottom measurement obtained 2 ft above the bed.

Table 8 (Concluded)

Hour CST	Depth ft	Speed fps	Direction deg
	Bottom (Continued)		
1711	29.1	0.7	120
1816	30.2	1.0	60
1925	30.1	0.6	130
2013	29.0	0.5	190
2110	26.4	0.1	270

Table 9

Current Data Observed at Station 2-D

19 January 1989

Hour CST	Depth ft	Speed fps	Direction deg*
		Surface**	
0859	3.0	1.3	305
0937	3.0	1.6	310
1025	3.0	1.4	310
1126	3.0	1.2	305
1221	3.0	1.4	300
1318	3.0	1.2	300
1418	3.0	0.1	360
1519	3.0	0.5	200
1624	3.0	2.0	135
1722	3.0	1.8	135
1828	3.0	1.6	140
1939	3.0	0.1	95
2025	3.0	0.8	310
2142	3.0	1.8	320
		Middepth	
0858	7.2	1.2	310
0936	6.9	1.6	320
1024	6.5	1.2	305
1124	6.2	1.2	305
1220	6.4	1.4	325
1317	5.5	1.0	300
1417	5.4	0.1	360
1518	5.8	0.1	210
1623	5.9	1.8	140
1720	6.7	2.2	135
1827	5.8	1.6	140
1938	7.6	0.8	125
2024	8.2	0.1	300
2140	6.6	1.5	300
		Bottom†	
0856	12.5	0.2	280
0934	11.8	0.7	330
1022	11.0	1.2	305
1123	10.4	0.9	360
1218	10.8	1.2	360
1315	9.0	0.8	340
1416	8.8	0.0	300
1516	9.6	0.1	85
1622	9.8	1.8	135

(Continued)

* deg = direction from true north from which the current is flowing.
** Surface measurement obtained 3 ft below the water surface.
† Bottom measurement obtained 2 ft above the bed.

Table 9 (Concluded)

Hour CST	Depth ft	Speed fps	Direction deg
		Bottom (Continued)	
1718	11.4	1.6	145
1825	11.7	1.3	145
1936	13.2	1.0	140
2023	14.4	0.1	265
2138	11.2	1.3	295

Table 10

Current Data Observed at Station 3-A

19 January 1989

Hour CST	Depth ft	Speed fps	Direction deg*
		Surface**	
0731	3.0	1.1	189
0814	3.0	0.4	96
0905	3.0	0.9	20
1005	3.0	2.0	21
1105	3.0	1.7	12
1204	3.0	1.8	18
1305	3.0	1.6	20
1404	3.0	1.8	24
1504	3.0	0.9	44
1604	3.0	0.6	169
1703	3.0	1.8	190
1804	3.0	2.2	194
1903	3.0	2.2	188
2002	3.0	0.8	182
		Middepth	
0729	8.5	0.7	189
0812	8.9	0.2	340
0903	8.8	1.0	19
1003	8.8	1.6	12
1102	8.5	1.4	30
1202	8.2	1.4	22
1303	7.8	1.8	28
1402	7.3	1.4	24
1502	7.5	0.7	28
1602	7.4	0.9	200
1702	7.9	2.0	190
1802	8.3	2.0	185
1901	8.6	1.8	190
2000	8.7	0.8	178
		Bottom†	
0727	15.0	0.3	200
0810	15.8	0.6	280
0901	15.6	0.5	147
1001	15.7	0.9	38
1101	15.0	1.2	6
1200	14.4	1.3	20
1301	13.7	1.7	32
1400	12.5	1.5	32
1500	12.9	0.6	358

(Continued)

* deg = direction from true north from which the current is flowing.
** Surface measurement obtained 3 ft below the water surface.
† Bottom measurement obtained 2 ft above the bed.

Table 10 (Concluded)

Hour CST	Depth ft	Speed fps	Direction deg
		Bottom (Continued)	
1600	12.8	0.8	218
1700	13.9	1.2	190
1800	14.6	1.3	184
1859	15.4	0.8	172
1958	15.4	0.3	48

Table 11

Current Data Observed at Station 3-B

19 January 1989

Hour CST	Depth ft	Speed fps	Direction deg*
		Surface**	
0741	3.0	1.0	180
0825	3.0	0.4	264
0915	3.0	1.4	2
1012	3.0	2.8	14
1114	3.0	2.8	8
1214	3.0	2.5	8
1312	3.0	2.2	12
1412	3.0	2.6	8
1511	3.0	1.6	350
1610	3.0	0.4	210
1711	3.0	2.0	190
1810	3.0	2.5	198
1911	3.0	2.0	188
2012	3.0	0.9	164
		Middepth	
0739	13.1	0.8	222
0821	13.2	0.4	160
0913	13.0	1.4	335
1010	13.3	2.4	4
1112	12.8	2.3	16
1212	11.7	2.8	6
1310	11.8	2.4	14
1410	11.7	2.0	18
1509	11.7	0.6	242
1608	11.8	1.4	192
1709	12.6	2.0	189
1808	13.0	1.9	218
1909	13.0	1.2	200
2010	13.0	0.8	248
		Bottom†	
0737	24.2	0.8	111
0819	24.4	0.8	129
0911	24.0	1.0	276
1008	24.6	0.6	359
1110	23.3	1.4	354
1210	21.4	1.2	10
1308	21.7	1.7	20
1408	21.4	1.2	342
1507	21.4	0.5	81

(Continued)

* deg = direction from true north from which the current is flowing.
** Surface measurement obtained 3 ft below the water surface.
† Bottom measurement obtained 2 ft above the bed.

Table 11 (Concluded)

Hour CST	Depth ft	Speed fps	Direction deg
		Bottom (Continued)	
1606	21.6	1.3	190
1707	23.2	1.0	172
1806	24.1	1.5	110
1907	24.0	1.9	154
2008	24.0	0.3	178

Table 12

Current Data Observed at Station 3-C

19 January 1989

Hour CST	Depth ft	Speed fps	Direction deg*
		Surface**	
0752	3.0	0.6	165
0836	3.0	0.4	348
0926	3.0	2.1	358
1022	3.0	2.4	11
1127	3.0	2.7	359
1221	3.0	2.0	24
1320	3.0	1.6	18
1419	3.0	1.5	22
1518	3.0	0.4	359
1617	3.0	0.2	64
1718	3.0	2.6	176
1819	3.0	2.7	182
1921	3.0	1.8	206
2025	3.0	0.6	182
		Middepth	
0750	12.5	1.0	218
0834	10.8	0.4	336
0924	10.5	1.7	8
1020	8.3	1.9	8
1125	8.8	1.5	21
1219	8.2	1.7	6
1318	7.6	1.0	20
1417	7.7	1.1	12
1516	5.5	0.4	28
1615	8.8	0.5	178
1716	10.6	2.5	190
1817	11.1	2.3	196
1919	11.1	1.9	180
2023	12.5	0.9	218
		Bottom†	
0748	22.9	0.3	330
0832	19.6	0.1	229
0922	19.1	1.0	354
1018	14.6	0.7	70
1123	16.9	1.0	28
1217	14.4	1.1	350
1316	13.2	0.9	14
1415	13.5	1.4	348
1514	9.0	0.4	359

(Continued)

* deg = direction from true north from which the current is flowing.
** Surface measurement obtained 3 ft below the water surface.
† Bottom measurement obtained 2 ft above the bed.

Table 12 (Concluded)

Hour CST	Depth ft	Speed fps	Direction deg
		Bottom (Continued)	
1613	15.7	0.3	210
1714	19.3	1.1	218
1815	20.2	1.0	216
1917	20.2	0.8	174
2021	22.5	0.8	254

Table 13

Current Data Observed at Station 3-D

19 January 1989

Hour CST	Depth ft	Speed fps	Direction deg*
		Surface**	
0803	3.0	0.4	144
0844	3.0	0.3	39
0935	3.0	1.7	2
1030	3.0	1.5	6
1136	3.0	1.2	350
1226	3.0	0.8	18
1325	3.0	1.2	8
1425	3.0	0.8	350
1524	3.0	0.2	350
1622	3.0	0.3	150
1724	3.0	1.8	144
1825	3.0	2.2	180
1927	3.0	1.0	165
2035	3.0	1.2	350
		Middepth	
0801	5.2	0.7	162
0842	5.9	0.4	31
0933	5.2	1.8	305
1028	5.0	1.6	16
1134	5.0	1.4	4
1621	4.0	0.6	212
1723	4.8	0.8	204
1823	4.5	1.8	152
1925	4.5	1.3	180
2033	5.1	0.4	52
		Bottom†	
0759	8.3	0.7	150
0840	9.8	0.6	10
0931	8.4	1.2	320
1026	7.0	1.4	16
1132	7.0	0.9	16
1224	5.0	0.6	8
1323	5.0	1.3	8
1423	4.2	1.0	359
1522	4.3	0.4	359
1619	5.8	0.9	190
1721	7.6	0.3	300
1821	7.0	1.8	144
1923	8.9	1.4	176
2031	8.2	0.4	42

* deg = direction from true north from which the current is flowing.

** Surface measurement obtained 3 ft below the water surface.

† Bottom measurement obtained 2 ft above the bed.

Table 14

Salinity Data Observed, 19 January 1989

Hour CST	Sta No.	Salinity, ppt Surface*	Middepth	Bottom**
		Range 1		
1401	A	14.2	15.0	15.0
1409	B	13.3	17.5	13.3
1417	C	13.2	18.9	12.3
1425	D	13.3	13.8	14.7
1856	A	30.8	31.2	31.1
1905	B	31.5	32.5	32.4
1914	C	32.7	32.7	32.0
1924	D	32.3	32.3	32.5
		Range 2		
1403	B	7.7	7.7	7.7
1410	C	6.6	7.7	19.7
1417	D	6.5	6.5	6.9
2007	B	18.9	19.9	20.4
2015	C	19.2	23.0	23.6
2024	D	19.1	21.5	22.9
		Range 3		
0812	A	7.3	10.0	11.8
0821	B	8.0	11.4	11.8
0834	C	8.8	10.4	11.7
0842	D	8.4	9.3	9.9
1502	A	2.7	2.8	3.4
1509	B	1.9	2.8	4.1
1516	C	1.9	1.7	2.5
1523	D	2.3	†	2.2

* - Surface measurement taken 3 ft below water surface.
** - Bottom measurement taken 2 ft above the bed.
† - No measurement taken; water depth too shallow for profiling.

Table 15

Suspended Sediment Concentration Data Observed at

Range 1, 19 January 1989

Hour CST	Sta No.	Concentration, mg/ℓ Surface*	Middepth	Bottom**
0751	A	28	28	26
0803	B	18	16	18
0820	C	13	12	13
0831	D	14	11	13
0901	A	18	24	22
0913	B	10	18	14
0922	C	8	16	8
0934	D	24	20	12
1010	A	17	28	19
1018	B	19	25	15
1027	C	17	16	26
1034	D	21	19	17
1101	A	29	34	41
1111	B	20	25	23
1119	C	19	22	30
1126	D	30	32	26
1201	A	32	38	38
1210	B	18	30	38
1219	C	30	26	26
1226	D	20	28	32
1301	A	44	50	86
1309	B	30	52	72
1317	C	34	42	44
1327	D	26	40	22
1401	A	54	68	72
1409	B	28	32	36
1417	C	26	26	28
1425	D	14	16	22
1501	A	22	74	68
1511	B	16	46	60
1519	C	16	18	50
1527	D	14	18	20
1601	A	12	26	86
1610	B	10	62	28
1647	C	32	42	54
1655	D	34	44	50
1705	A	40	42	40
1714	B	24	26	38
1724	C	24	26	30
1737	D	20	36	38
1801	A	34	24	28
1811	B	20	20	24

(Continued)

* Surface measurement obtained 3 ft below the water surface.
** Bottom measurement obtained 2 ft above the bed.

Table 15 (Concluded)

Hour CST	Sta No.	Concentration, mg/ℓ		
		Surface	Middepth	Bottom
1821	C	14	16	20
1830	D	18	18	22
1856	A	30	28	11
1905	B	24	22	26
1914	C	12	12	18
1924	D	14	14	14
2001	A	18	16	14
2009	B	10	14	16
2020	C	10	12	16
2030	D	12	14	18
2051	A	16	32	34
2106	B	14	24	26
2120	C	24	24	26
2133	D	30	32	36

Table 16

Suspended Sediment Concentration Data Observed at Range 2, 19 January 1989

Hour CST	Sta No.	Concentration, mg/ℓ Surface*	Middepth	Bottom**
0826	A	18	18	-
0840	B	12	12	12
0848	C	22	18	16
0858	D	6	10	18
0906	A	50	-	-
0913	B	10	20	24
0927	C	6	10	14
0936	D	19	16	23
1000	A	88	-	-
1008	B	33	44	59
1016	C	9	31	28
1024	D	30	39	30
1102	A	133	-	-
1110	B	37	49	64
1117	C	38	30	64
1124	D	54	76	76
1204	B	32	64	72
1212	C	28	62	168
1220	D	28	36	60
1302	B	64	66	68
1309	C	40	44	220
1317	D	26	26	38
1403	B	34	36	38
1410	C	24	32	134
1417	D	18	20	16
1504	B	16	22	34
1510	C	20	20	326
1518	D	18	22	20
1601	A	20	-	-
1611	B	18	32	50
1617	C	24	40	126
1623	D	16	30	50
1701	A	59	-	-
1706	B	16	50	80
1712	C	10	52	186
1719	D	28	28	94
1801	A	46	-	-
1809	B	70	32	44
1817	C	24	80	124
1827	D	18	64	94
1900	A	30	-	-

(Continued)

Note: - = No sample obtained, water depth too shallow for profiling.
* Surface measurement obtained 3 ft below the water surface.
** Bottom measurement obtained 2 ft above the bed.

Table 16 (Concluded)

Hour CST	Sta No.	Concentration, mg/ℓ		
		Surface	Middepth	Bottom
1921	B	62	18	16
1927	C	14	26	40
1938	D	28	26	66
2000	A	8	-	-
2008	B	16	18	20
2015	C	14	34	58
2024	D	12	14	24
2100	A	36	-	-
2110	C	10	10	22
2120	B	20	30	28
2140	D	108	140	78

Table 17

Suspended Sediment Concentration Data Observed at

Range 3, 19 January 1989

Hour CST	Sta No.	Concentration, mg/ℓ Surface*	Middepth	Bottom**
0729	A	19	23	42
0739	B	15	26	93
0750	C	16	18	34
0801	D	18	21	17
0812	A	10	19	20
0821	B	12	19	26
0834	C	15	16	27
0842	D	14	14	18
0903	A	10	13	58
0913	B	12	14	44
0924	C	22	19	41
0931	D	56	50	31
1003	A	24	23	29
1010	B	13	13	218
1020	C	28	34	63
1028	D	47	50	53
1103	A	40	74	285
1112	B	18	23	222
1125	C	35	69	188
1134	D	36	29	39
1202	A	34	68	344
1212	B	27	31	174
1219	C	57	62	214
1226	D	28	–	43
1303	A	36	53	52
1310	B	24	26	107
1318	C	48	46	52
1324	D	32	–	36
1402	A	18	36	42
1410	B	20	28	170
1417	C	24	20	30
1424	D	20	–	18
1502	A	30	30	26
1509	B	32	36	46
1516	C	32	30	32
1523	D	50	–	66
1602	A	28	26	28
1608	B	24	24	102
1615	C	20	32	86
1621	D	36	34	44
1702	A	18	40	254
1709	B	18	42	420

(Continued)

Note: – = No sample obtained, water depth too shallow for profiling.
* Surface measurement obtained 3 ft below the water surface.
** Bottom measurement obtained 2 ft above the bed.

Table 17 (Concluded)

Hour CST	Sta No.	Concentration, mg/ℓ		
		Surface	Middepth	Bottom
1716	C	22	40	58
1723	D	40	40	44
1802	A	50	76	370
1808	B	16	52	298
1817	C	18	48	140
1823	D	34	52	56
1903	A	18	20	140
1909	B	20	34	202
1919	C	18	24	112
1925	D	16	26	34
2000	A	12	14	32
2010	B	14	16	38
2023	C	20	20	44
2033	D	24	26	44

Table 18

Automatic Sampler Suspended Sediment Concentration for 18 October-12 November 1988

Sample Start Date*	Sample Start Time* CST	AWS-1 Range Marker mg/ℓ	AWS-2 CM 24 mg/ℓ	AWS-3 Belle Isle mg/ℓ	AWS-4 Belle Isle mg/ℓ
18 Oct 88	1139	140	20	21	18
19 Oct 88	1231	33	17	42	15
20 Oct 88	1223	27	21	--**	31
21 Oct 88	1315	48	28	72	17
22 Oct 88	1407	47	48	76	26
23 Oct 88	1459	42	35	50	42
24 Oct 88	1551	55	58	132	41
25 Oct 88	1643	38	22	72	34
26 Oct 88	1735	32	32	50	31
27 Oct 88	1827	26	21	140	34
28 Oct 88	1919	33	24	60	37
29 Oct 88	2011	23	21	57	33
30 Oct 88	2103	30	17	61	20
31 Oct 88	2155	28	16	85	20
1 Nov 88	2247	23	15	--**	13
2 Nov 88	2349	22	11	--**	15
4 Nov 88	0041	20	9	--**	16
5 Nov 88	0133	46	17	--**	14
6 Nov 88	0225	88	15	--**	6
7 Nov 88	0317	70	15	--**	30
8 Nov 88	0409	72	18	--**	34
9 Nov 88	0501	50	22	--**	36
10 Nov 88	0553	40	23	--**	46
11 Nov 88	0645	47	17	--**	60

* Composite samples; i.e., four samples per bottle with a 373-min interval between samples.

** No sample, equipment malfunction.

Table 19

Automatic Sampler Suspended Sediment Concentration for 12 December 1988-6 January 1989

Sample Start Date*	Sample Start Time* CST	AWS-2 CM 24 mg/ℓ
12 Dec 88	2000	42
13 Dec 88	2052	27
14 Dec 88	2144	38
15 Dec 88	2236	21
16 Dec 88	2328	26
18 Dec 88	0020	26
19 Dec 88	0112	26
20 Dec 88	0204	31
21 Dec 88	0256	17
22 Dec 88	0348	23
23 Dec 88	0440	24
24 Dec 88	0532	25
25 Dec 88	0624	20
26 Dec 88	0716	18
27 Dec 88	0808	23
28 Dec 88	0900	19
29 Dec 88	0952	27
30 Dec 88	1044	18
31 Dec 88	1136	21
1 Jan 89	1228	19
2 Jan 89	1320	21
3 Jan 89	1412	20
4 Jan 89	1502	72
5 Jan 89	1556	34

* Composite samples; i.e., four samples per bottle with a 373-min interval between samples.

Table 20

Automatic Sampler Suspended Sediment Concentration

for 18 January-3 February 1989

Sample Start Date*	Sample Start Time* CST	AWS-1 Range Marker mg/ℓ	AWS-2 CM 24 mg/ℓ	AWS-3A Belle Isle mg/ℓ
18 Jan 89	1400	40	26	62
19 Jan 89	1452	34	26	36
20 Jan 89	1544	50	18	54
21 Jan 89	1636	40	44	60
22 Jan 89	1728	38	34	32
23 Jan 89	1820	50	68	40
24 Jan 89	1912	34	42	76
25 Jan 89	2004	32	42	44
26 Jan 89	2056	26	28	24
27 Jan 89	2148	12	46	18
28 Jan 89	2240	12	20	14
29 Jan 89	2332	14	30	20
31 Jan 89	0024	26	40	26
1 Feb 89	0116	20	42	32
2 Feb 89	0208	22	22	34
3 Feb 89	0300	8	20	76

* Composite samples; i.e., four samples per bottle with a 373-min interval between samples.

Table 21

Automatic Sampler Suspended Sediment Concentration

for 3-16 February 1989

Sample Start Date*	Sample Start Time* CST	AWS-1 Range Marker mg/ℓ	AWS-1A Range Marker mg/ℓ	AWS-2 CM 24 mg/ℓ	AWS-3A Belle Isle mg/ℓ
3 Feb 89	1400	37	69	29	26
4 Feb 89	1452	33	48	41	63
5 Feb 89	1544	32	42	50	61
6 Feb 89	1636	32	45	54	86
7 Feb 89	1728	38	43	54	74
8 Feb 89	1820	36	39	47	63
9 Feb 89	1912	38	46	57	47
10 Feb 89	2004	32	35	39	49
11 Feb 89	2056	39	39	37	42
12 Feb 89	2148	28	29	30	37
13 Feb 89	2240	28	29	17	--**
14 Feb 89	2332	29	32	17	--**
16 Feb 89	0024	32	38	14	--**
17 Feb 89	0116	60	--**	60	--**
18 Feb 89	0208	48	--**	38	--**
19 Feb 89	0300	35	--**	42	--**
20 Feb 89	0352	35	--**	60	--**
21 Feb 89	0444	42	--**	57	--**
22 Feb 89	0536	48	--**	40	--**
23 Feb 89	0628	68	--**	37	--**
24 Feb 89	0720	103	--**	30	--**
25 Feb 89	0812	38	--**	18	--**
26 Feb 89	0904	66	--**	24	--**
27 Feb 89	0956	61	--**	17	--**

* Composite samples; i.e., four samples per bottle with a 373-min interval between samples.

** No sample, equipment malfunction.

Table 22

Current Data Observed for BLAPS Deployment

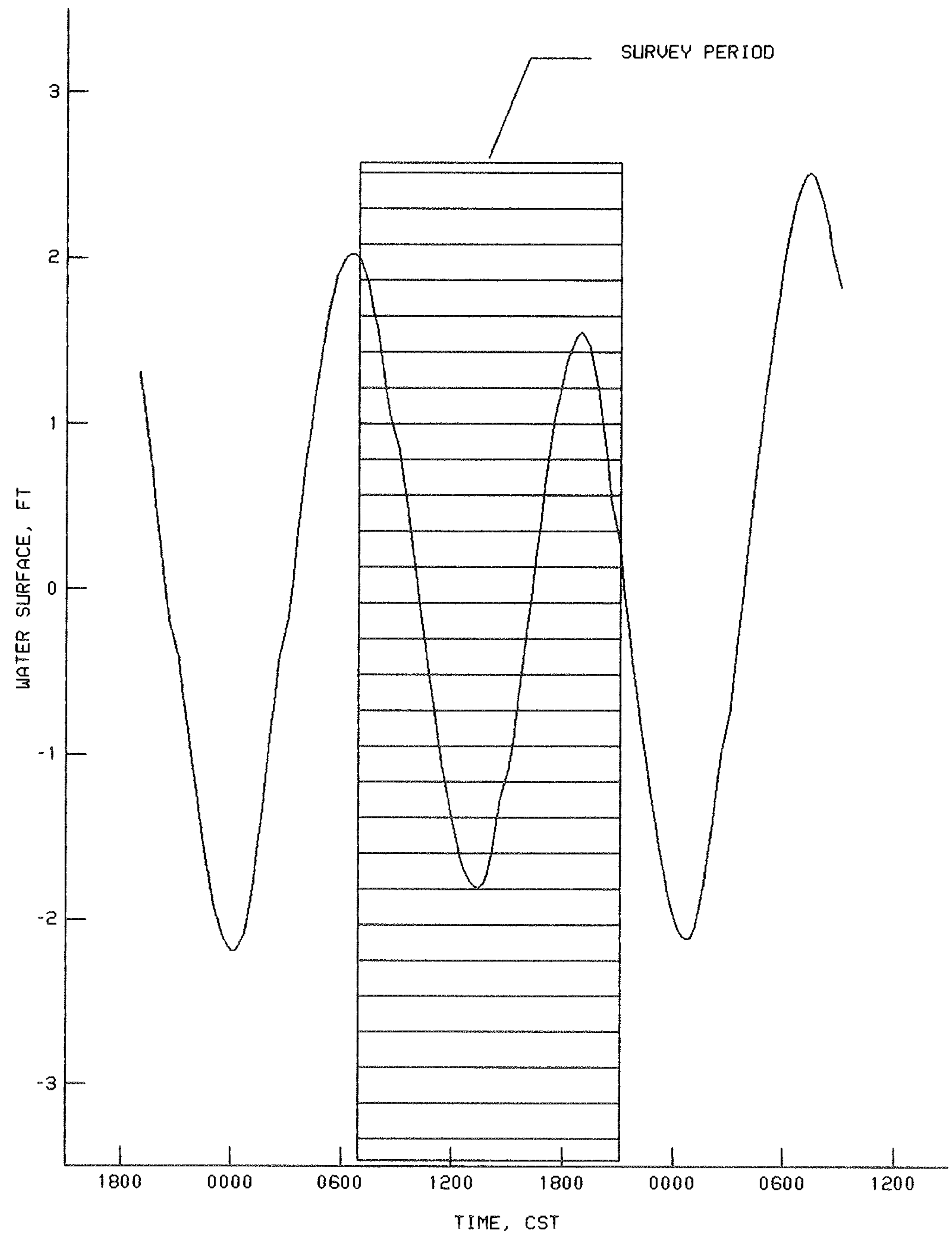
Hour CST	Depth ft	Speed fps	Direction deg*
		Test Site 1	
1720	14.00	0.1	246
1729	13.75	0.2	228
1736	13.50	0.2	272
1734	13.25	0.3	281
1738	13.00	0.3	308
1740	12.75	0.2	318
1745	12.50	0.2	278
1749	12.25	0.2	280
1756	12.00	0.7	295
		Test Site 2	
0833	23.3	0.8	329
0836	23.3	0.7	330
0839	23.3	0.7	329
0842	23.3	0.7	330
0845	23.3	0.7	329
0848	23.1	0.7	322
0851	22.9	1.0	326
0854	22.6	1.0	325
0857	22.3	0.9	326
0900	22.0	1.2	328
0903	21.7	1.3	335
0906	21.4	1.3	342
0909	21.0	1.4	345
0912	19.5	1.6	350
0913	18.0	2.0	339
0915	16.5	2.2	340
0916	15.0	2.6	335
0918	12.0	2.6	330
0920	9.0	2.5	335
0921	6.0	3.2	325
0922	3.0	2.7	320
		Test Site 3	
1438	16.2	1.6	146
1441	16.2	2.0	146
1444	16.2	2.0	140
1447	16.2	1.8	142
1450	16.2	1.6	146
1453	15.9	1.6	142

(Continued)

* deg = direction from true north from which the current is flowing

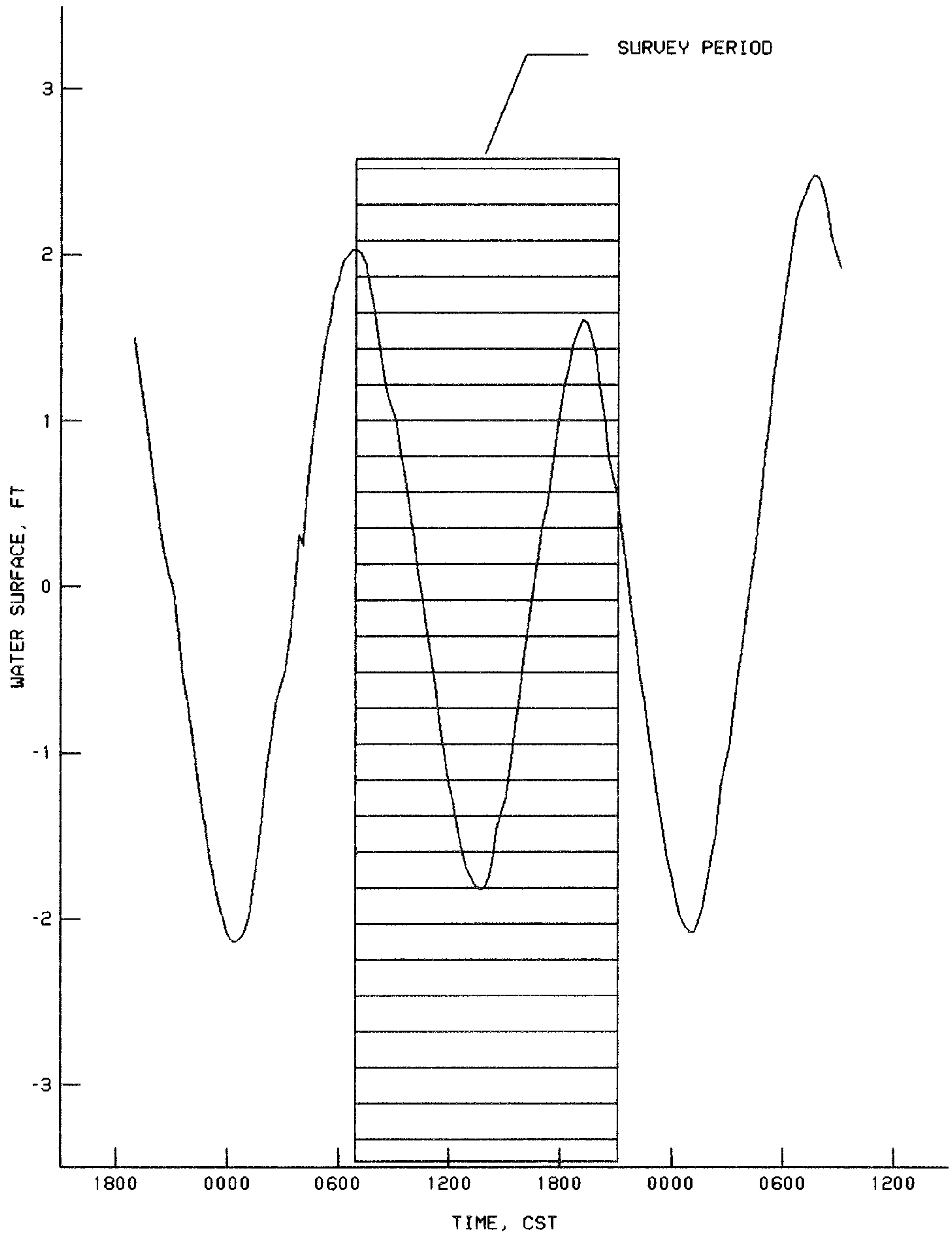
Table 22 (Concluded)

Hour CST	Depth ft	Speed fps	Direction deg
	Test Site 3 (Continued)		
1456	15.6	1.7	140
1459	15.3	1.6	140
1502	15.0	1.3	144
1505	14.7	1.2	142
1508	14.4	1.1	140
1511	14.1	1.0	140
1514	13.8	1.0	140
1517	13.5	1.0	140
1519	11.0	1.0	128
1520	9.0	1.0	120
1521	7.0	1.0	120
1522	5.0	1.1	120
1525	3.0	1.1	122



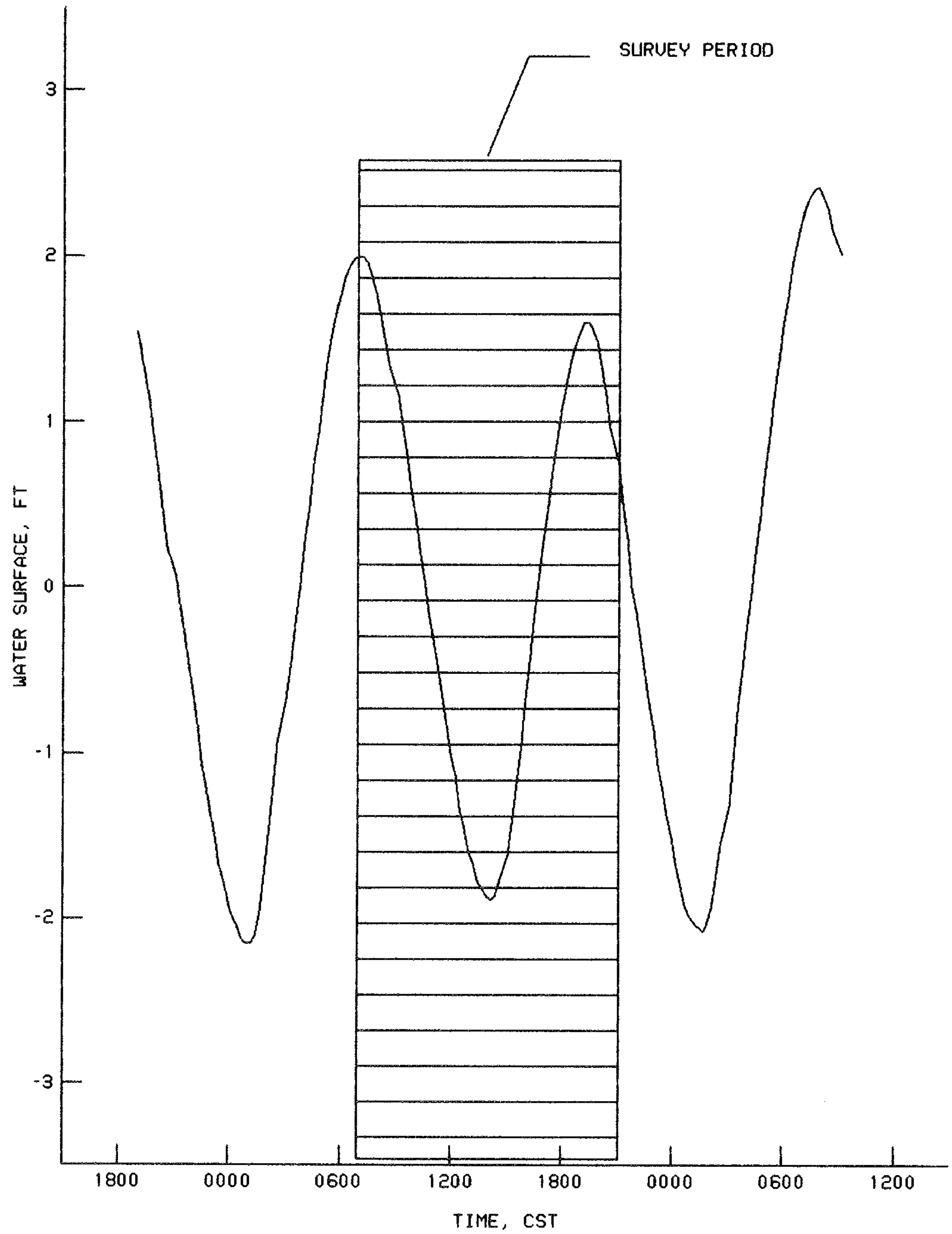
NOTE: MEAN WATER LEVEL READING USED AS DATUM

WATER-SURFACE ELEVATIONS
GAGE TLR-1
18-20 JANUARY 1989



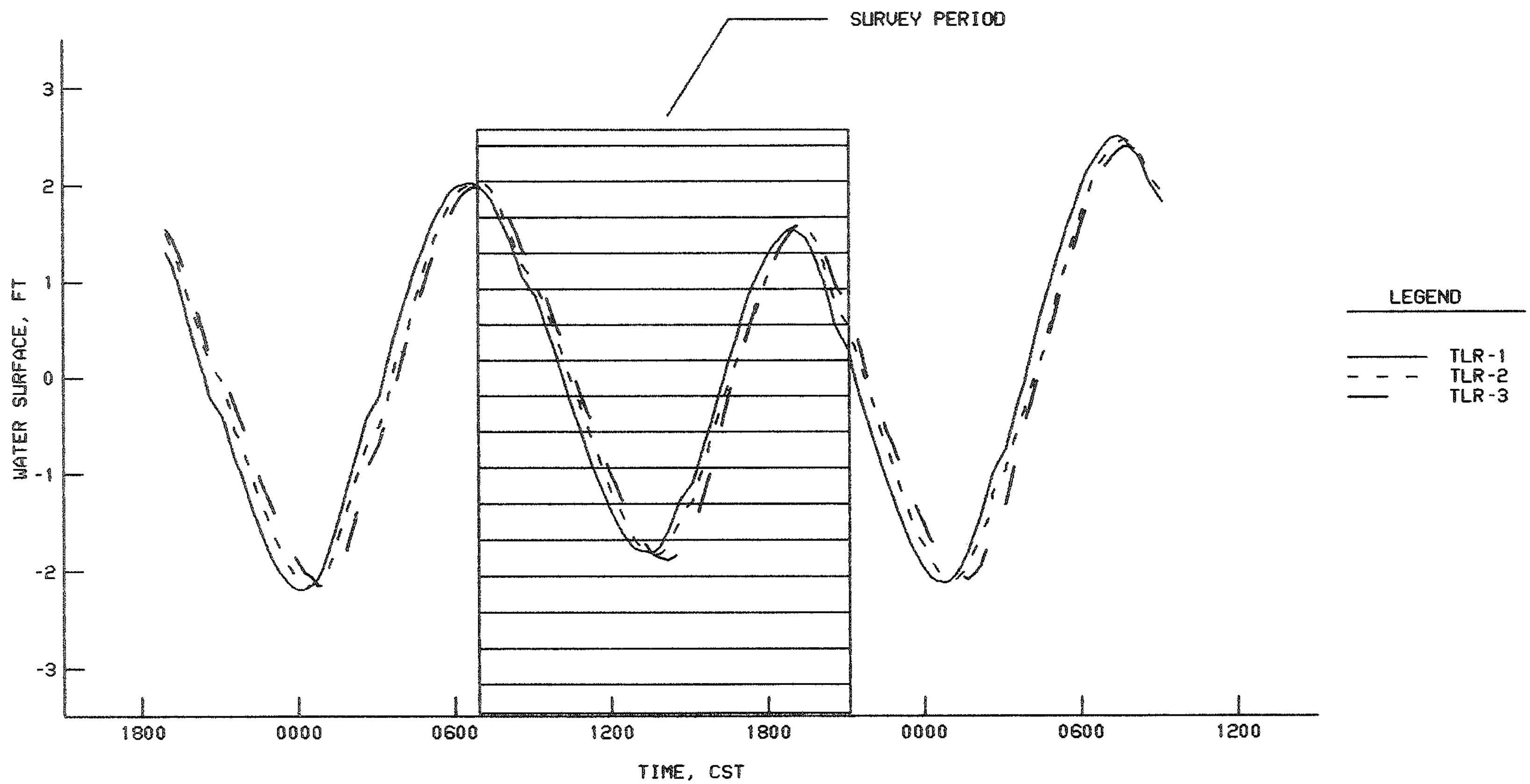
NOTE: MEAN WATER LEVEL READING USED AS DATUM

WATER-SURFACE ELEVATIONS
GAGE TLR-2
18-20 JANUARY 1989



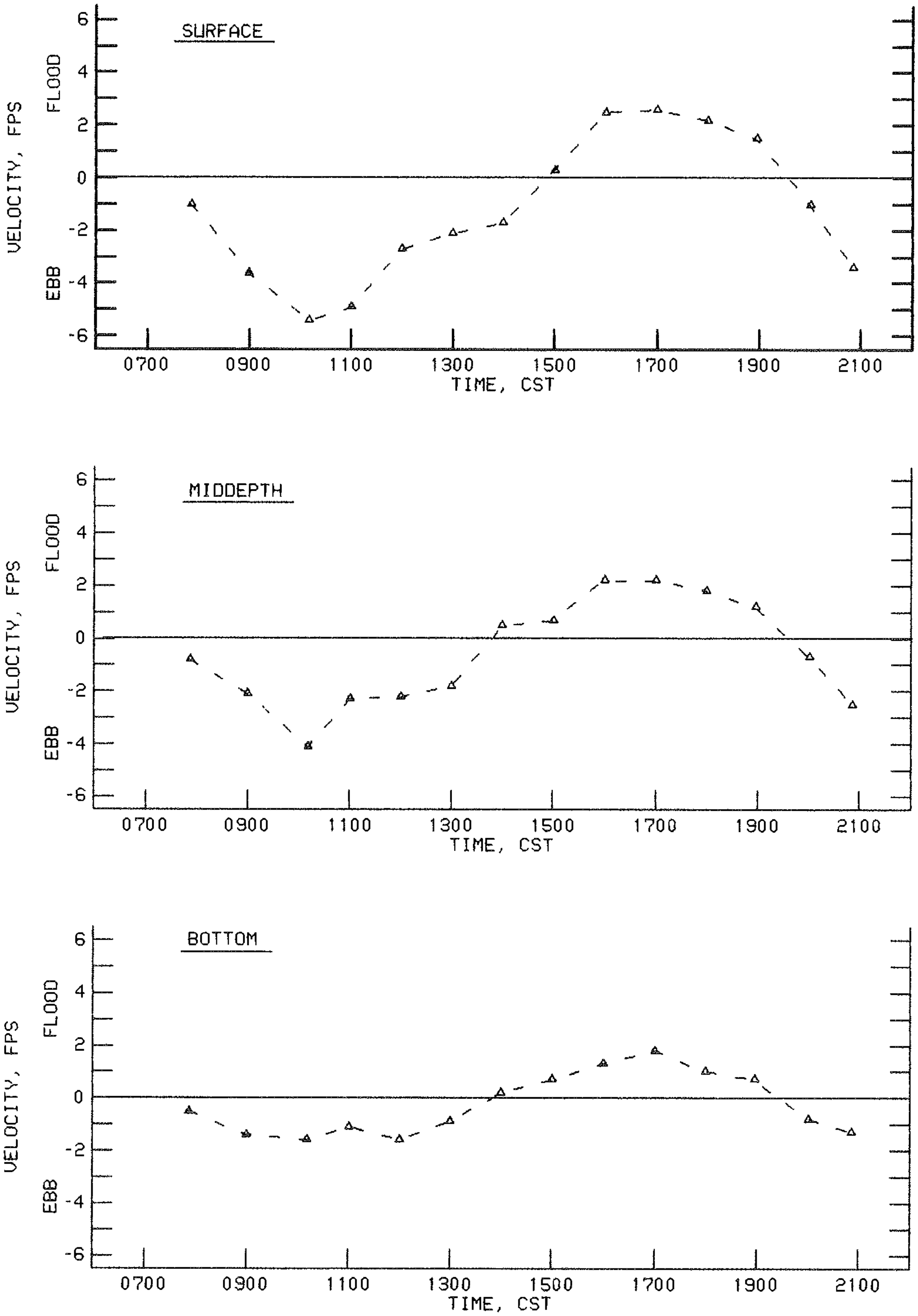
NOTE: MEAN WATER LEVEL READING USED AS DATUM

WATER-SURFACE ELEVATIONS
GAGE TLR-3
18-20 JANUARY 1989

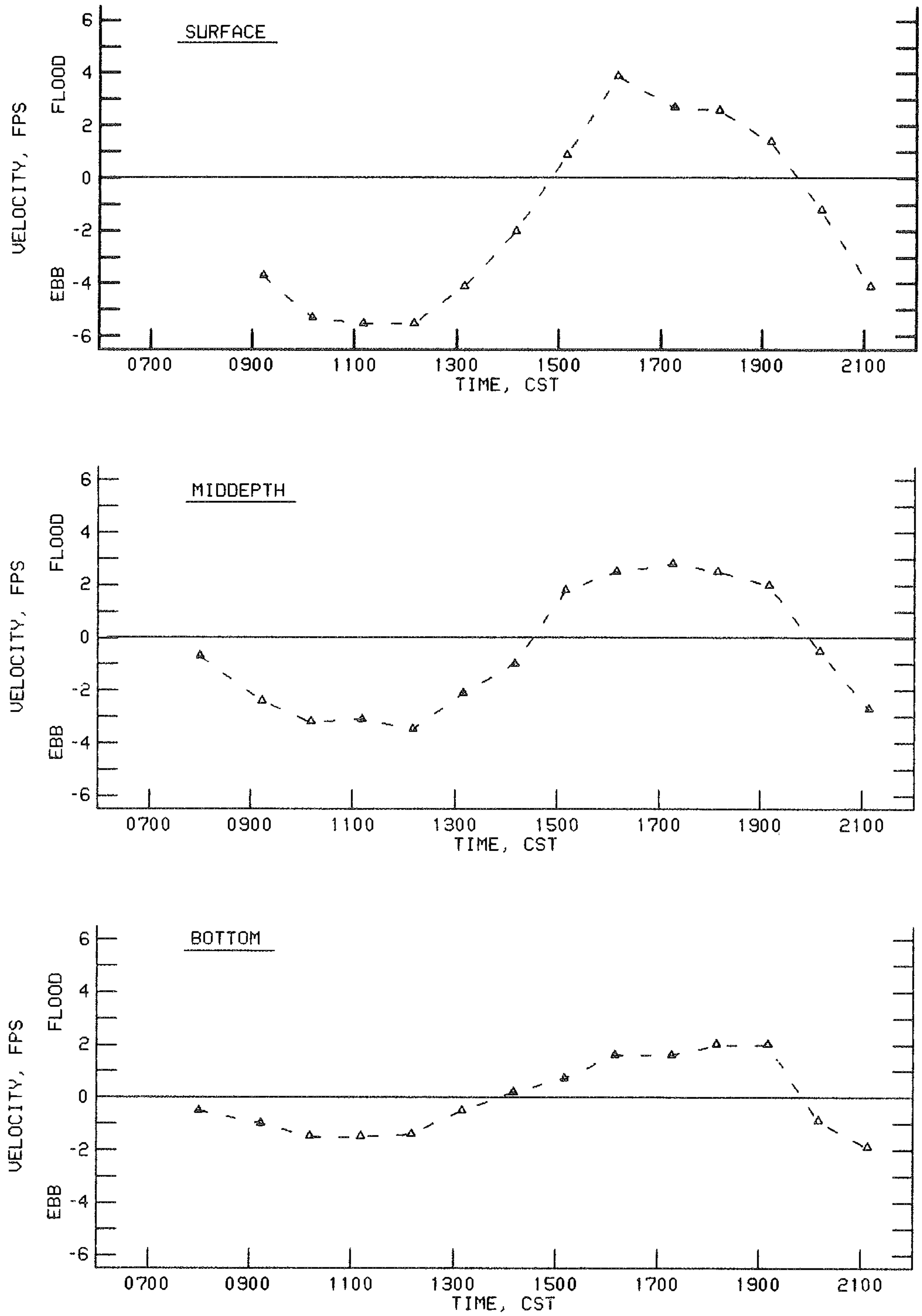


NOTE: MEAN WATER LEVEL READING USED AS DATUM

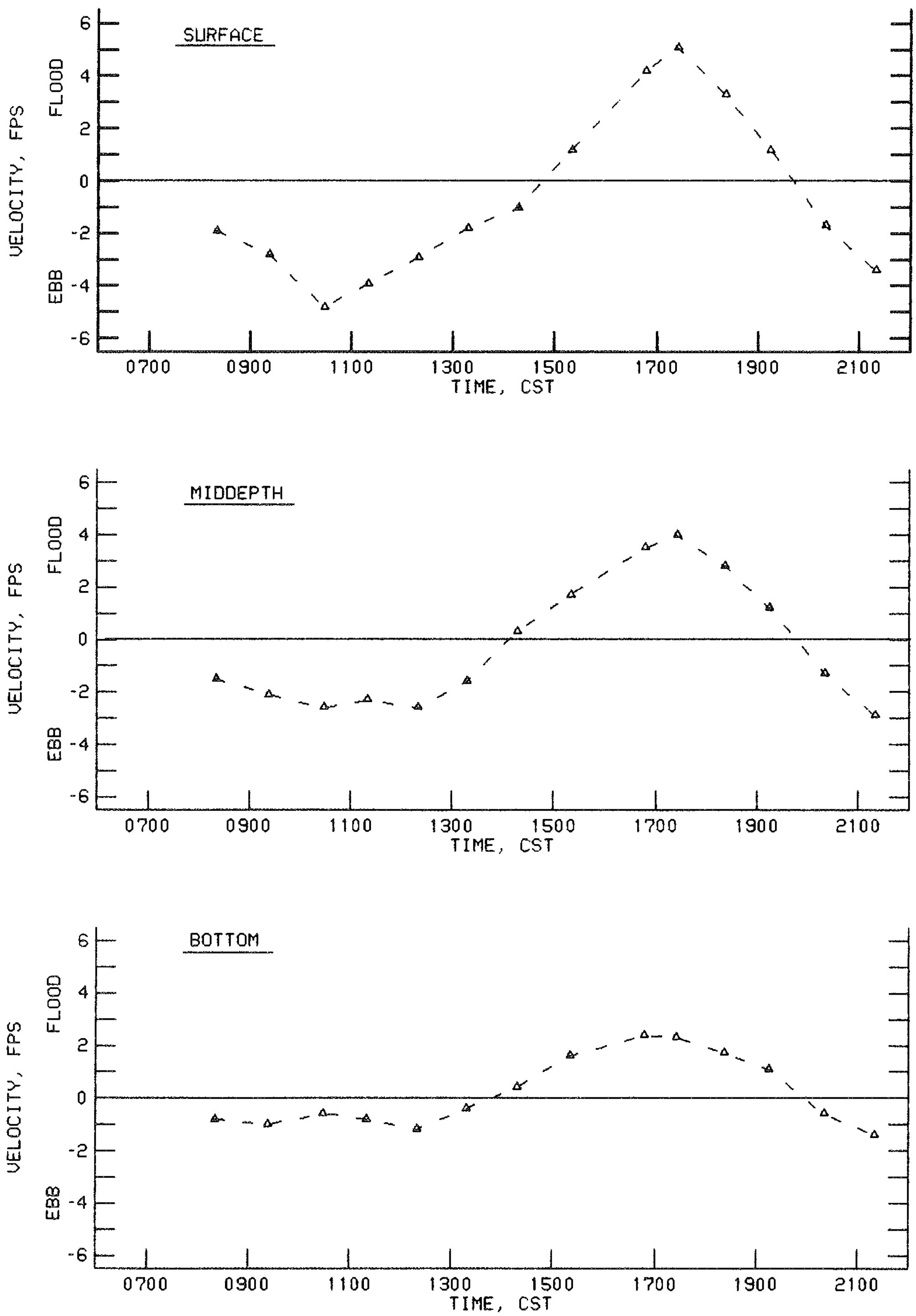
WATER-SURFACE ELEVATIONS
GAGES TLR-1, TLR-2 AND TLR-3
18-20 JANUARY 1989



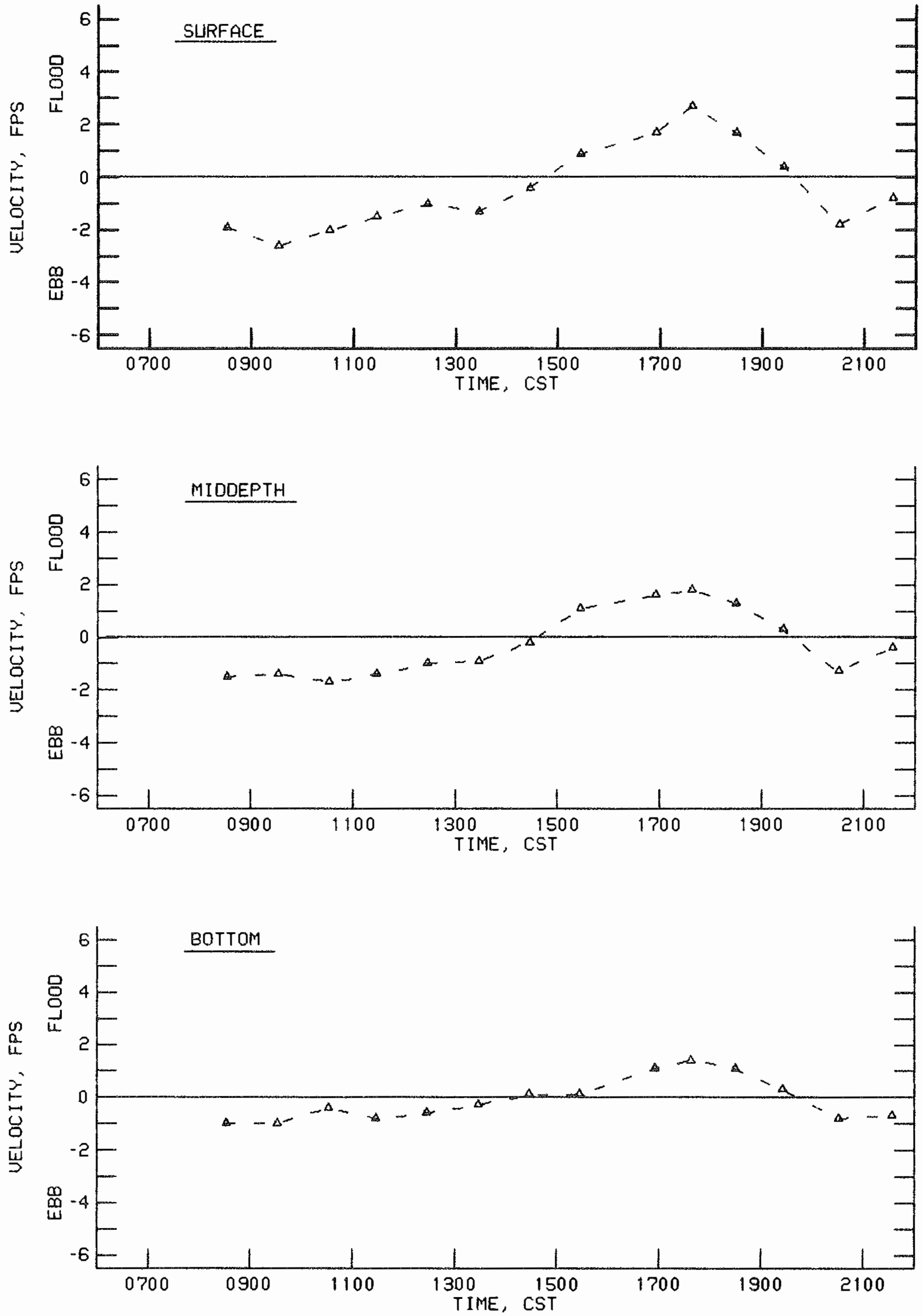
VELOCITIES AT STATION 1-A
19 JANUARY 1989



VELOCITIES AT STATION 1-B
19 JANUARY 1989

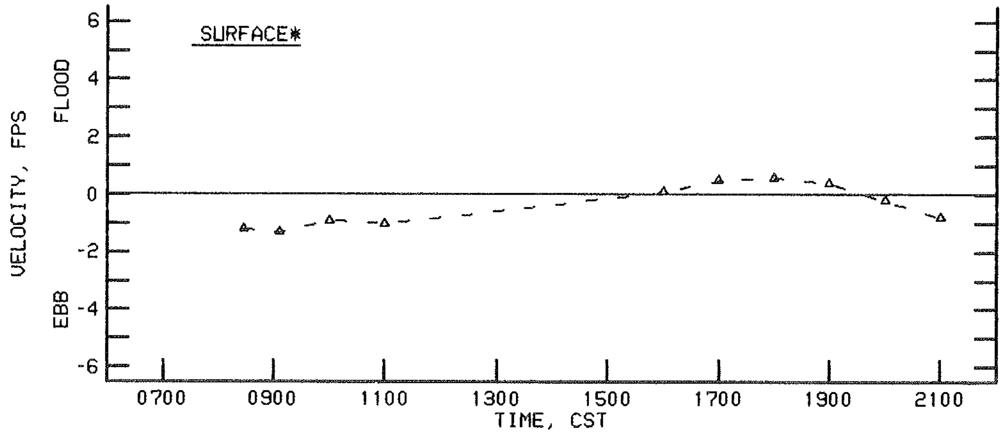


VELOCITIES AT STATION 1-C
19 JANUARY 1989



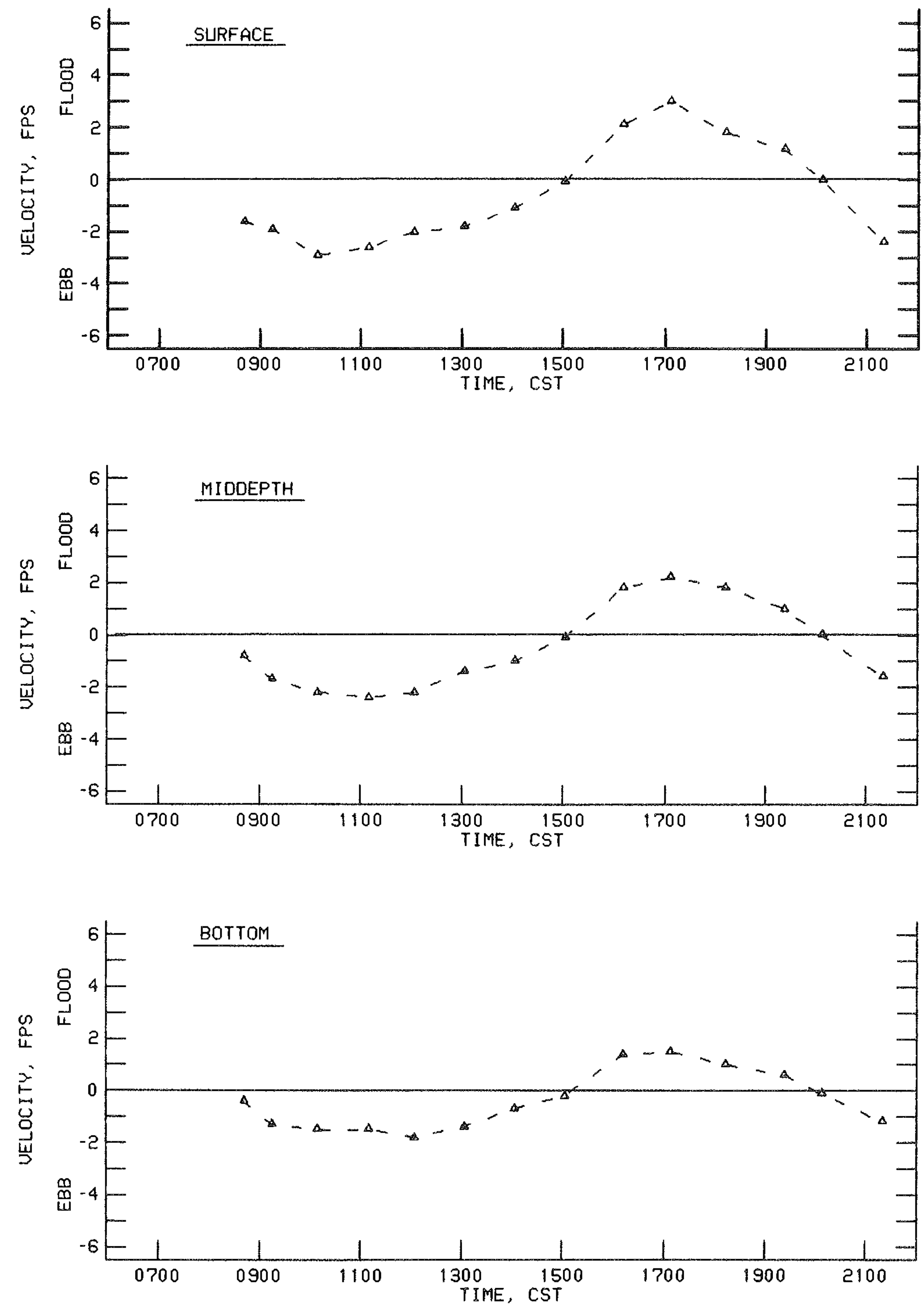
VELOCITIES AT STATION 1-D
19 JANUARY 1989

PLATE 8

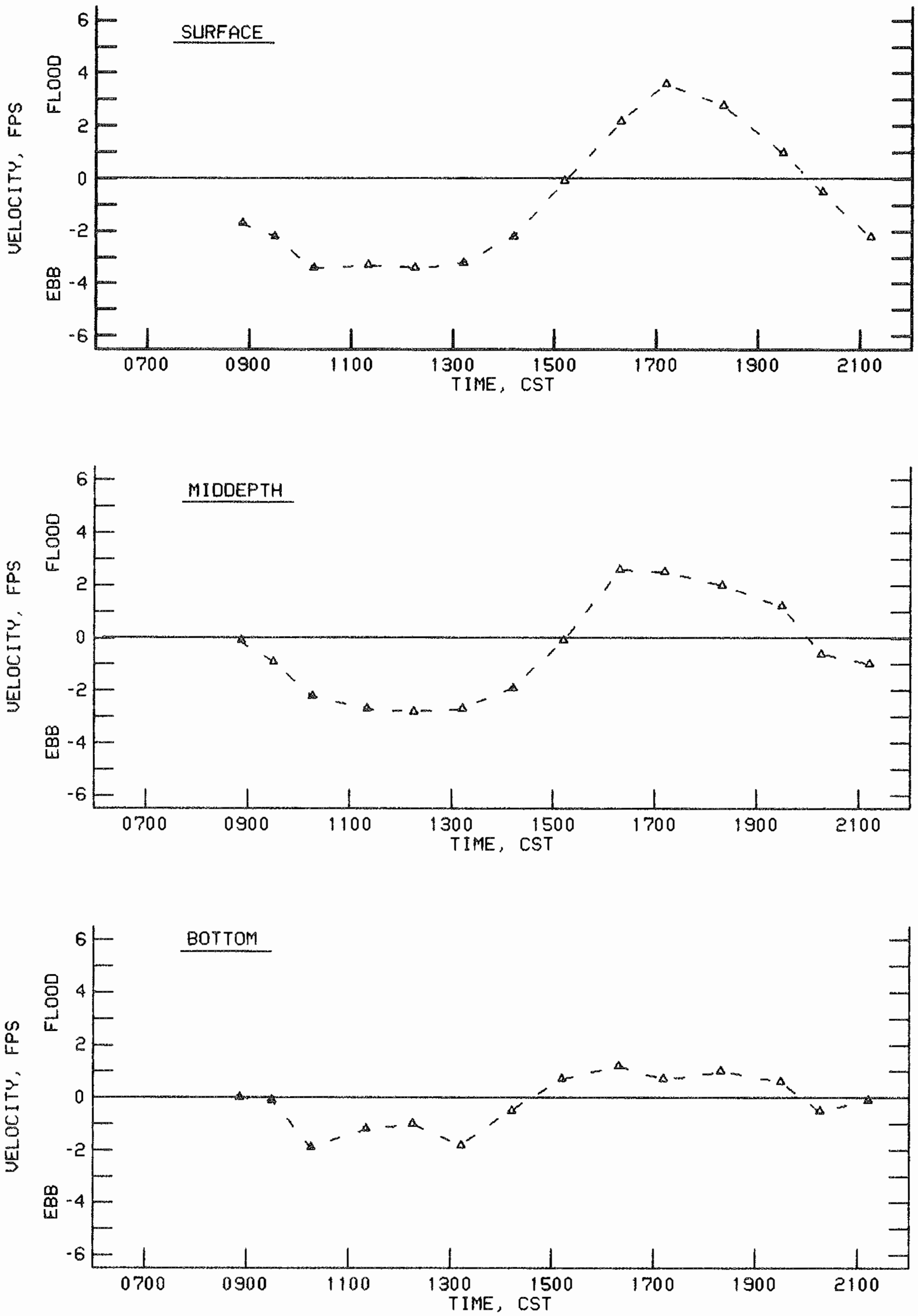


*Note: Water depth too shallow for profiling;
only one depth measured.

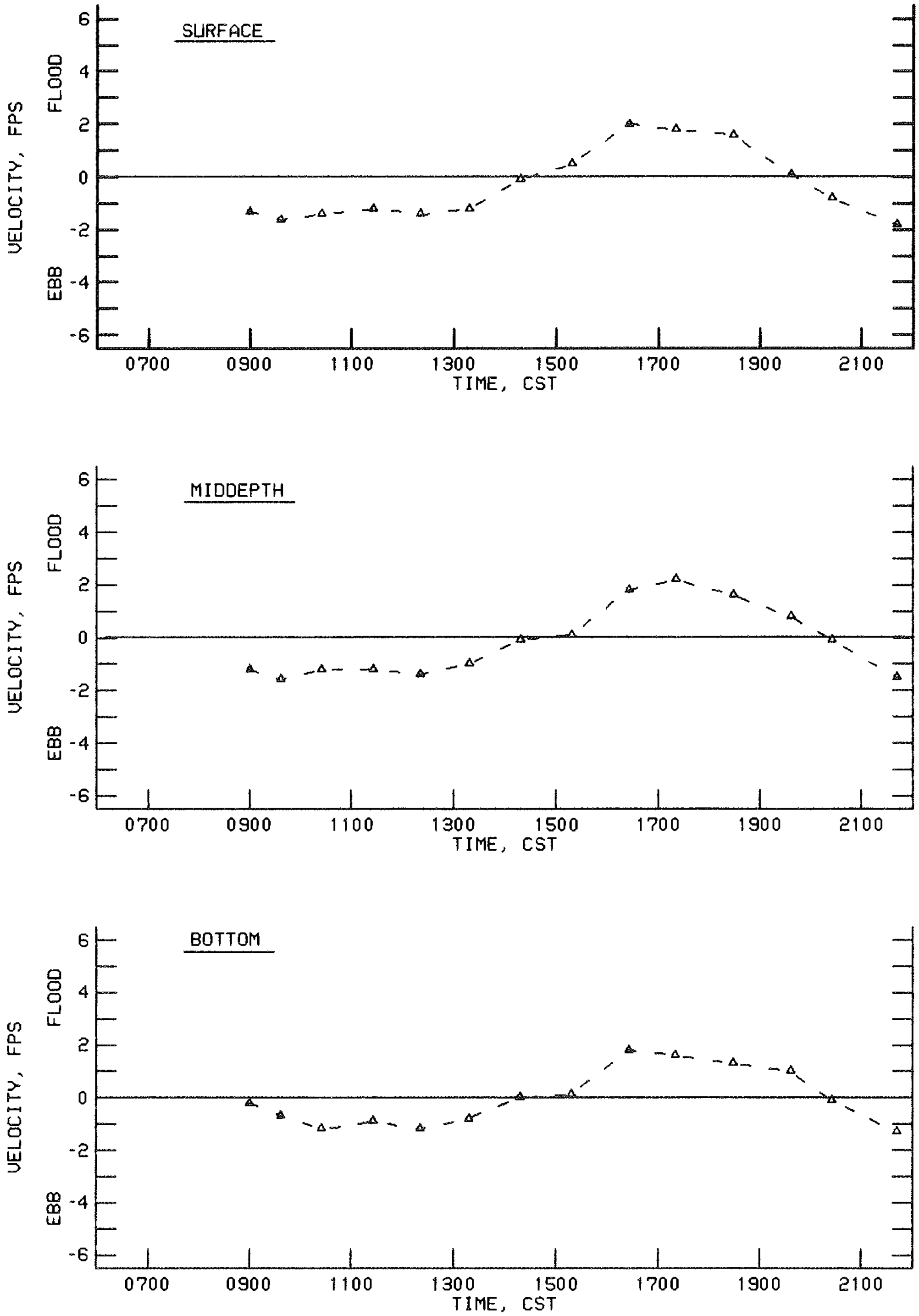
VELOCITIES AT STATION 2-A
19 JANUARY 1989



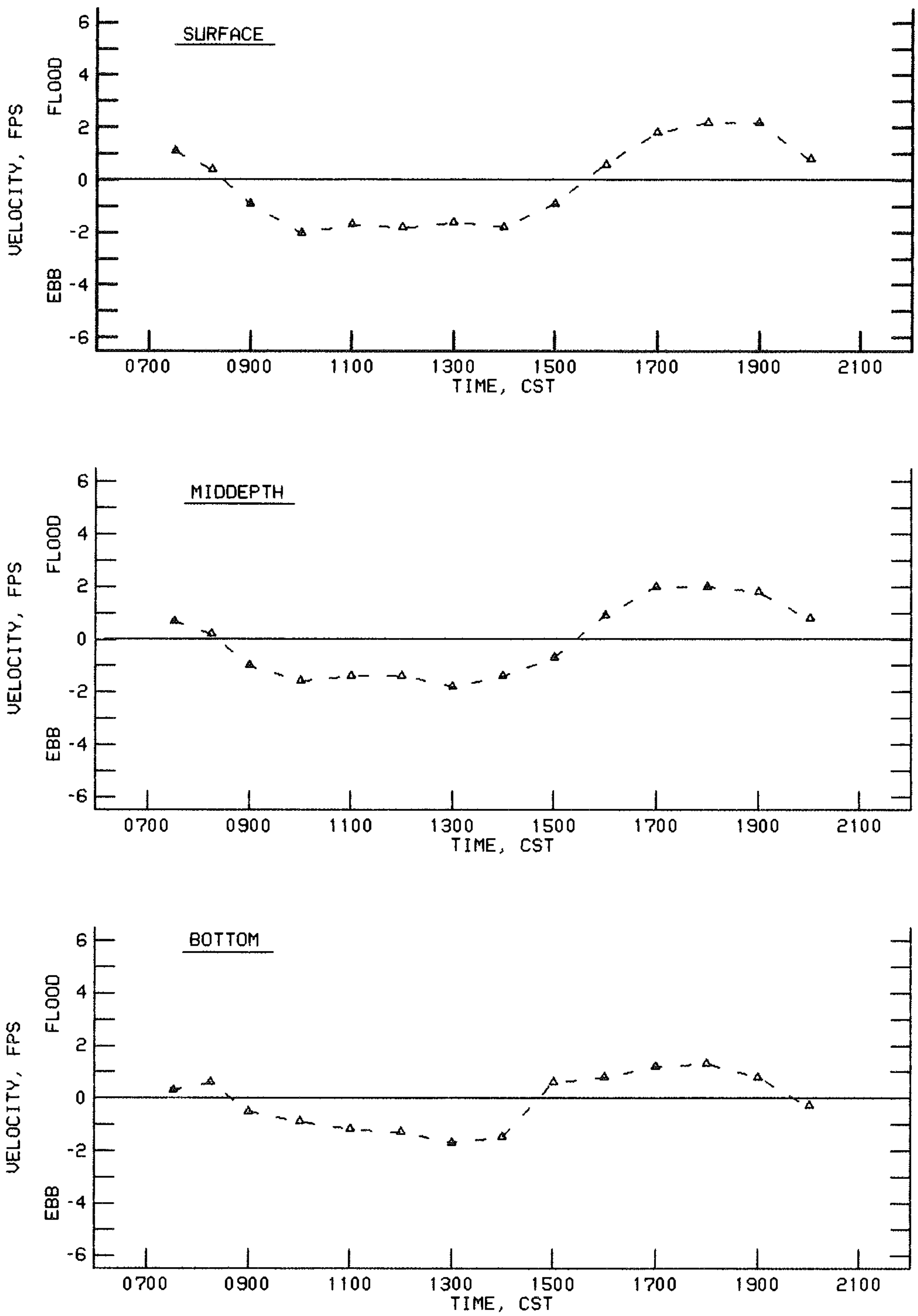
VELOCITIES AT STATION 2-B
19 JANUARY 1989



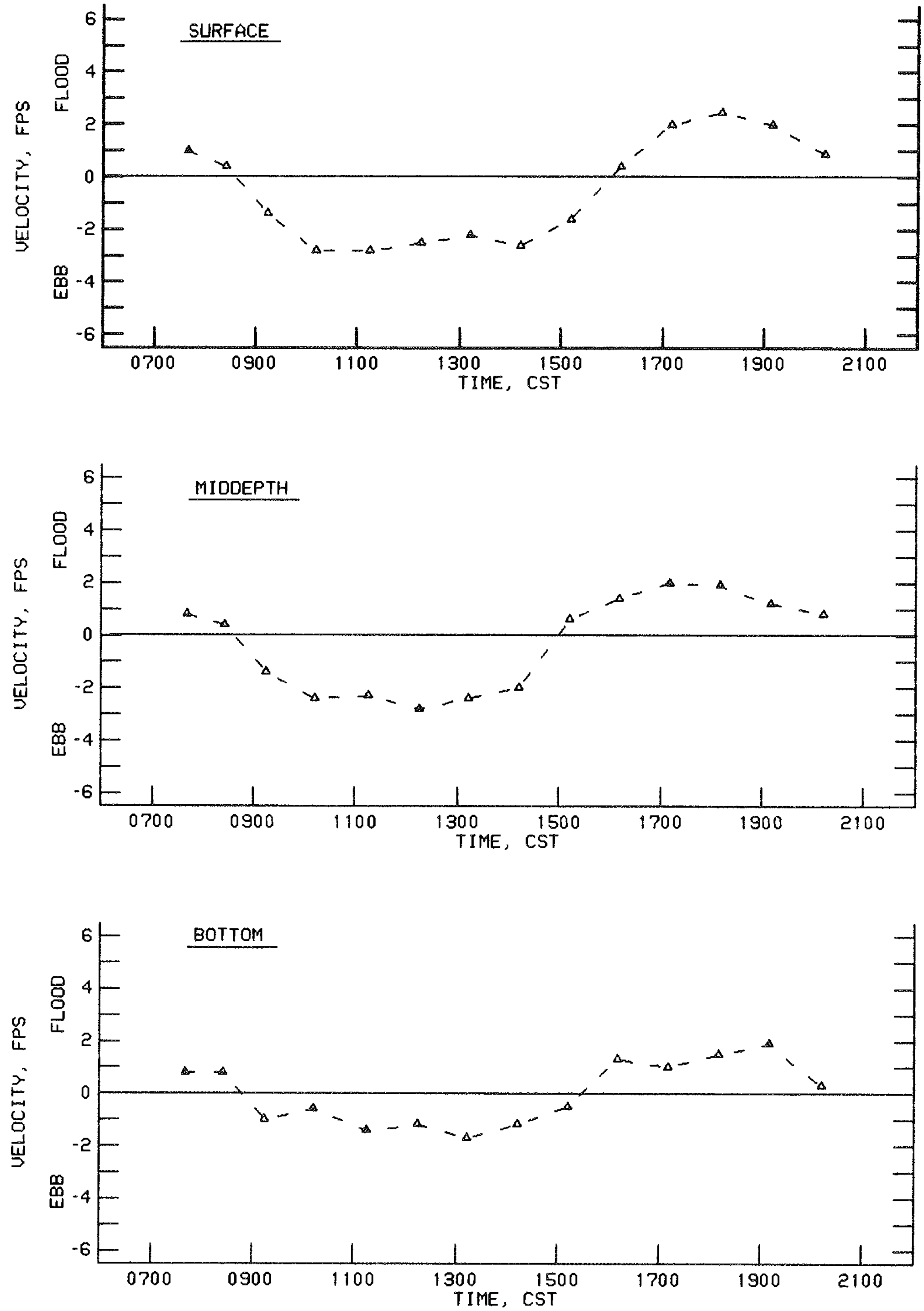
VELOCITIES AT STATION 2-C
19 JANUARY 1989



VELOCITIES AT STATION 2-D
19 JANUARY 1989

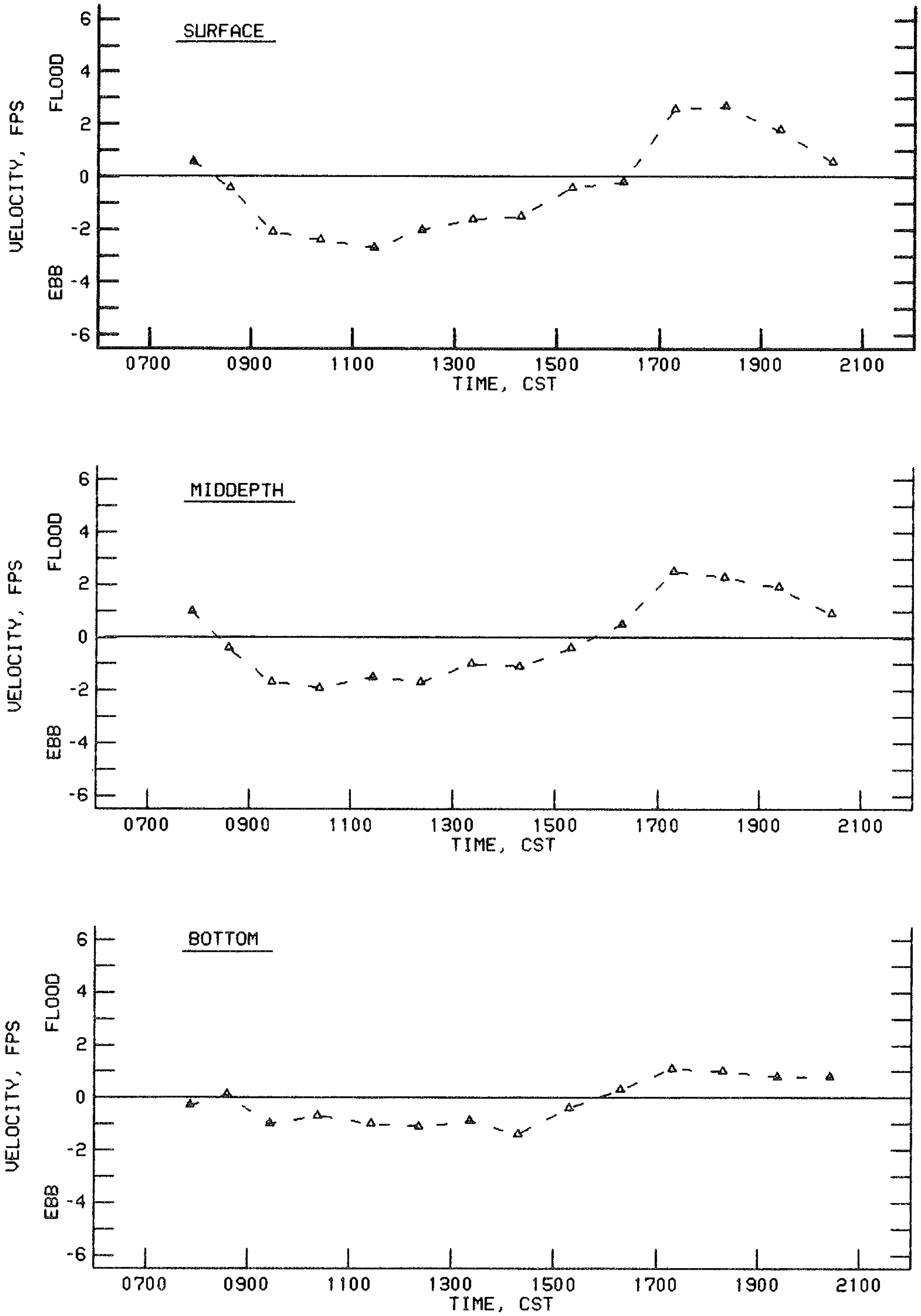


VELOCITIES AT STATION 3-A
19 JANUARY 1989

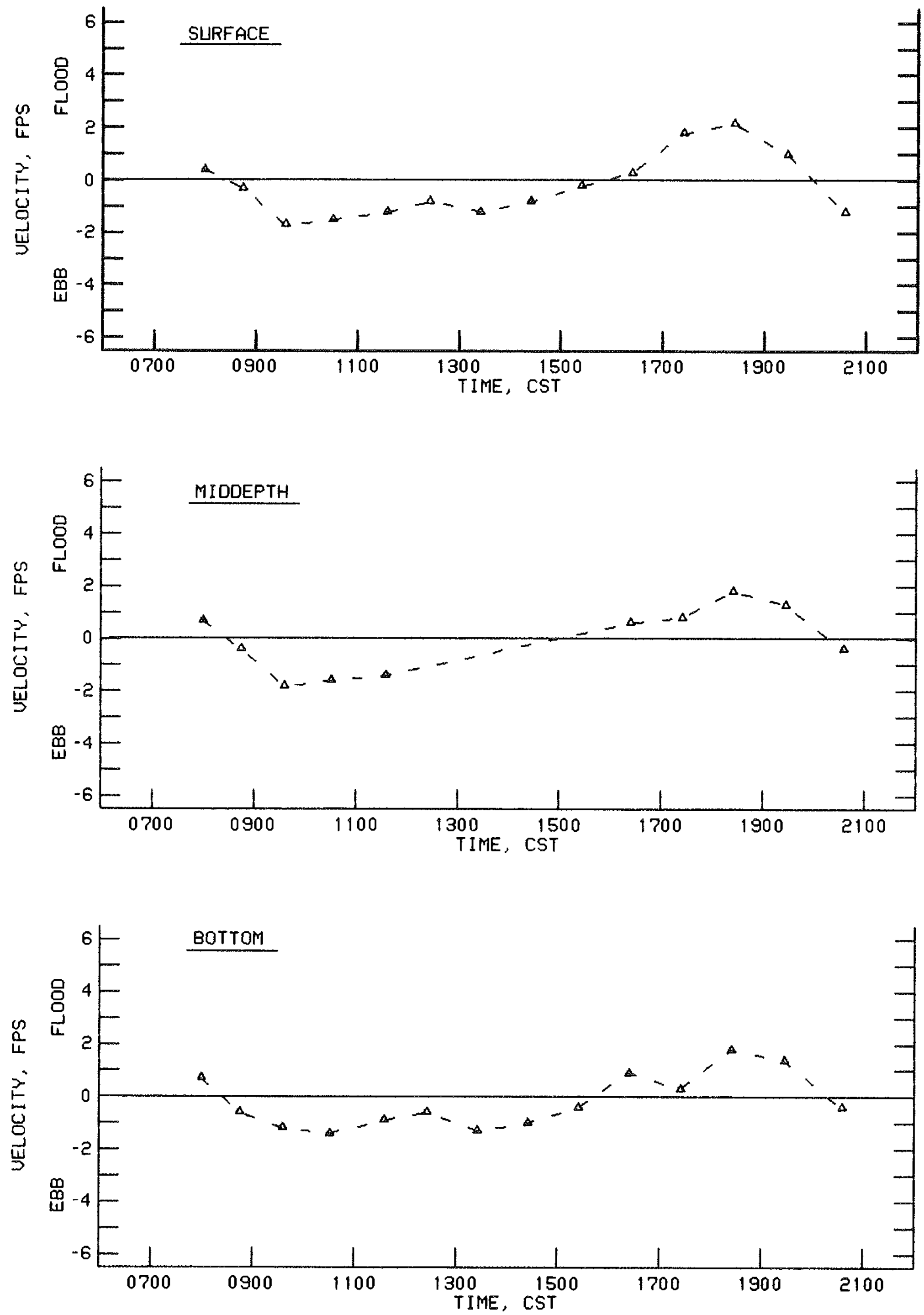


VELOCITIES AT STATION 3-B
19 JANUARY 1989

PLATE 14

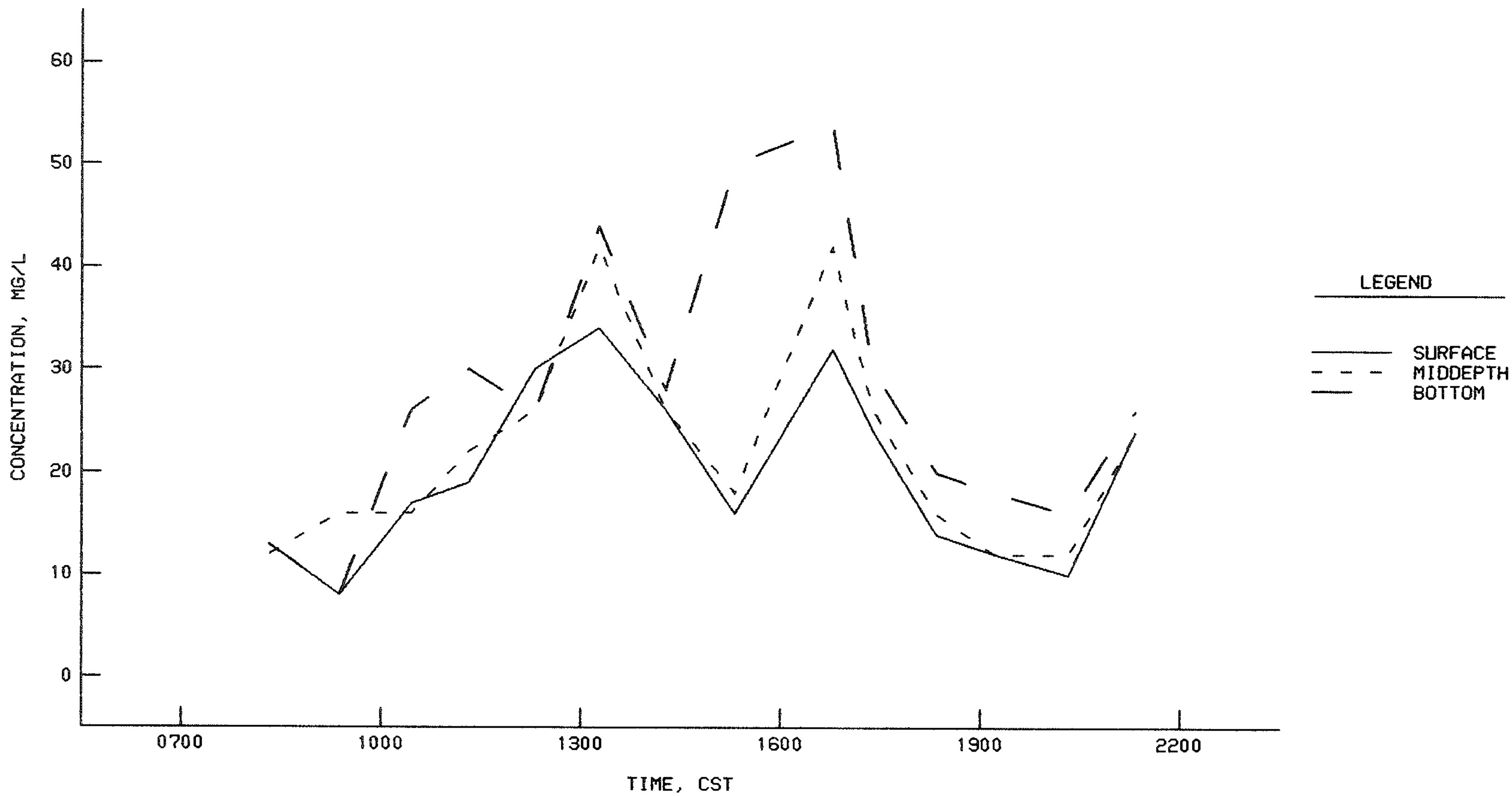


VELOCITIES AT STATION 3-C
19 JANUARY 1989



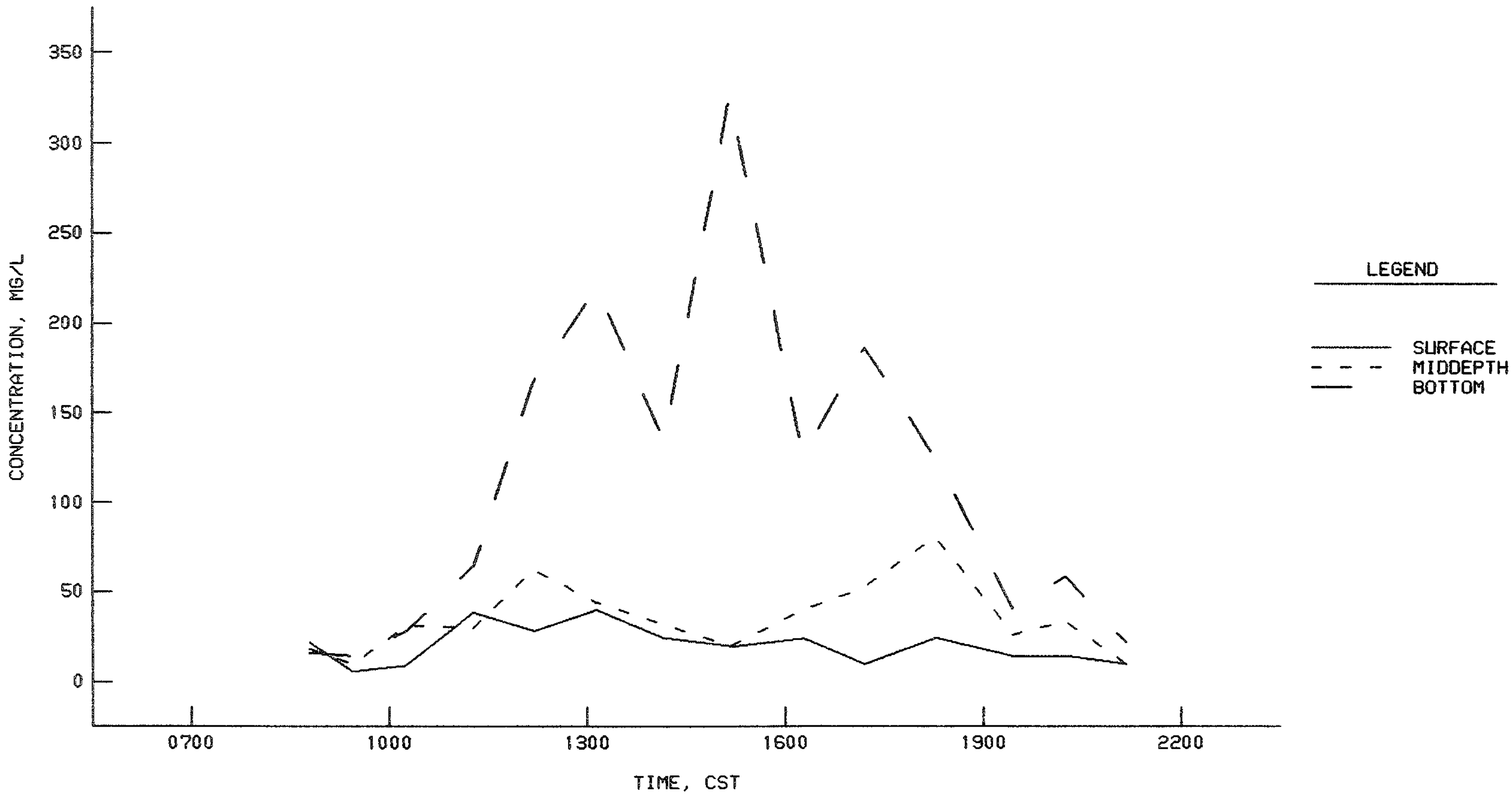
VELOCITIES AT STATION 3-D
19 JANUARY 1989

PLATE 16

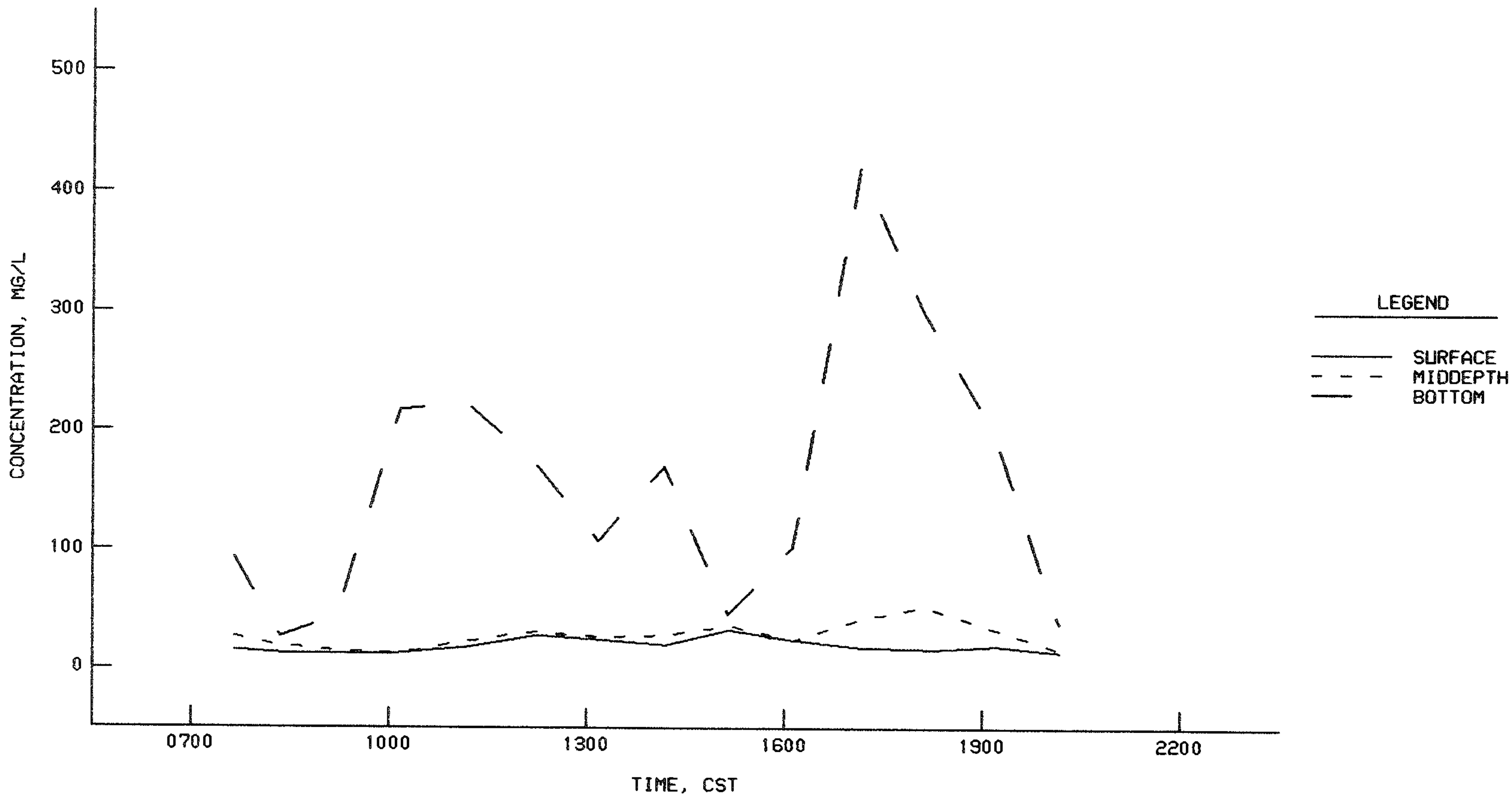


SUSPENDED SEDIMENT CONCENTRATIONS
STATION 1-C
19 JANUARY 1989

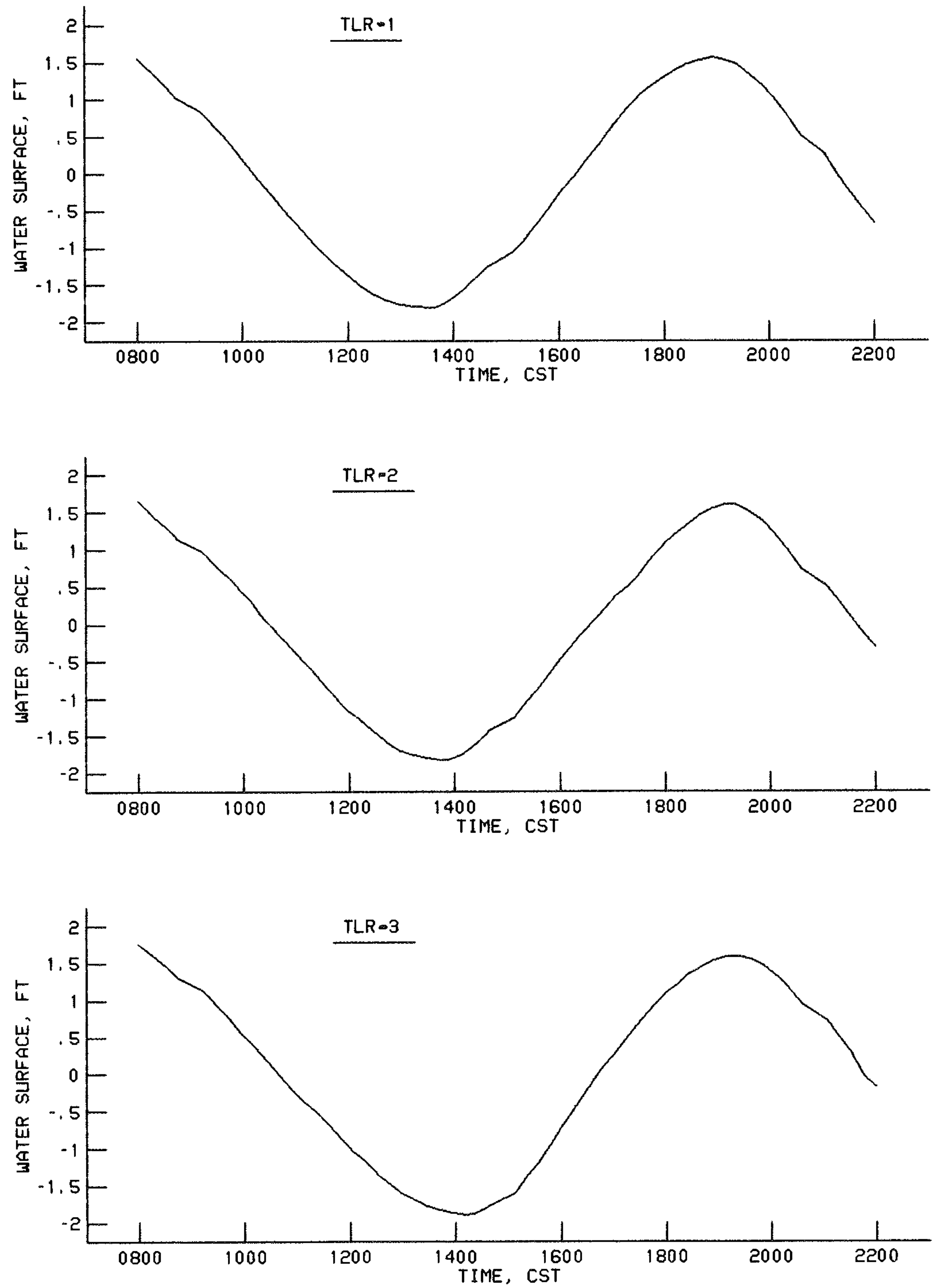
PLATE 18



SUSPENDED SEDIMENT CONCENTRATIONS
STATION 2-C
19 JANUARY 1989



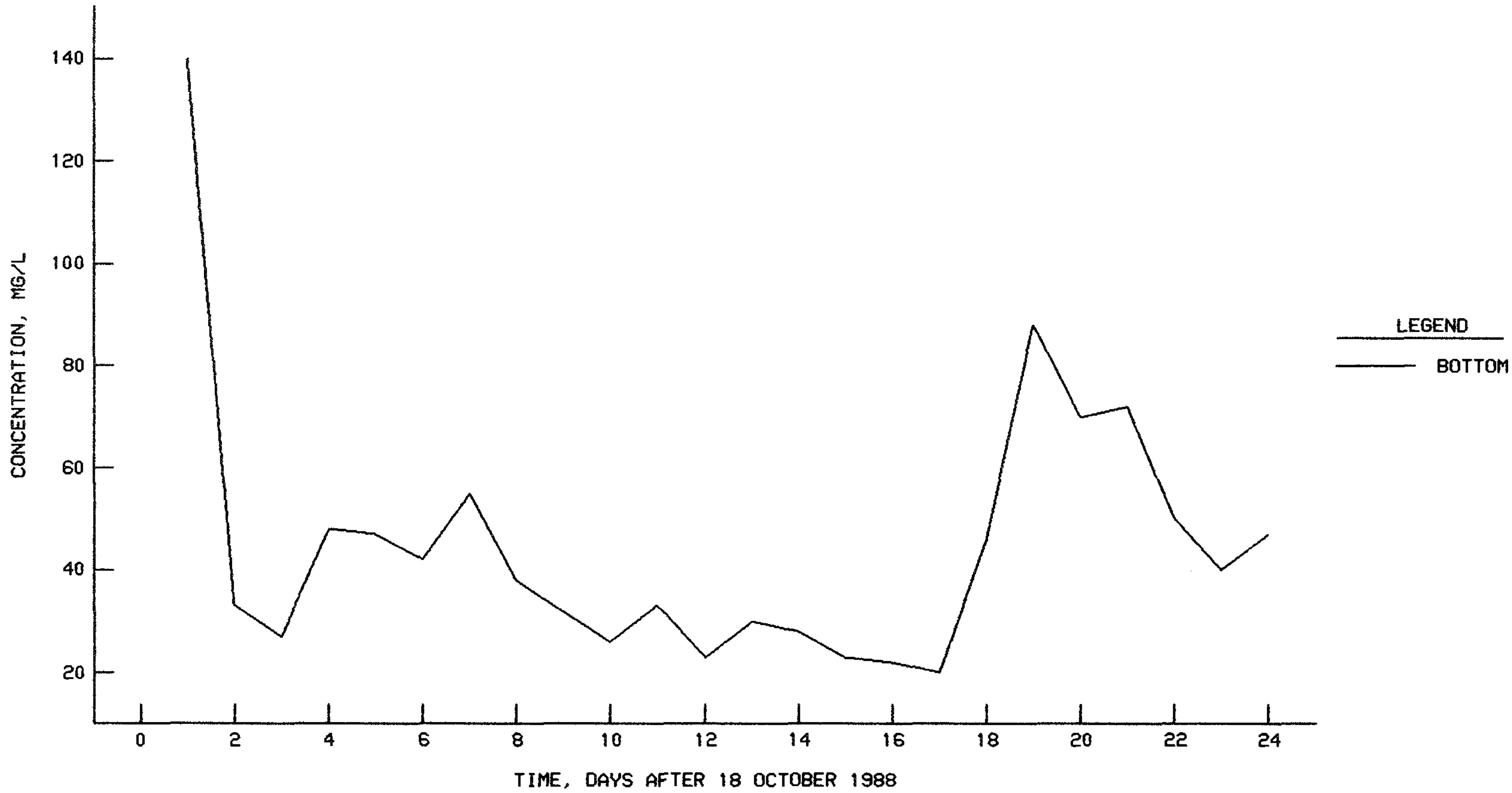
SUSPENDED SEDIMENT CONCENTRATIONS
STATION 3-B
19 JANUARY 1989



NOTE: MEAN WATER LEVEL READING
USED AS DATUM

WATER-SURFACE ELEVATIONS
18-20 JANUARY 1989

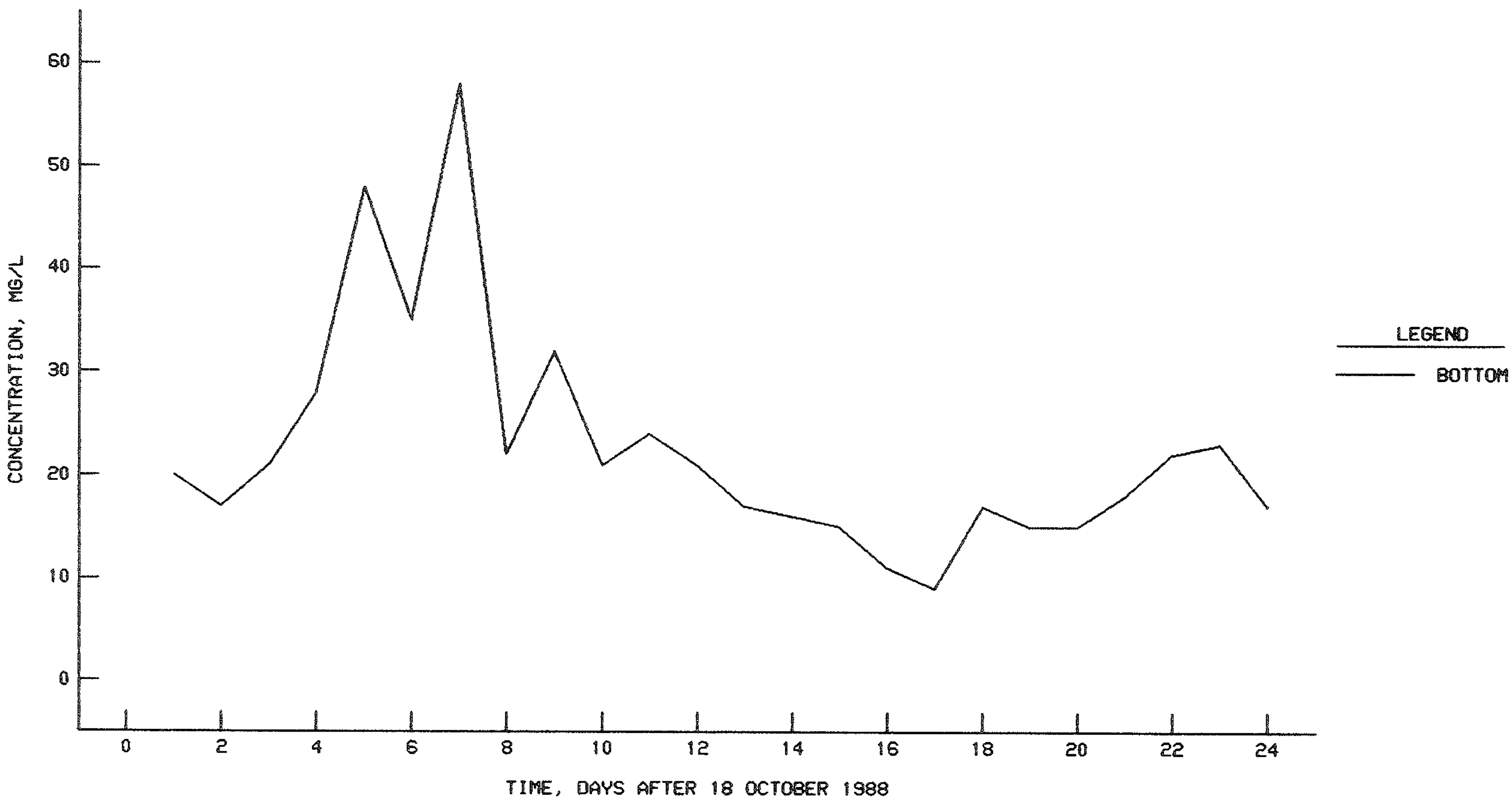
PLATE 20



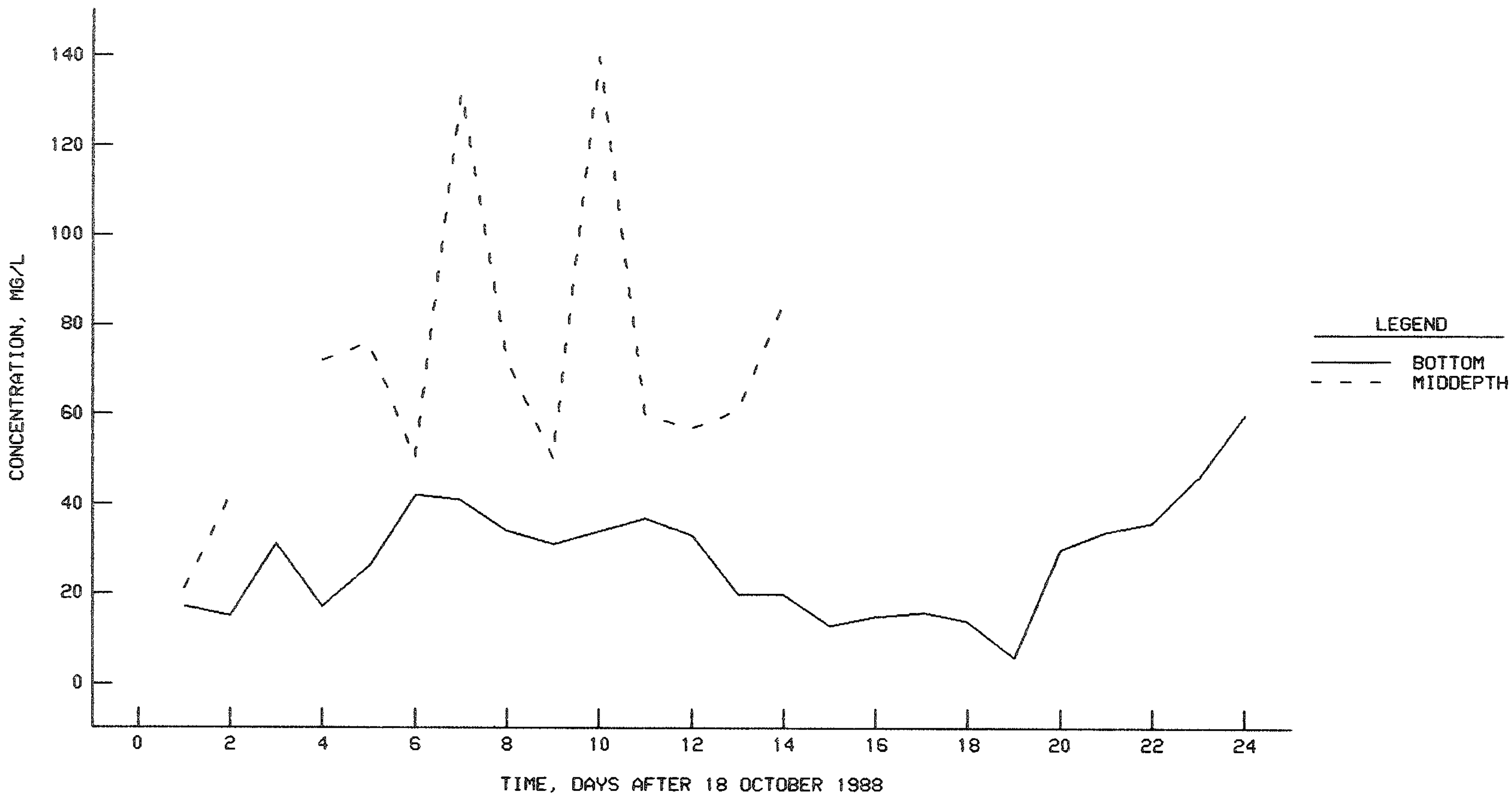
SUSPENDED SEDIMENT CONCENTRATIONS
AUTOMATIC SAMPLER, AWS-1
OCTOBER - NOVEMBER 1988

PLATE 21

PLATE 22

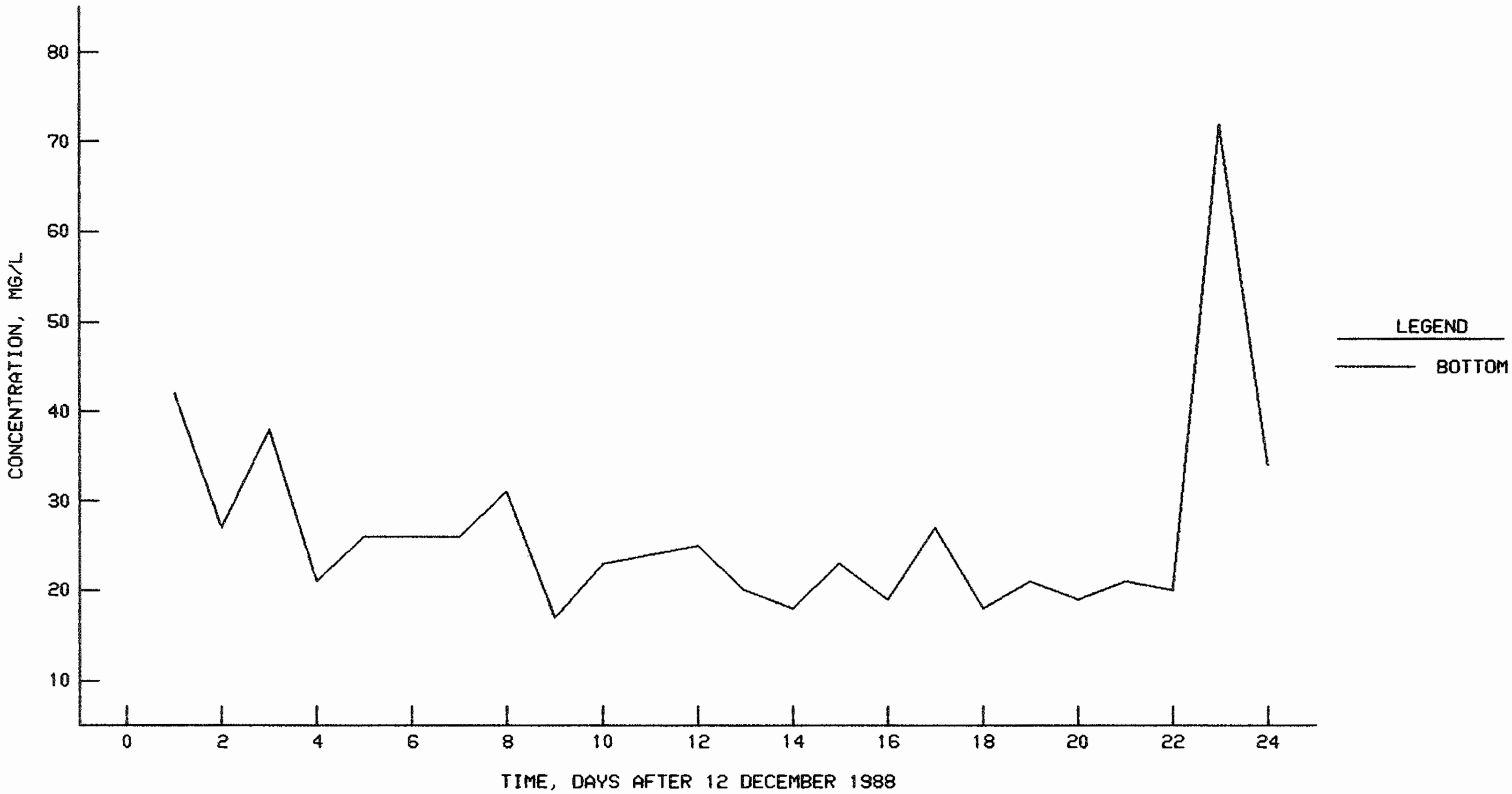


SUSPENDED SEDIMENT CONCENTRATIONS
AUTOMATIC SAMPLER, AWS-2
OCTOBER - NOVEMBER 1988

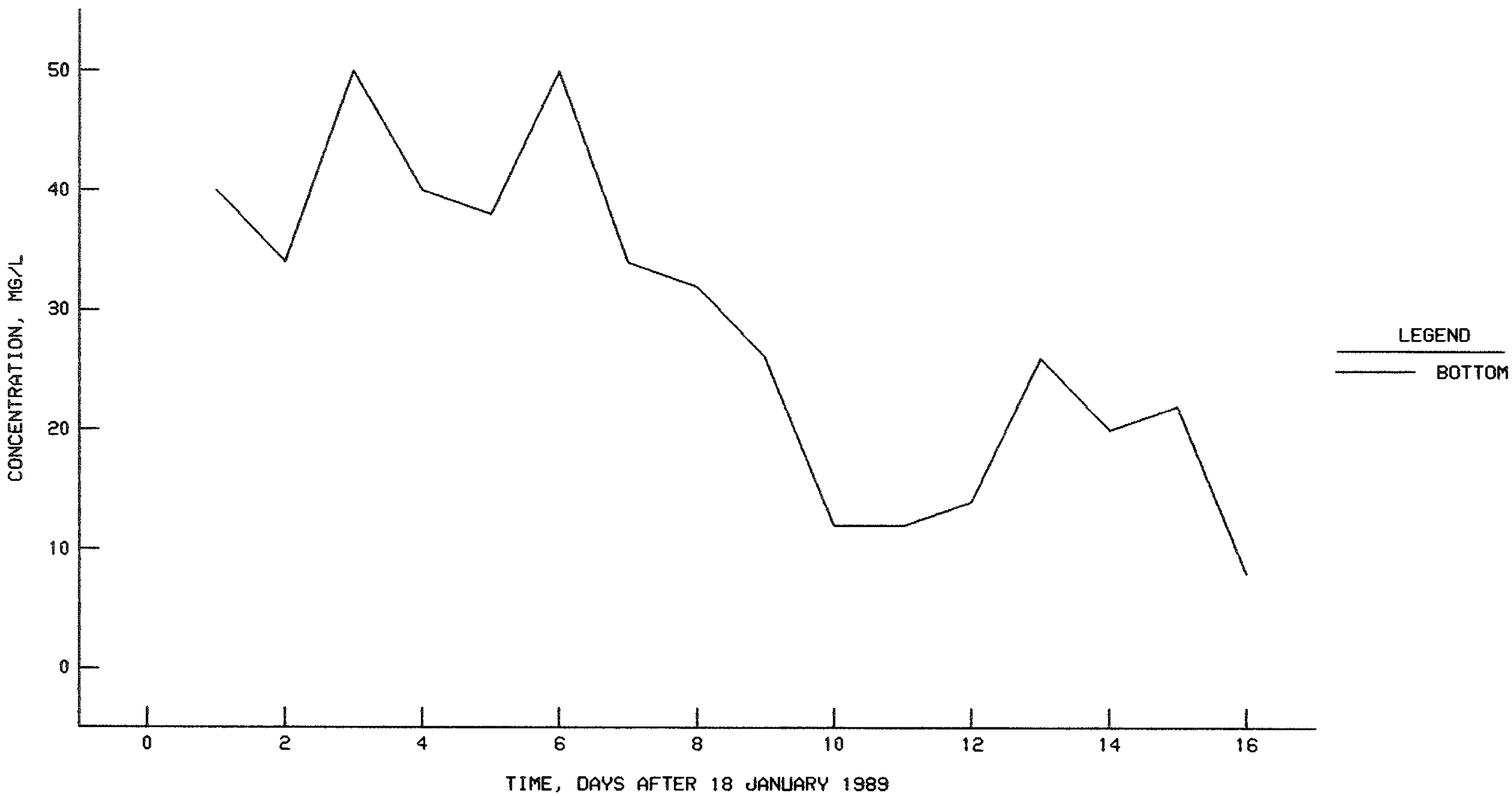


SUSPENDED SEDIMENT CONCENTRATIONS
AUTOMATIC SAMPLER, AWS-3
OCTOBER - NOVEMBER 1988

PLATE 24

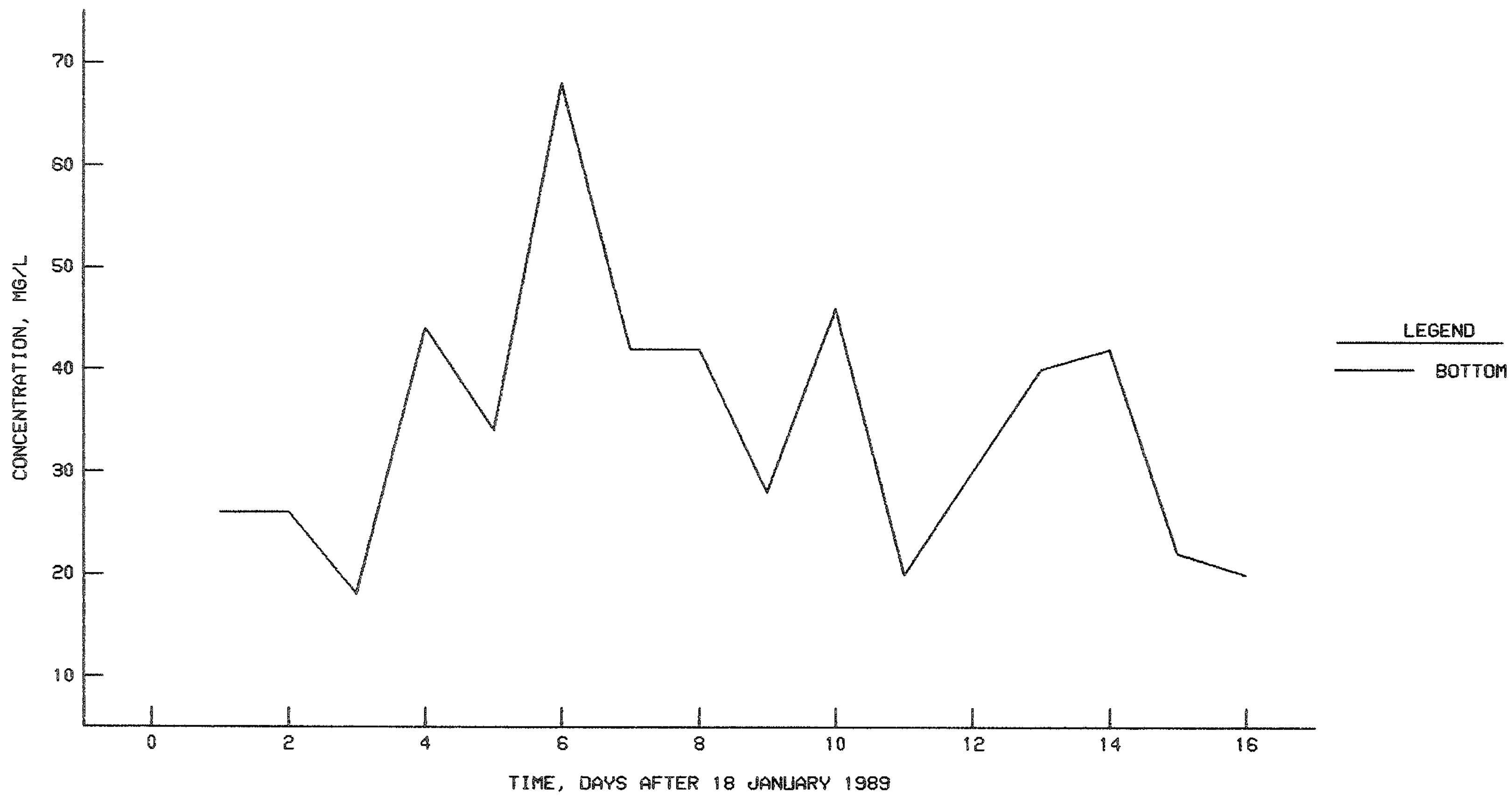


SUSPENDED SEDIMENT CONCENTRATIONS
AUTOMATIC SAMPLER, AWS-2
DECEMBER 1988 - JANUARY 1989

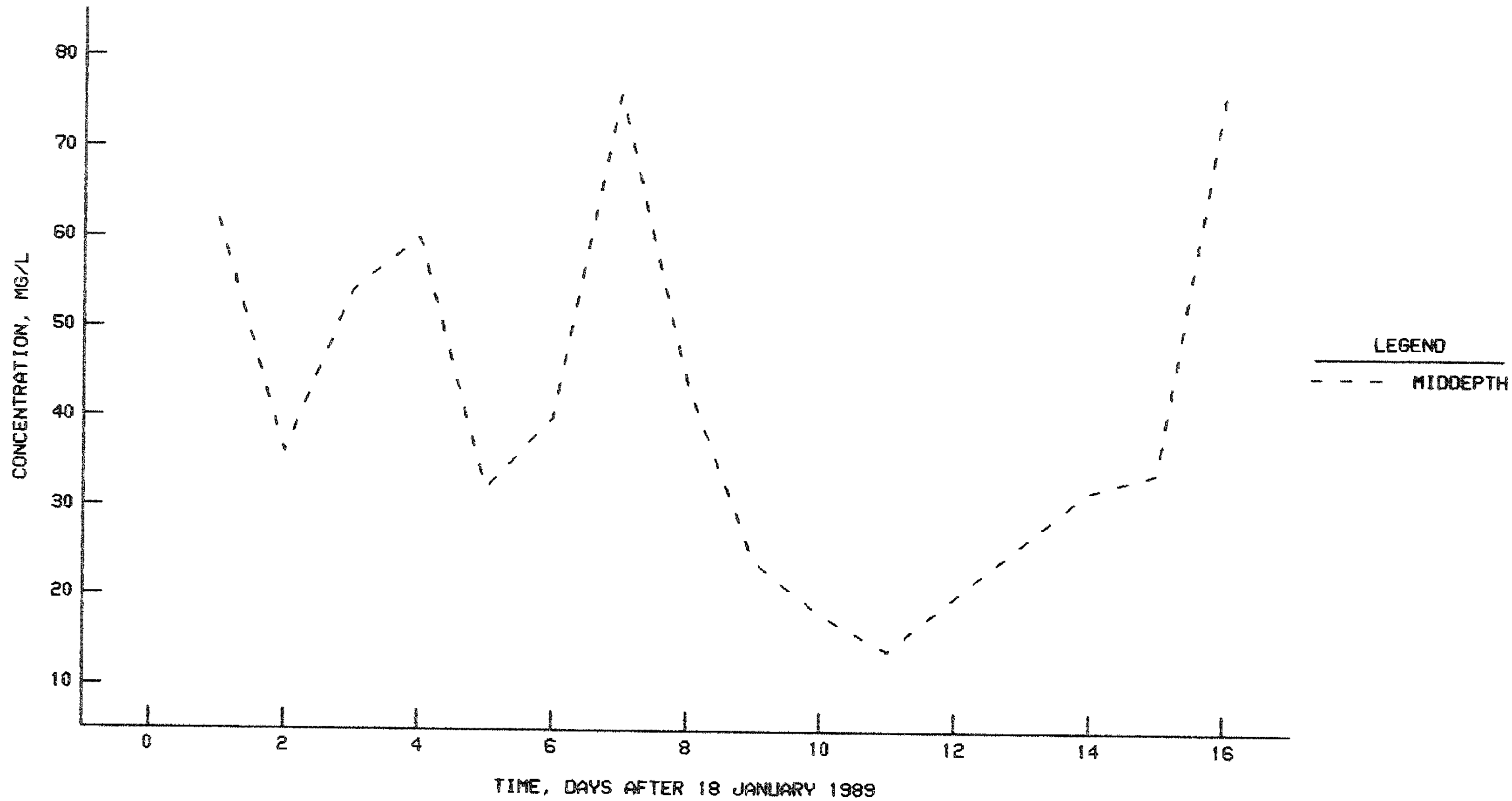


SUSPENDED SEDIMENT CONCENTRATIONS
AUTOMATIC SAMPLER, AWS-1
JANUARY - FEBRUARY 1989

PLATE 26



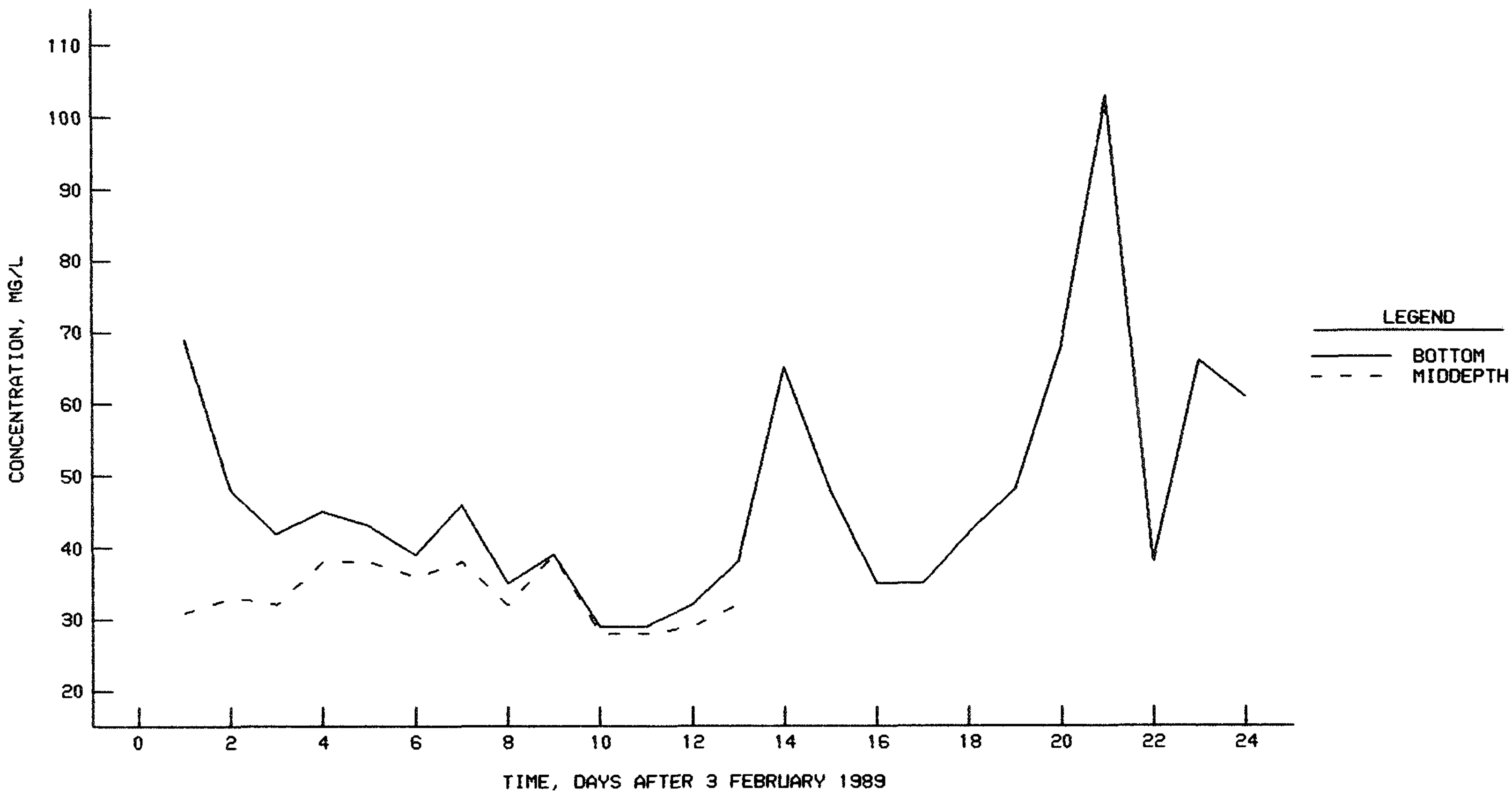
SUSPENDED SEDIMENT CONCENTRATIONS
AUTOMATIC SAMPLER, AWS-2
JANUARY - FEBRUARY 1989



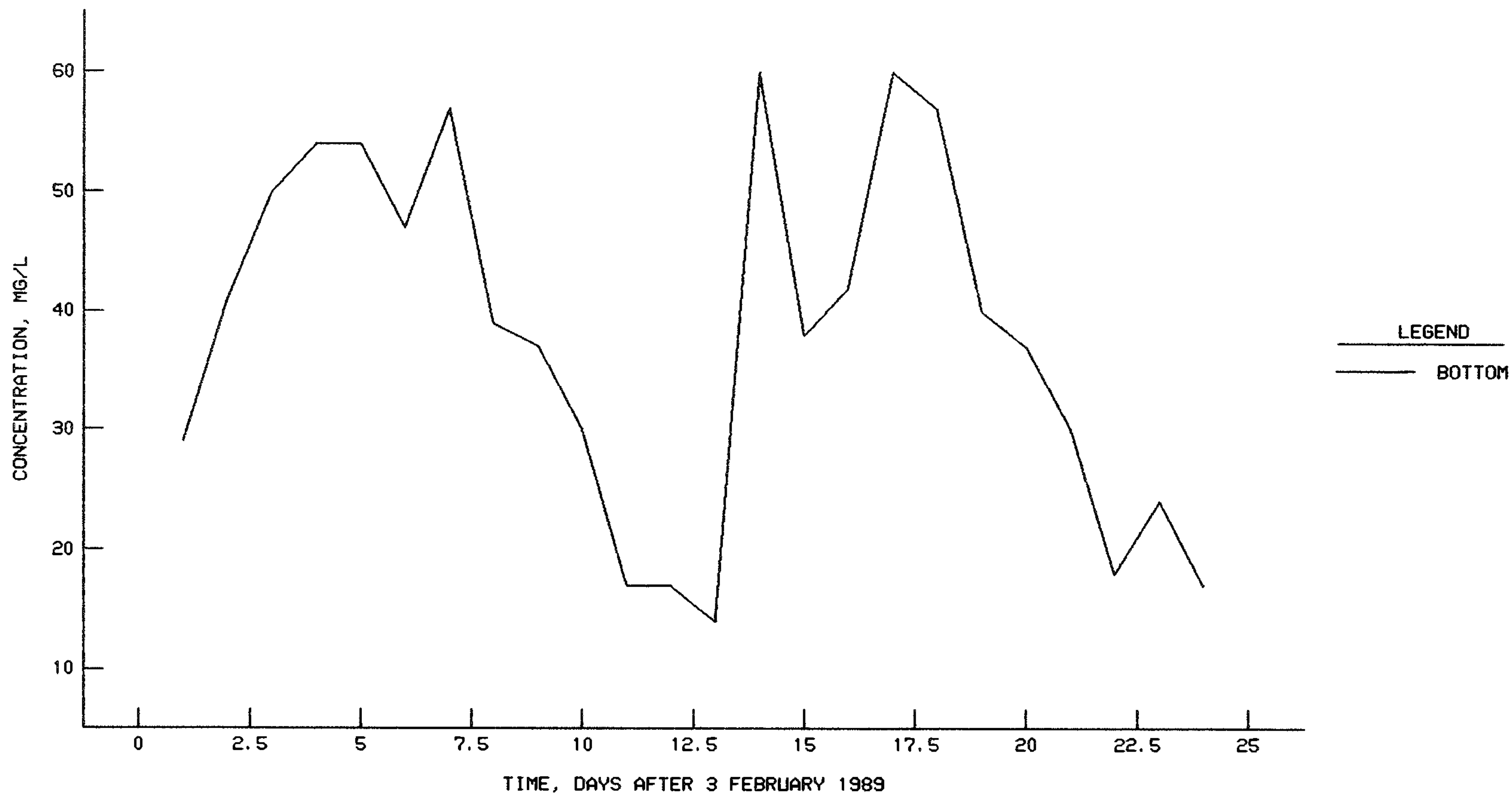
SUSPENDED SEDIMENT CONCENTRATIONS
AUTOMATIC SAMPLER, AWS-3
JANUARY - FEBRUARY 1989

PLATE 27

PLATE 28



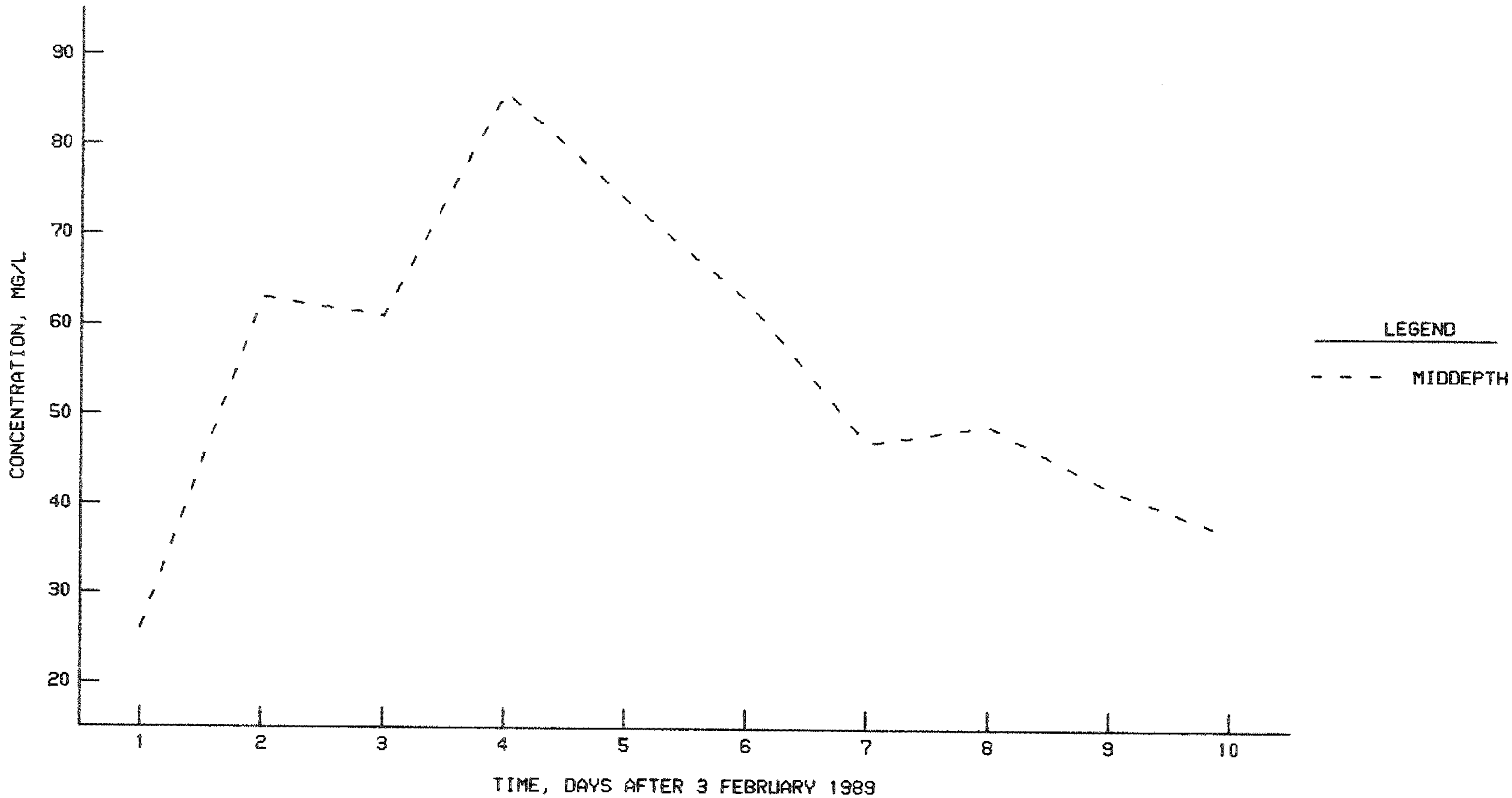
SUSPENDED SEDIMENT CONCENTRATIONS
AUTOMATIC SAMPLER, AWS-1
FEBRUARY 1989



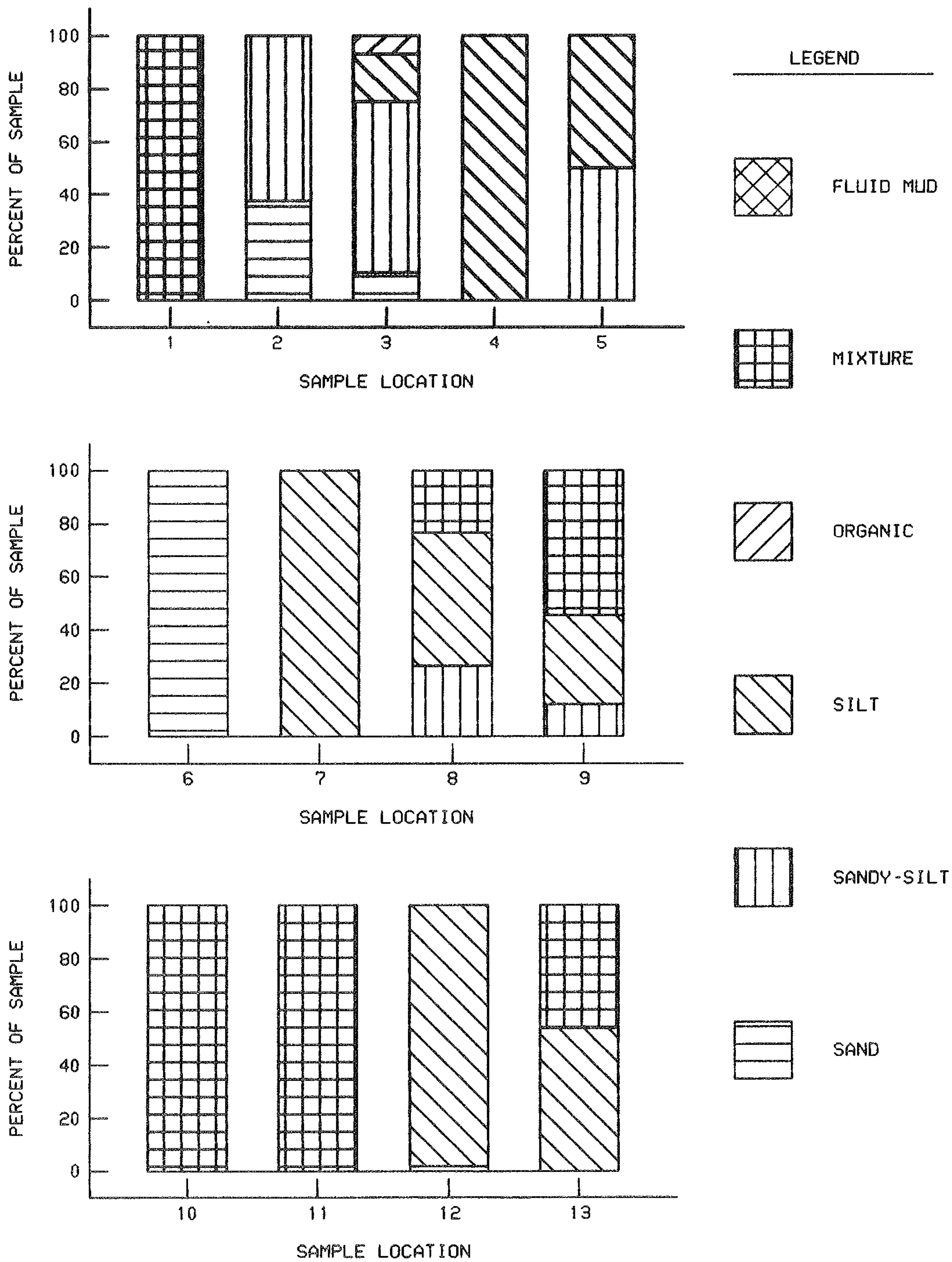
SUSPENDED SEDIMENT CONCENTRATIONS
AUTOMATIC SAMPLER, AWS-2
FEBRUARY 1989

PLATE 29

PLATE 30



SUSPENDED SEDIMENT CONCENTRATIONS
AUTOMATIC SAMPLER, AWS-3
FEBRUARY 1989



NOTE: SAMPLING LOCATIONS ARE SHOWN
IN FIGURE 10.

BOTTOM SAMPLE CLASSIFICATIONS
OCTOBER 1988

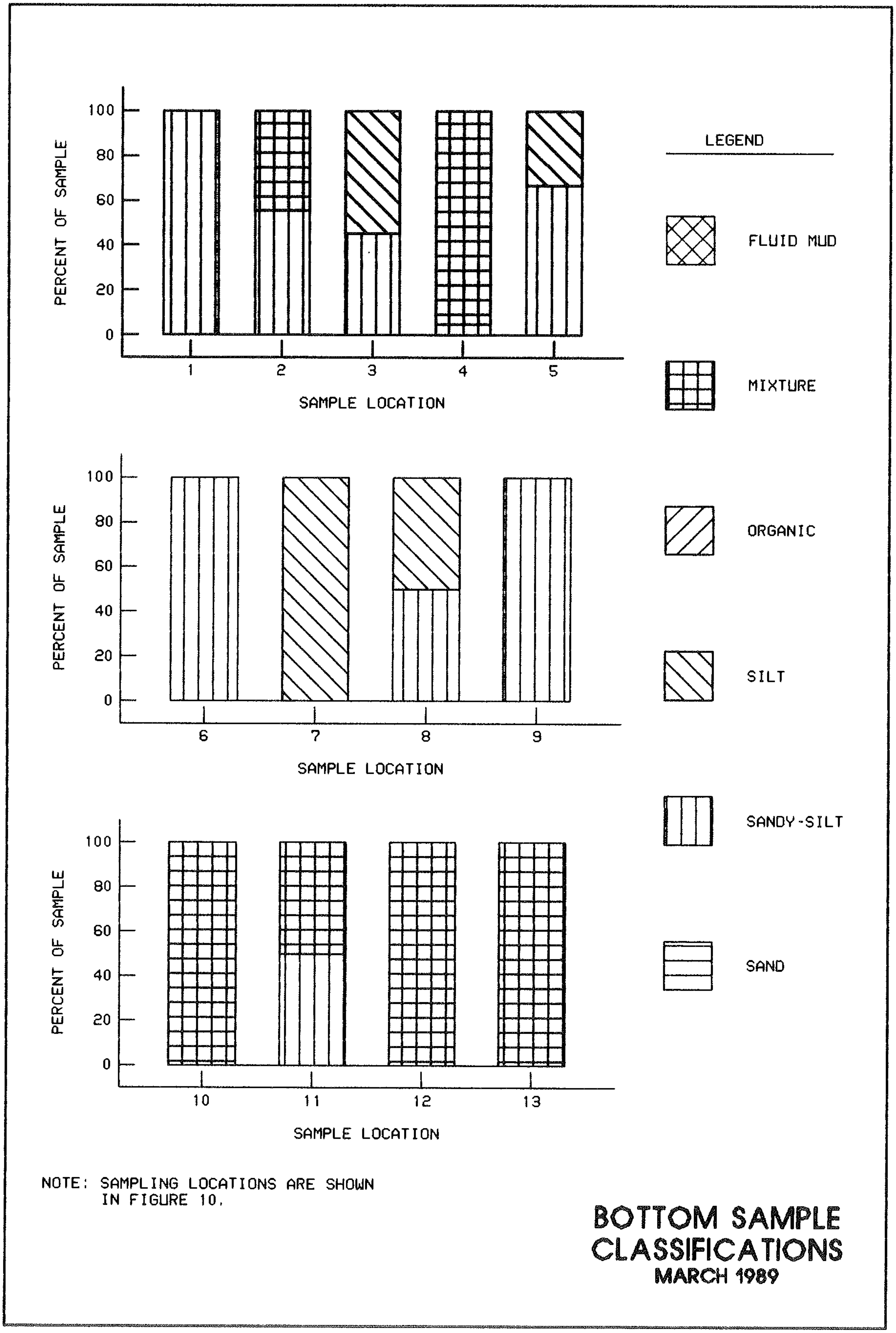
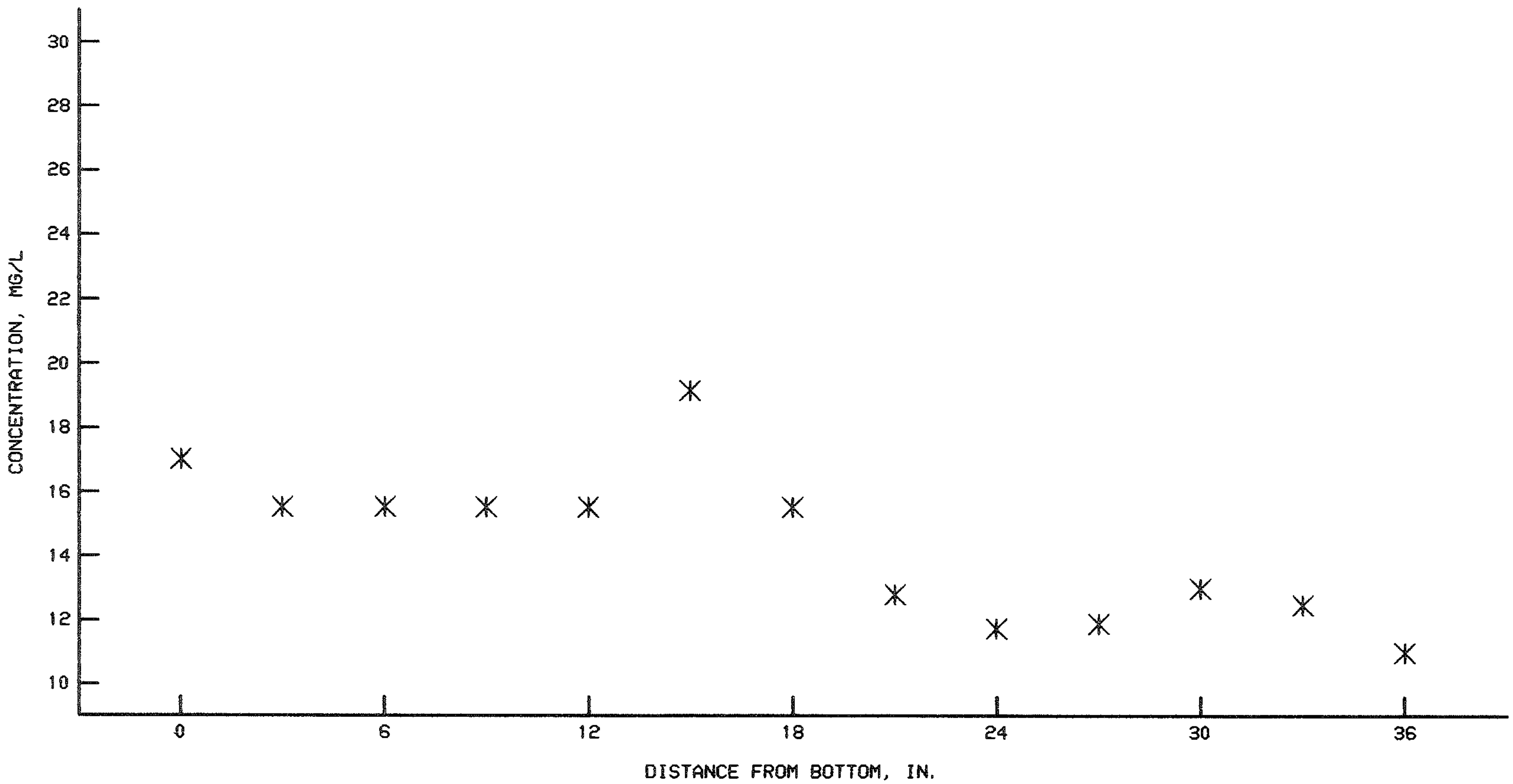
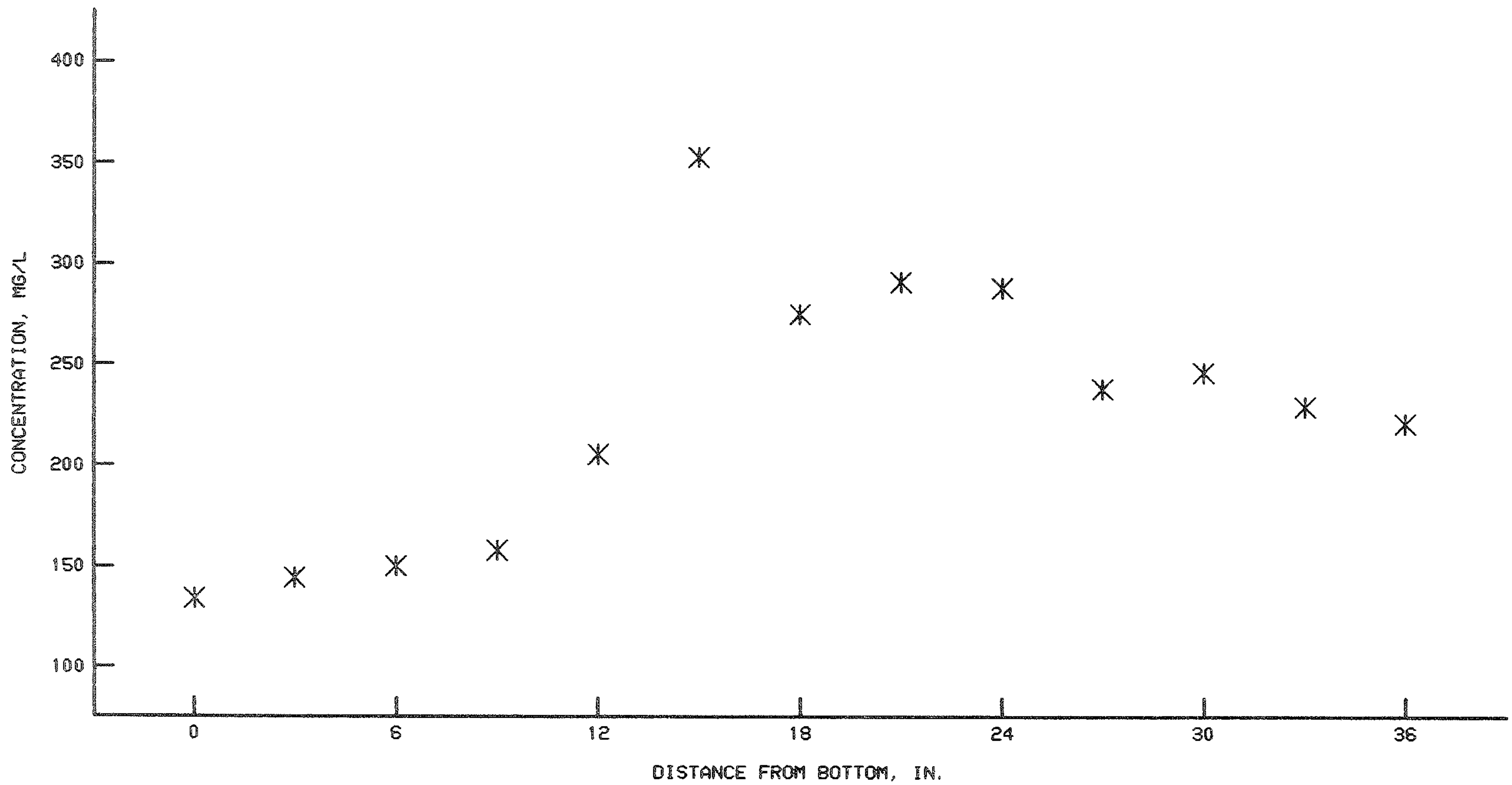

100
80
60
40
20
0
PERCENT OF SAMPLE
1
2
3
4
5
SAMPLE LOCATION
6
7
8
9
SAMPLE LOCATION
10
11
12
13
SAMPLE LOCATION
LEGEND
FLUID MUD
MIXTURE
ORGANIC
SILT
SANDY-SILT
SAND
NOTE: SAMPLING LOCATIONS ARE SHOWN IN FIGURE 10.
BOTTOM SAMPLE CLASSIFICATIONS
MARCH 1989

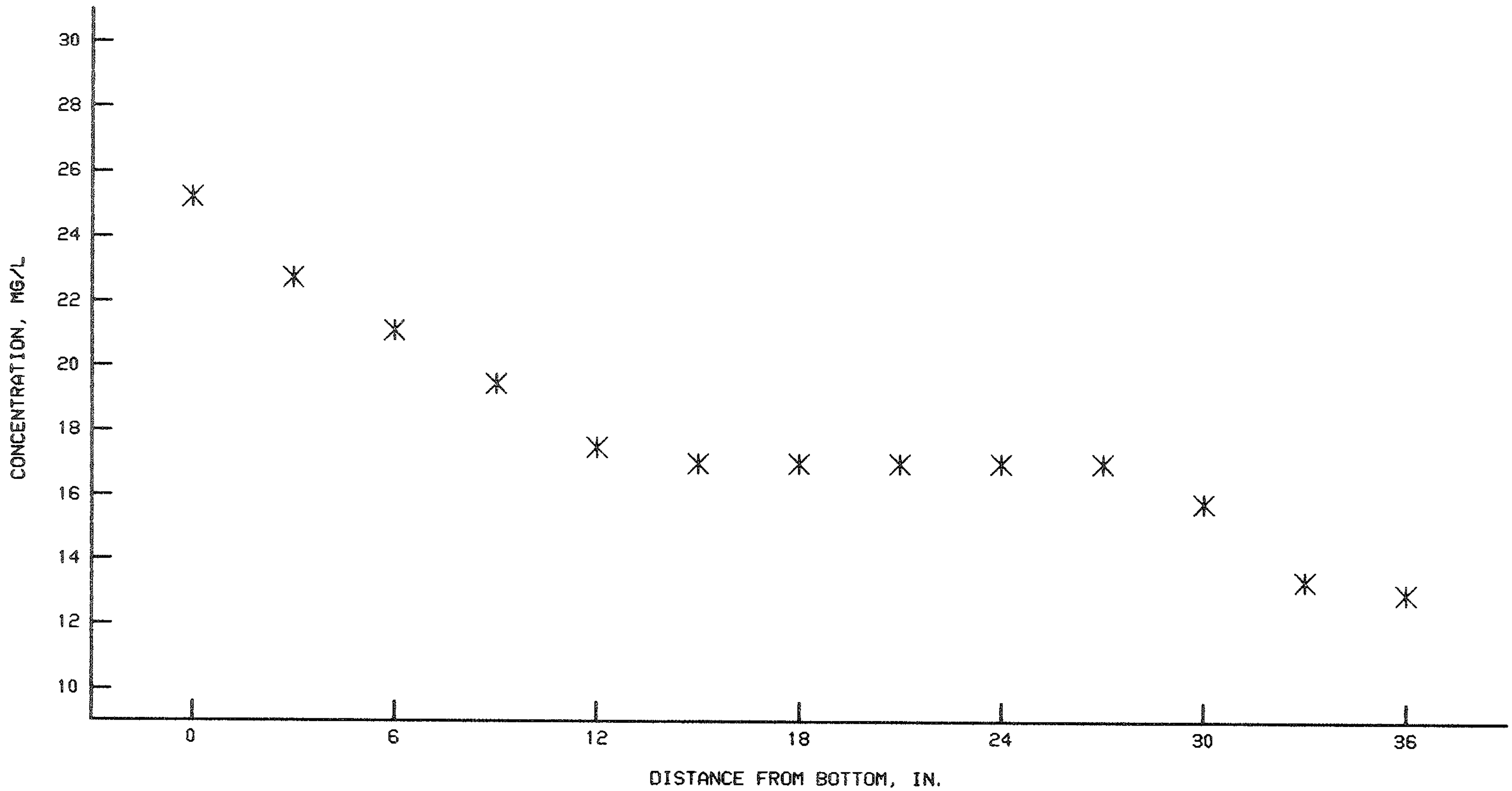
PLATE 32



SEDIMENT PROFILE
SITE 1
31 JANUARY 1989



SEDIMENT PROFILE
SITE 2
1 FEBRUARY 1989



SEDIMENT PROFILE
SITE 3
1 FEBRUARY 1989

APPENDIX A: IN SITU SEDIMENT DENSITY PROFILES
WINYAH BAY (GEORGETOWN), SOUTH CAROLINA
21-23 JANUARY 1989

Introduction

1. The survey was conducted in Winyah Bay on 21-23 January 1989, using the South Carolina Department of Natural Resources/Bureau of Fisheries survey boat, *Carolina Pride*.

2. The overall objective was to investigate the areal distribution and depth of low-density sediments, particularly in areas that had been used and were being used as dredged material disposal sites. Sampling sites are shown in Figure A1.

3. The intention was to obtain: (a) acoustic data using an ODOM, 28-Khz survey fathometer (with tape facilities for recording data for subsequent signal analysis); (b) vertical sediment density/depth profiles using a SIRAD B.S.G. 1 gamma backscatter density gage at locations listed in Table A1; and (c) physical samples of low-density, fluid mud sediments using a prototype vacuum sediment sampler (VSS).

General Comments

4. At the onset of this survey, it was anticipated that significant quantities of fluid mud would be found. In the context of this data report, fluid mud is considered as cohesive sediment with an in situ specific gravity (SG) of less than 1.2 and is referred to as "low-density" sediment in the descriptions of the profiles.

5. During the survey no significant areas of fluid mud were located and only two density profiles (Profile SC 1026, station 17, and Profile 1024, station 16) indicated thin layers of the material.

6. Two profiles (SC 1016, station 5, and SC 1019, station 12A), indicated accumulations of "settled mud," sediment with an SG of 1.3-1.4.

7. The other profiles indicated an overall lack of both fluid and settled mud in the survey area, because under both free- and slow-fall conditions, the backscatter gage did not penetrate appreciably into the bottom sediment--in many cases 6 in. or less. This situation generally indicates a consolidated mud or a muddy sand.

8. Because of the vertical spacing between the source and detector in the backscatter gage, resolution is low--the order of 1 ft. Therefore for

any future work, it is recommended that a transmission gage is deployed in addition to the backscatter gage.

9. The vacuum sediment sampler appeared to work; however, due to the lack of fluid mud, no samples of low-density sediment were obtained. Samples of bottom water were drawn into the sampler tubes at various stations where the sediment strength was sufficient to support the weight of the sampler, while at station 5, a sample of bottom water and settled mud was obtained when a sampling nozzle penetrated into the sediment.

10. Figures A2-A22 show the vertical gamma density profiles with brief descriptions.

Table A1

Profile Locations

Date	Profile No.	Station No.	Profile Rate
1/21/89	SC 1003	Alongside Georgetown Landing	Free Fall
	SC 1007	8A	Free Fall
	SC 1009	14	Free Fall
	SC 1010	14	Slow Fall
1/22/89	SC 1011	4	Slow Fall
	SC 1012	4	Free Fall
	SC 1013	2	Free Fall
	SC 1014	2	Slow Fall
	SC 1015	5	Free Fall
	SC 1016	5	Slow Fall
	SC 1017	12	Free Fall
	SC 1018	12	Slow Fall
	SC 1019	12A	Slow Fall
	SC 1020	Near to 6	Free Fall
	SC 1021	15	Slow Fall
	SC 1022	15	Free Fall
1/23/89	SC 1023	16	Slow Fall
	SC 1024	16	Slow Fall
	SC 1025	17	Free Fall
	SC 1026	17	Slow Fall
	SC 1027	17	Free Fall

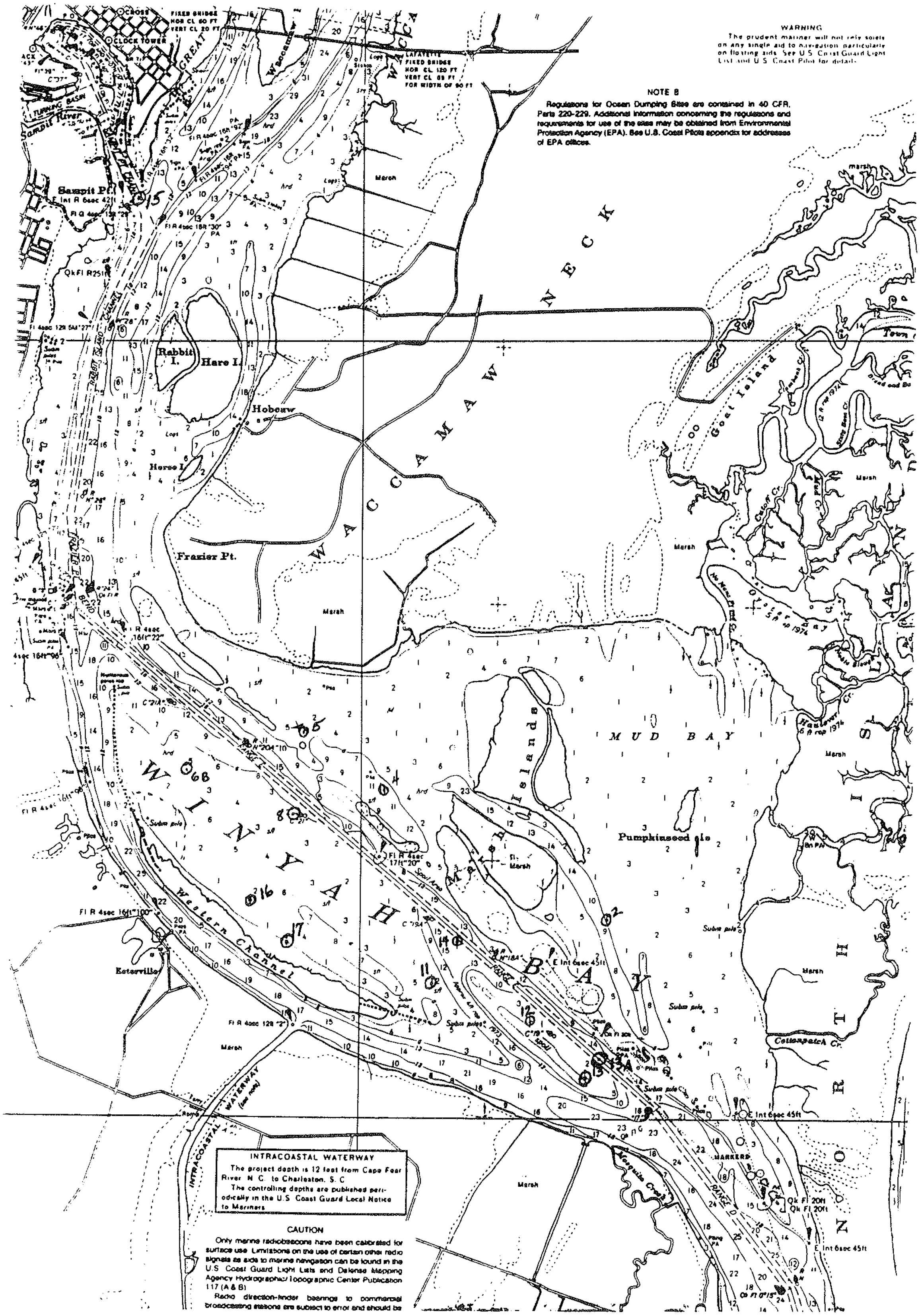


Figure A1. Sampling locations for gamma backscatter density gage

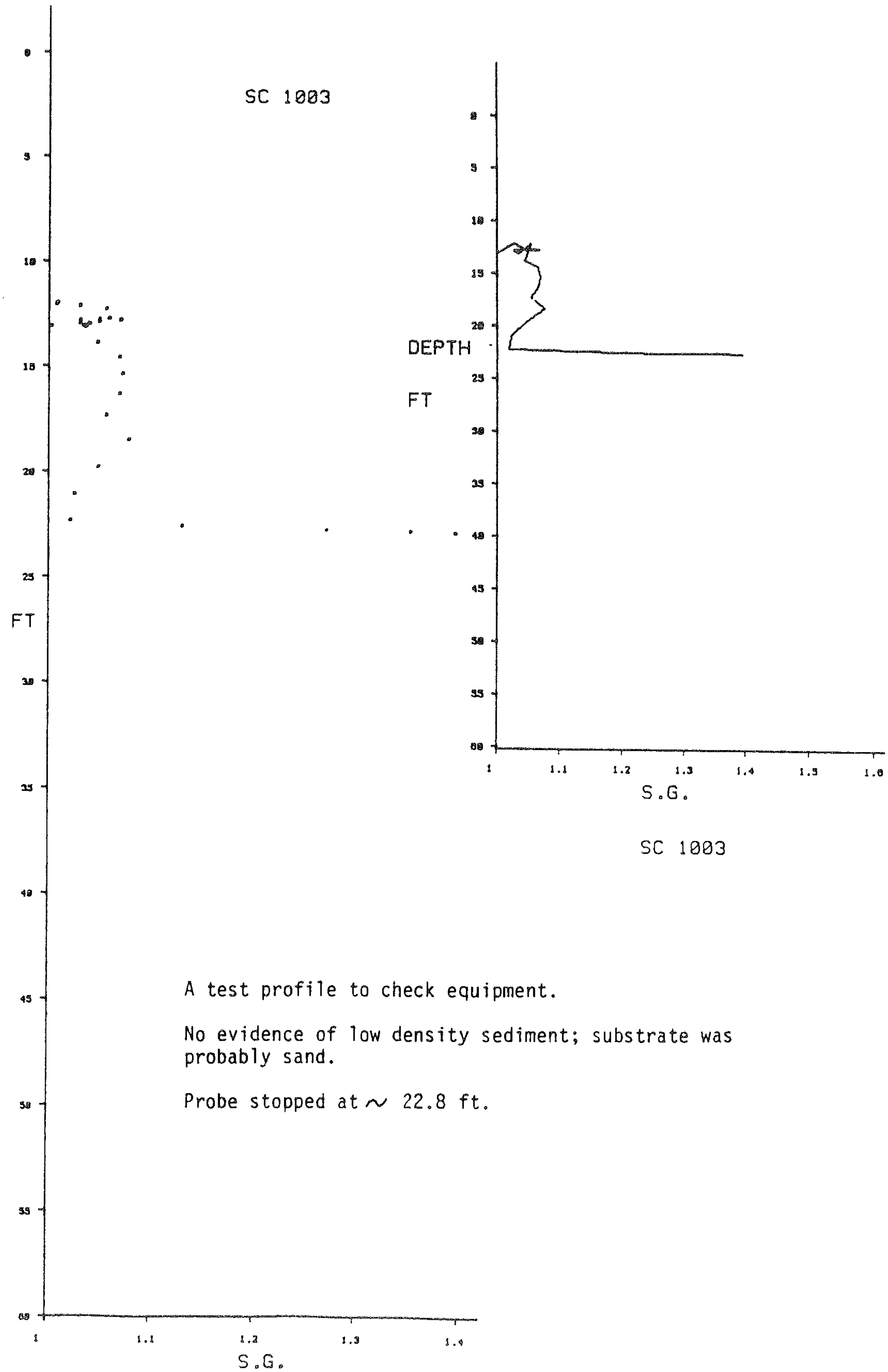
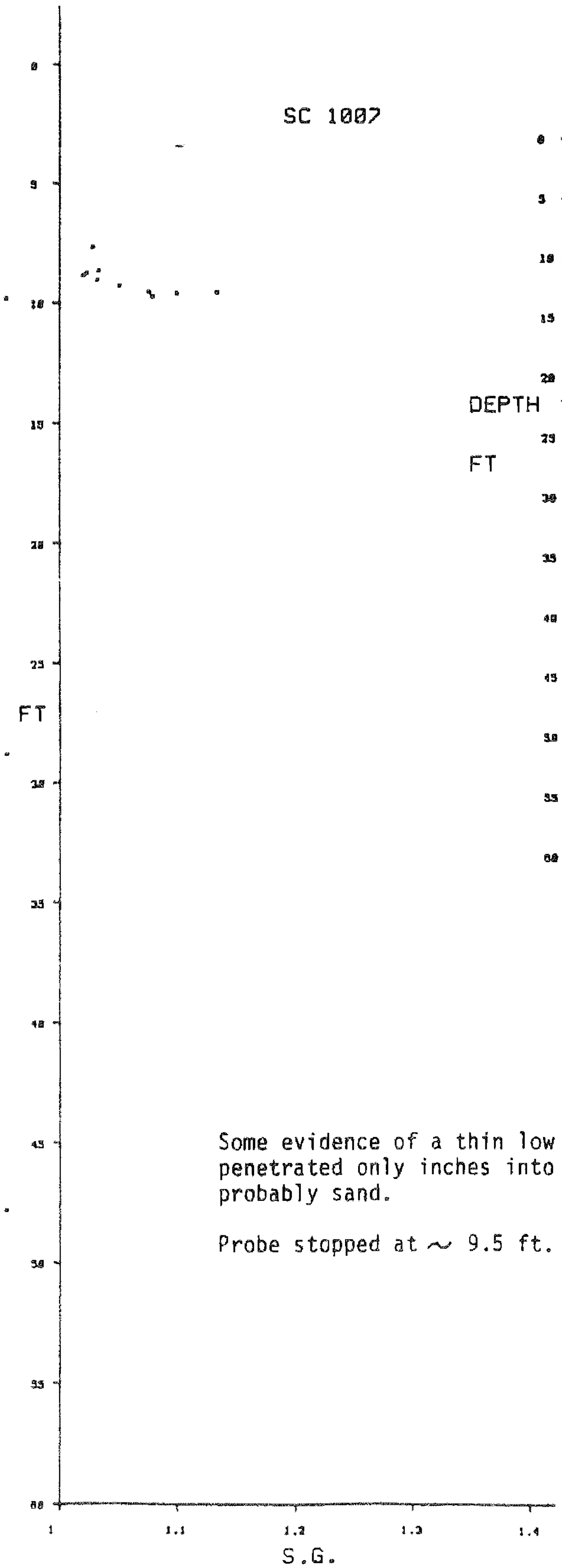
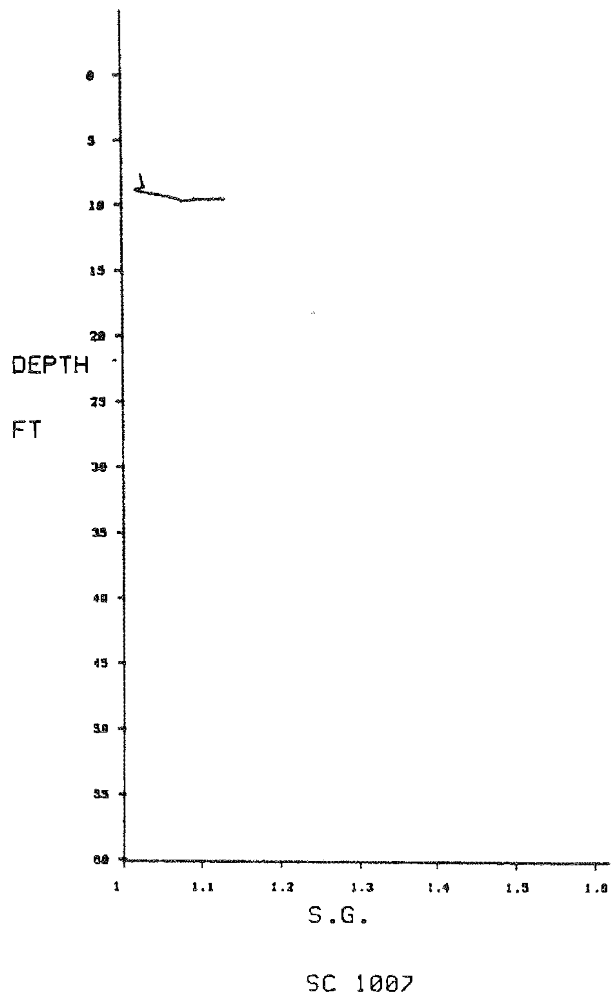


Figure A2. Station alongside Georgetown Landing, free fall





Some evidence of a thin low density sediment layer. Probe penetrated only inches into underlying substrate which was probably sand.

Probe stopped at ~ 9.5 ft.

Figure A3. Station 8A, free fall

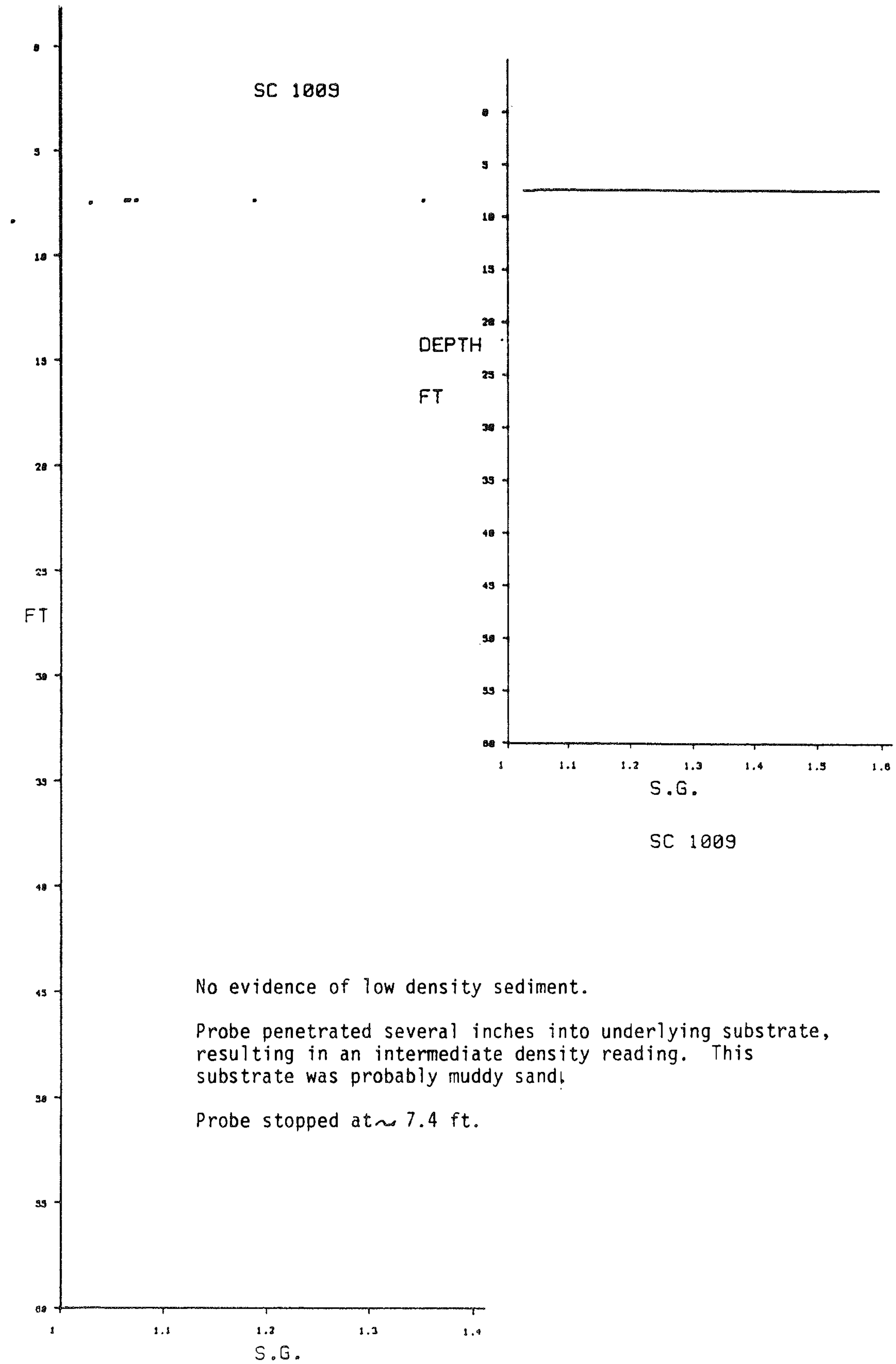
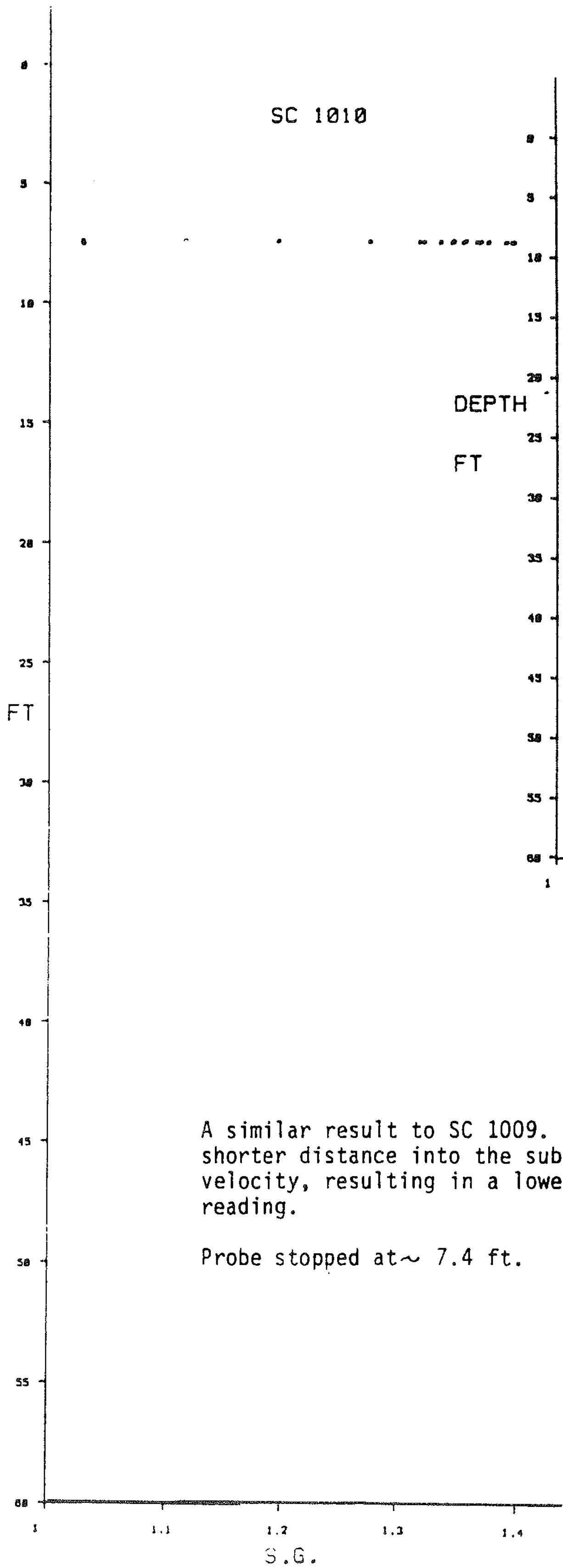
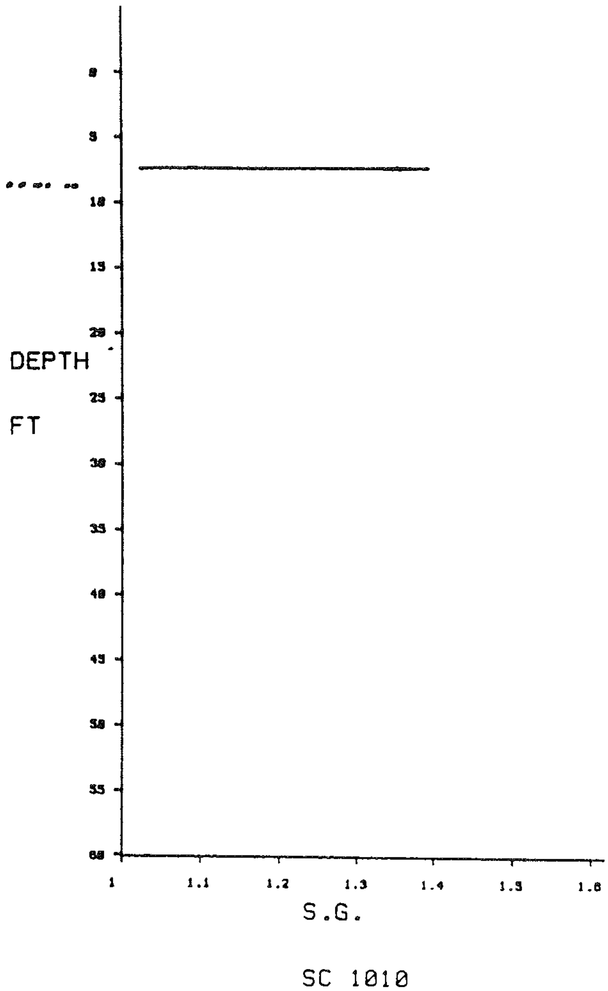


Figure A4. Station 14, free fall





A similar result to SC 1009. The probe penetrated a shorter distance into the substrate, due to the lower fall velocity, resulting in a lower intermediate density reading.

Probe stopped at ~ 7.4 ft.

Figure A5. Station 14, slow fall

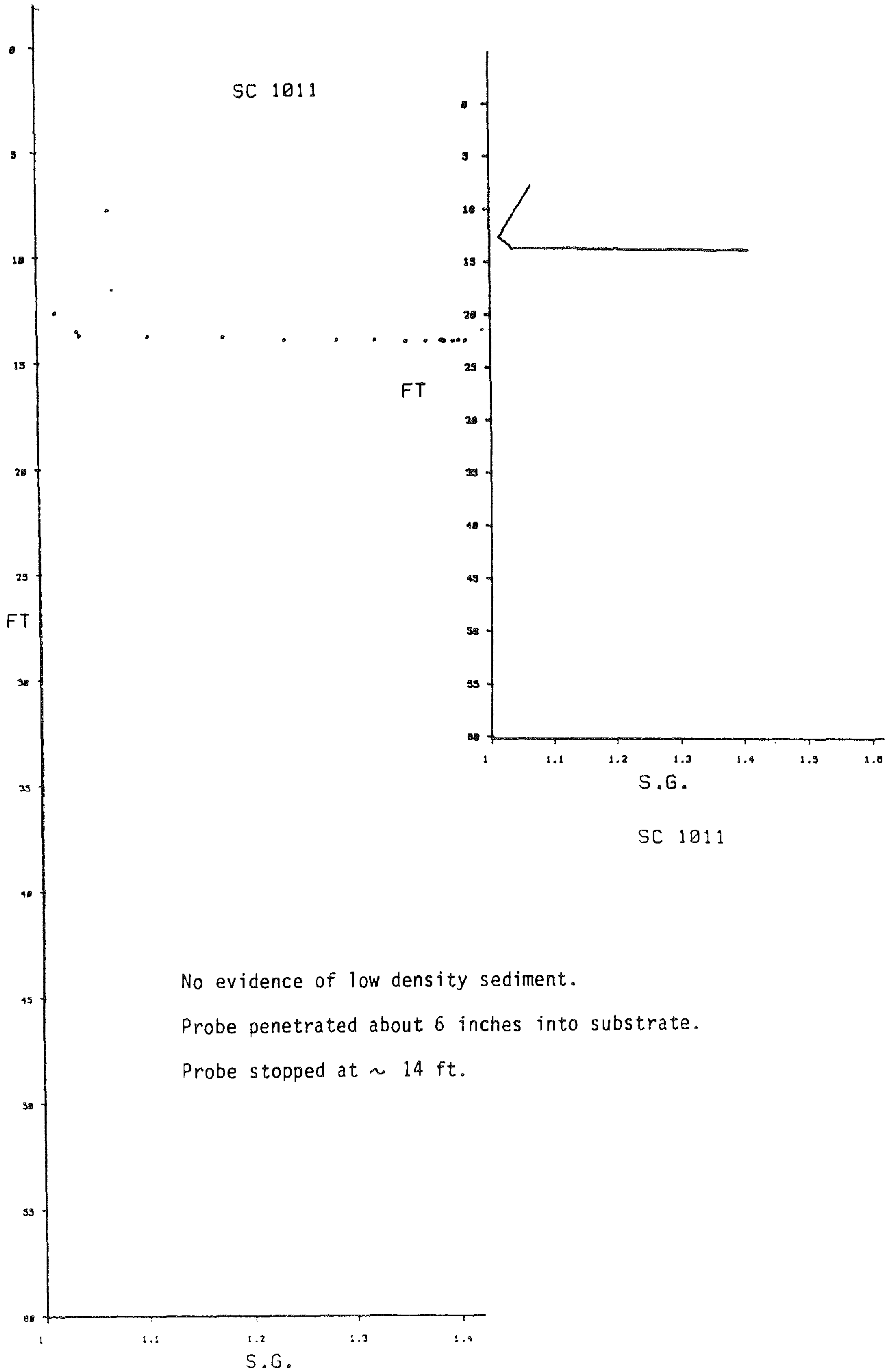
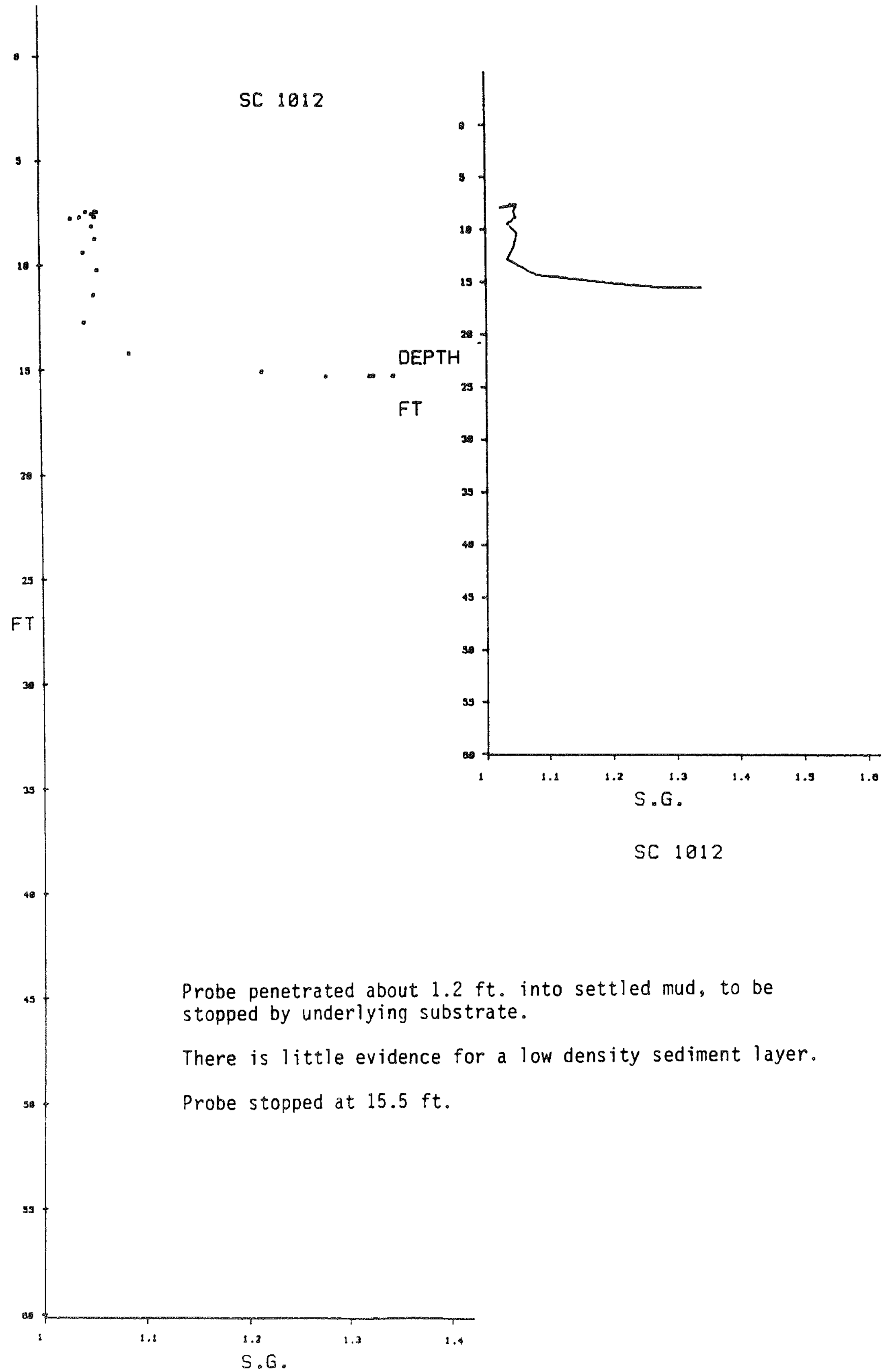


Figure A6. Station 4, slow fall

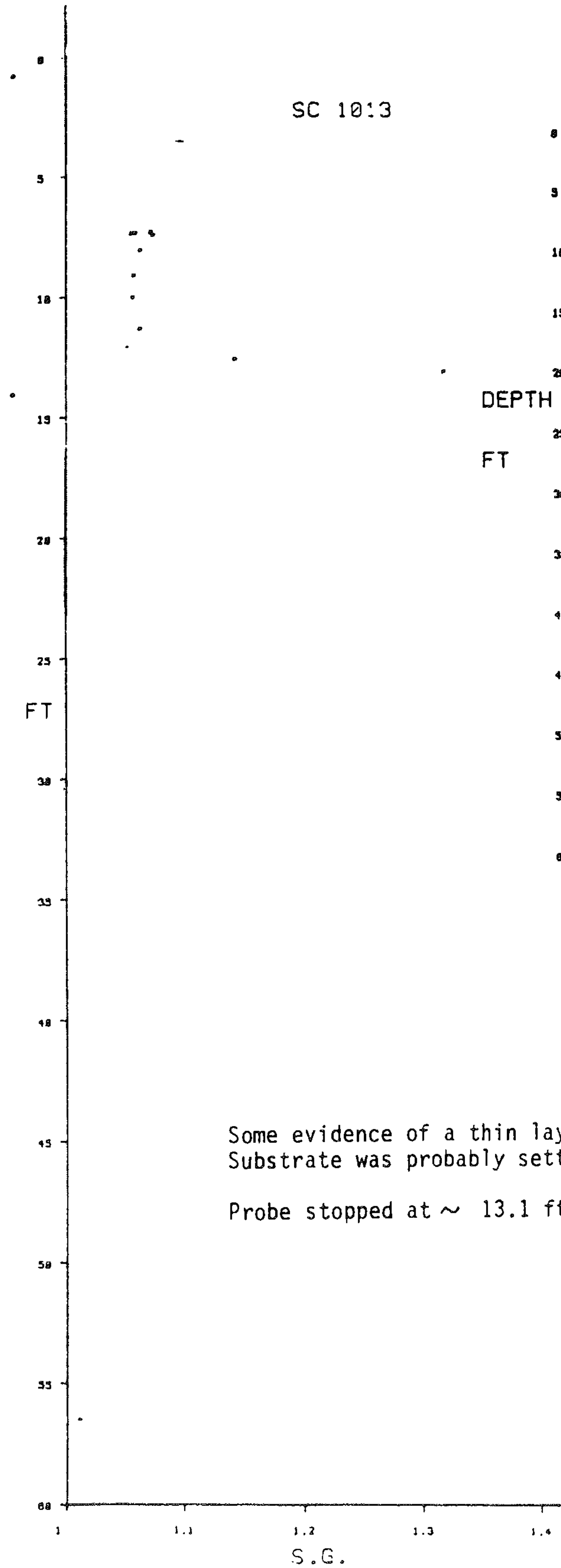


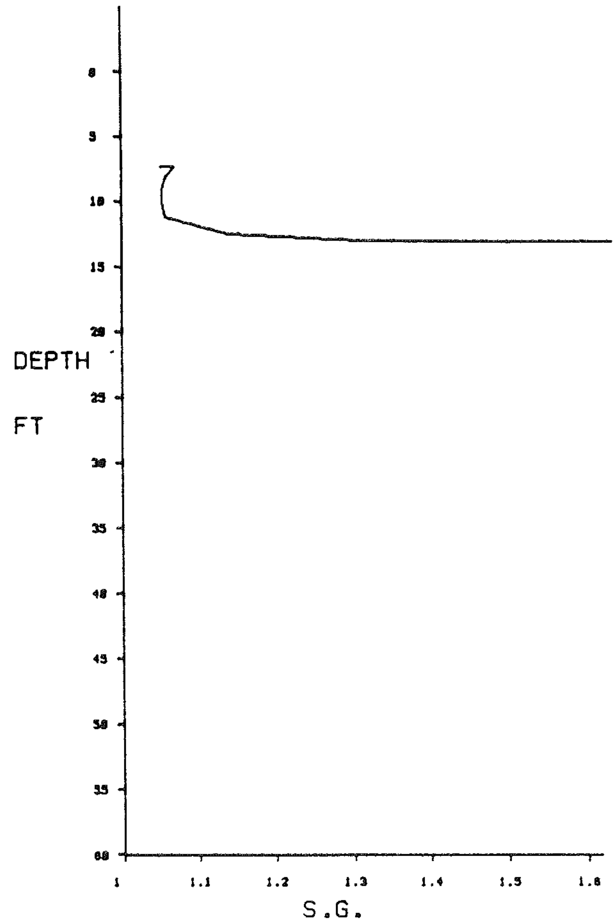
Probe penetrated about 1.2 ft. into settled mud, to be stopped by underlying substrate.

There is little evidence for a low density sediment layer.

Probe stopped at 15.5 ft.

Figure A7. Station 4, free fall

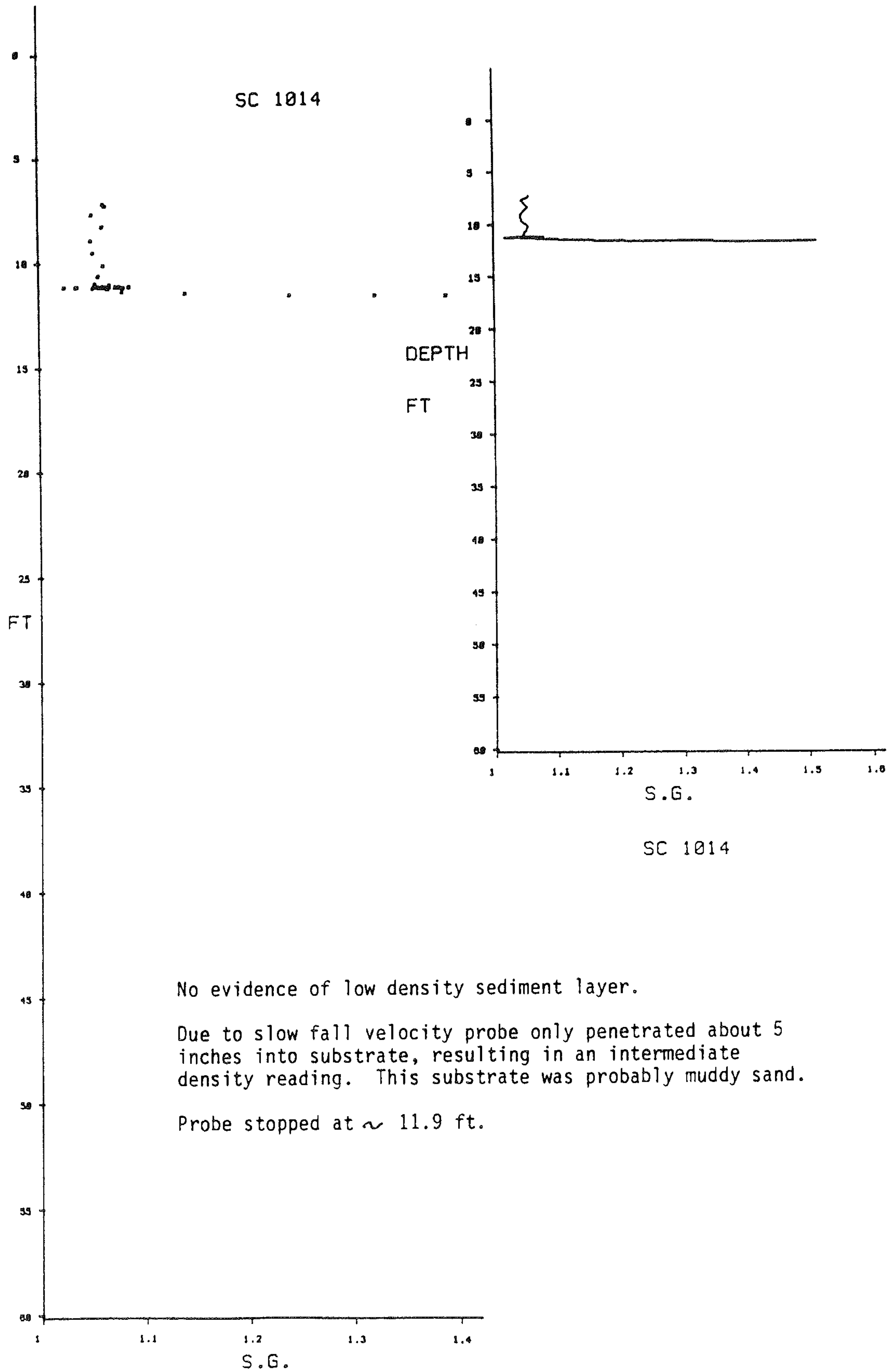




Some evidence of a thin layer of low density sediment.
Substrate was probably settled mud or muddy sand.

Probe stopped at ~ 13.1 ft.

Figure A8. Station 2, free fall



No evidence of low density sediment layer.

Due to slow fall velocity probe only penetrated about 5 inches into substrate, resulting in an intermediate density reading. This substrate was probably muddy sand.

Probe stopped at ~ 11.9 ft.

Figure A9. Station 2, slow fall

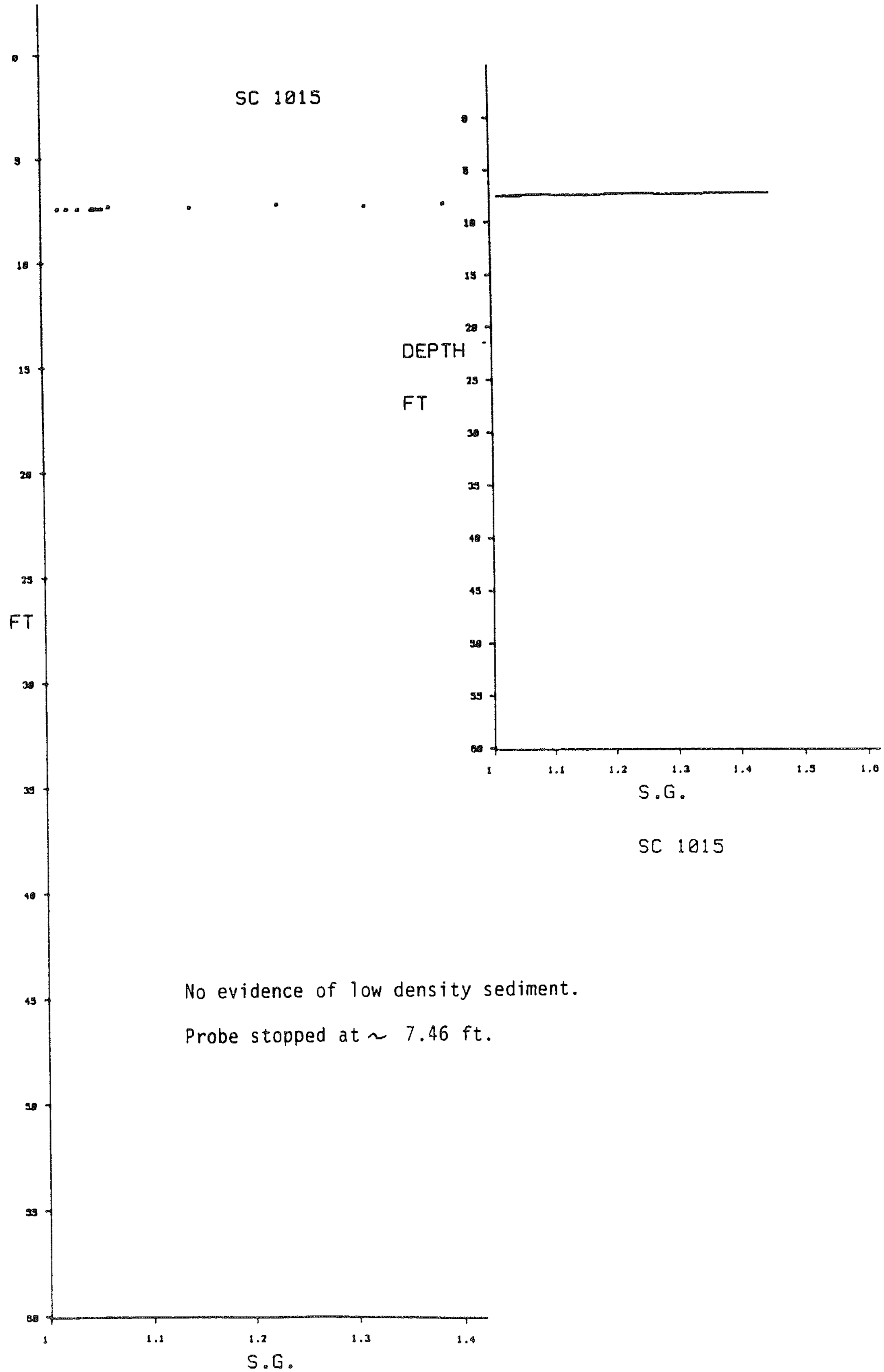
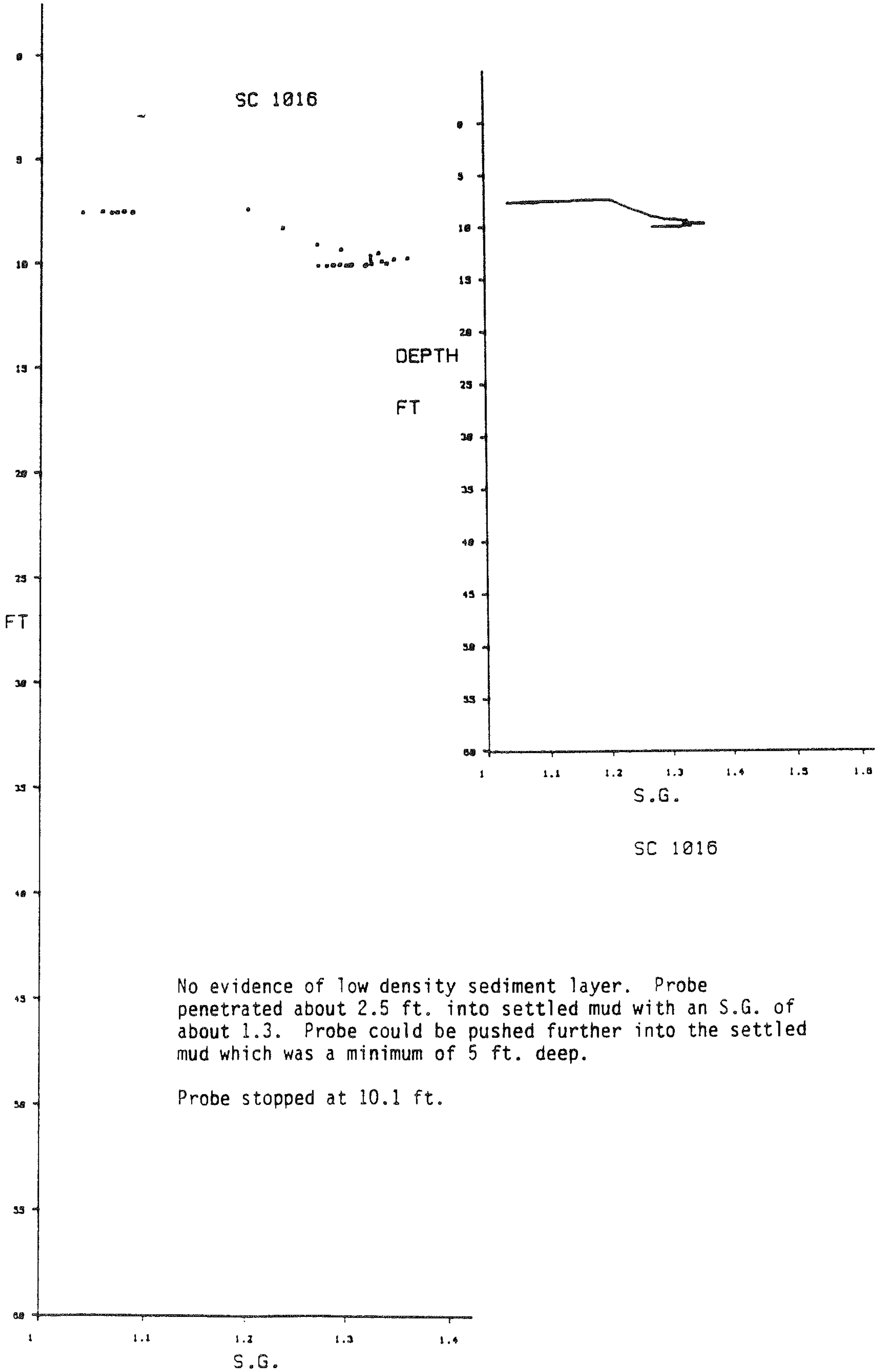


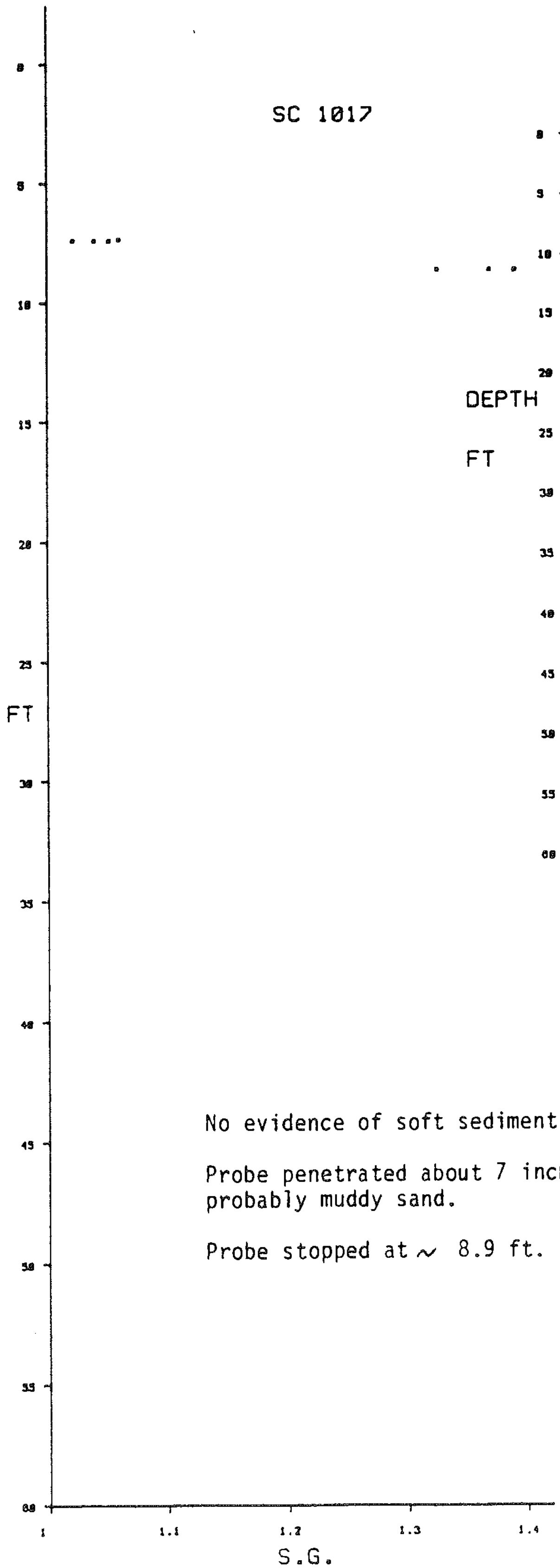
Figure A10. Station 5, free fall

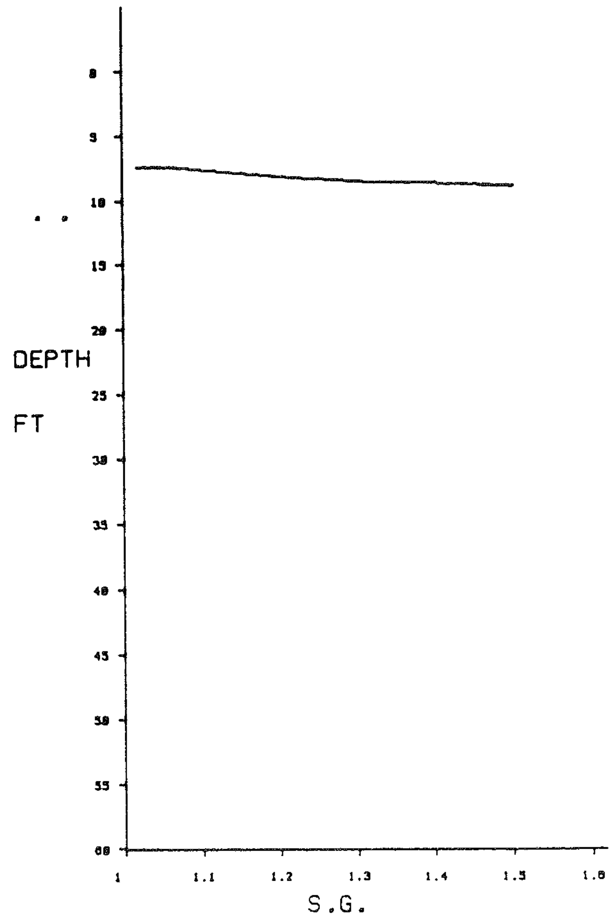


No evidence of low density sediment layer. Probe penetrated about 2.5 ft. into settled mud with an S.G. of about 1.3. Probe could be pushed further into the settled mud which was a minimum of 5 ft. deep.

Probe stopped at 10.1 ft.

Figure A11. Station 5, slow fall



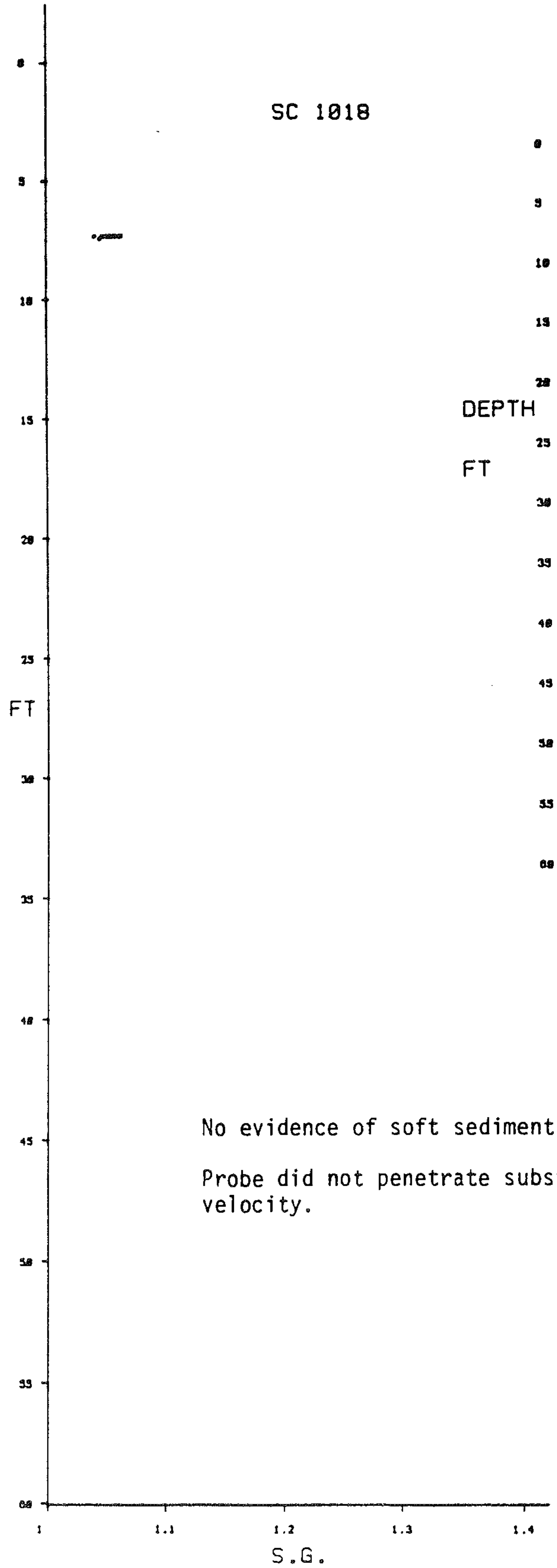


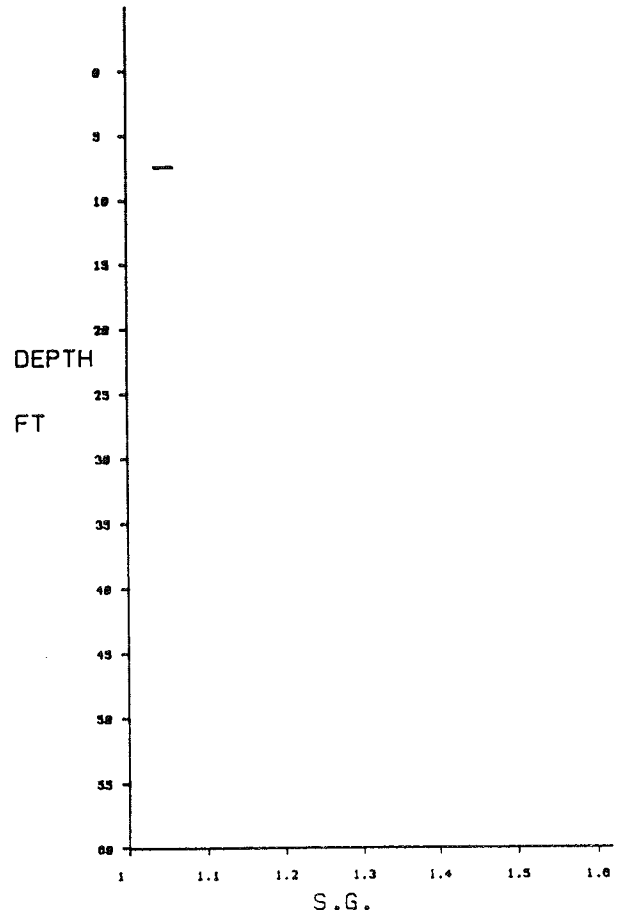
No evidence of soft sediment layer.

Probe penetrated about 7 inches into substrate, which was probably muddy sand.

Probe stopped at ~ 8.9 ft.

Figure A12. Station 12, free fall





No evidence of soft sediment.

Probe did not penetrate substrate, due to slow fall velocity.

Figure A13. Station 12, slow fall

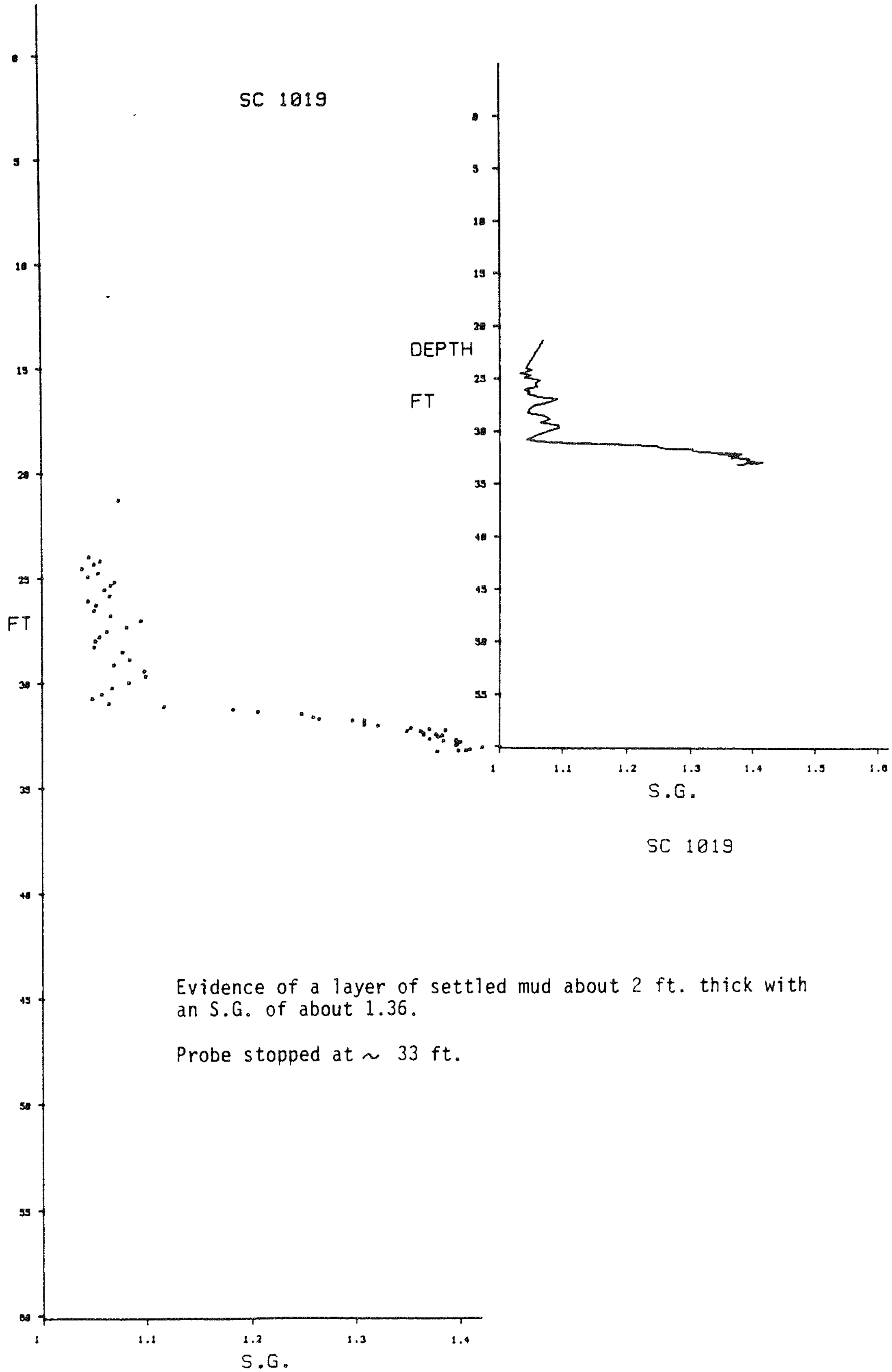
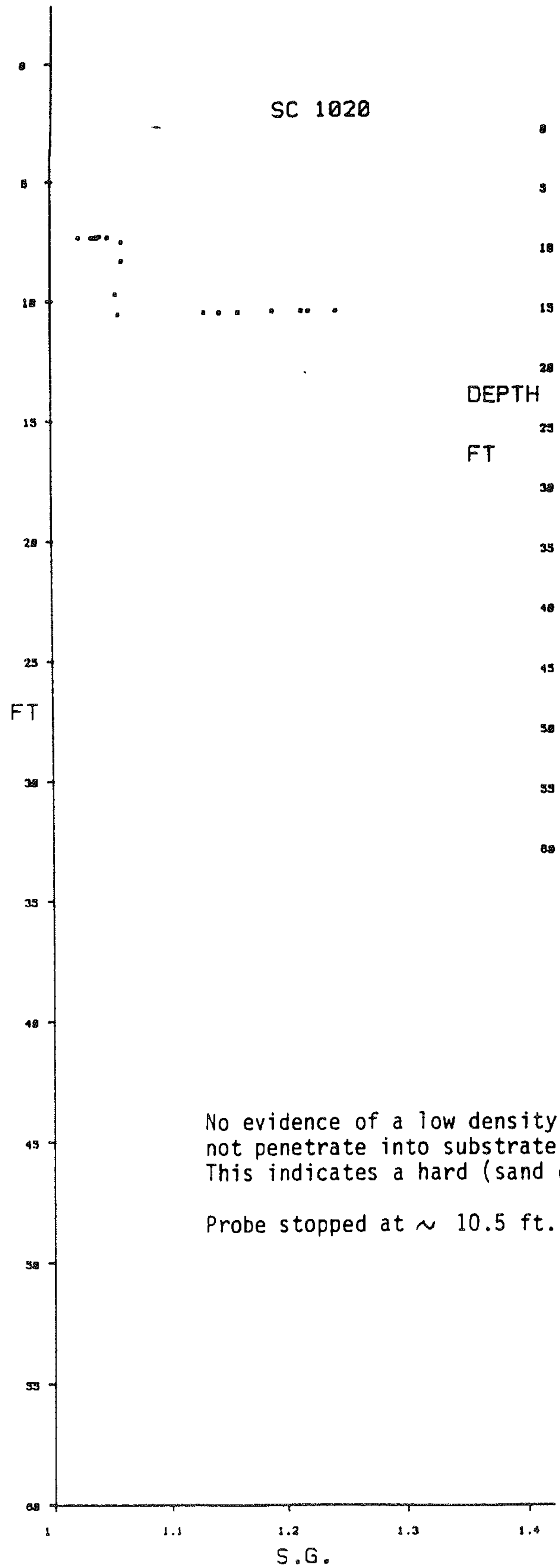
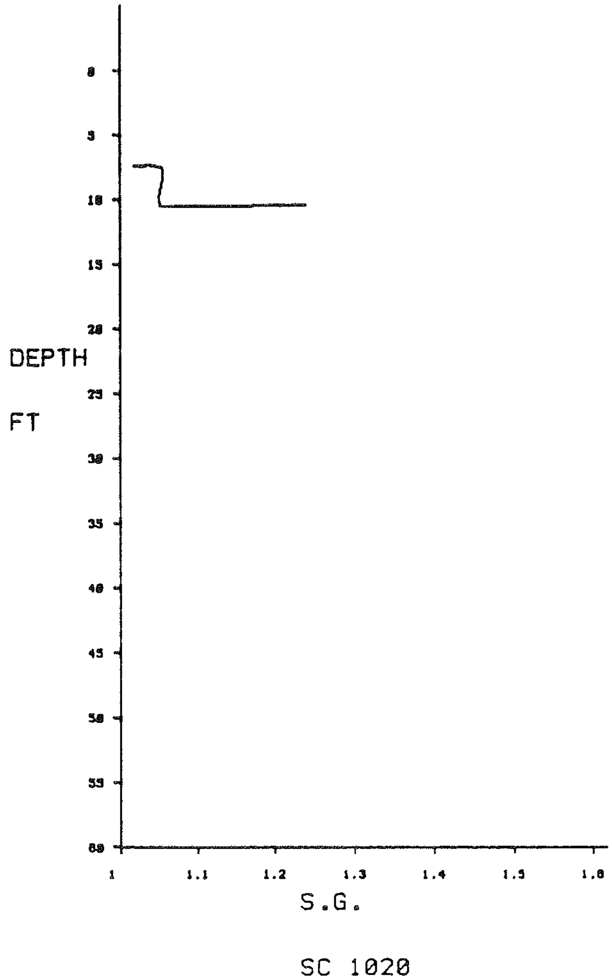


Figure A14. Station 12A, slow fall

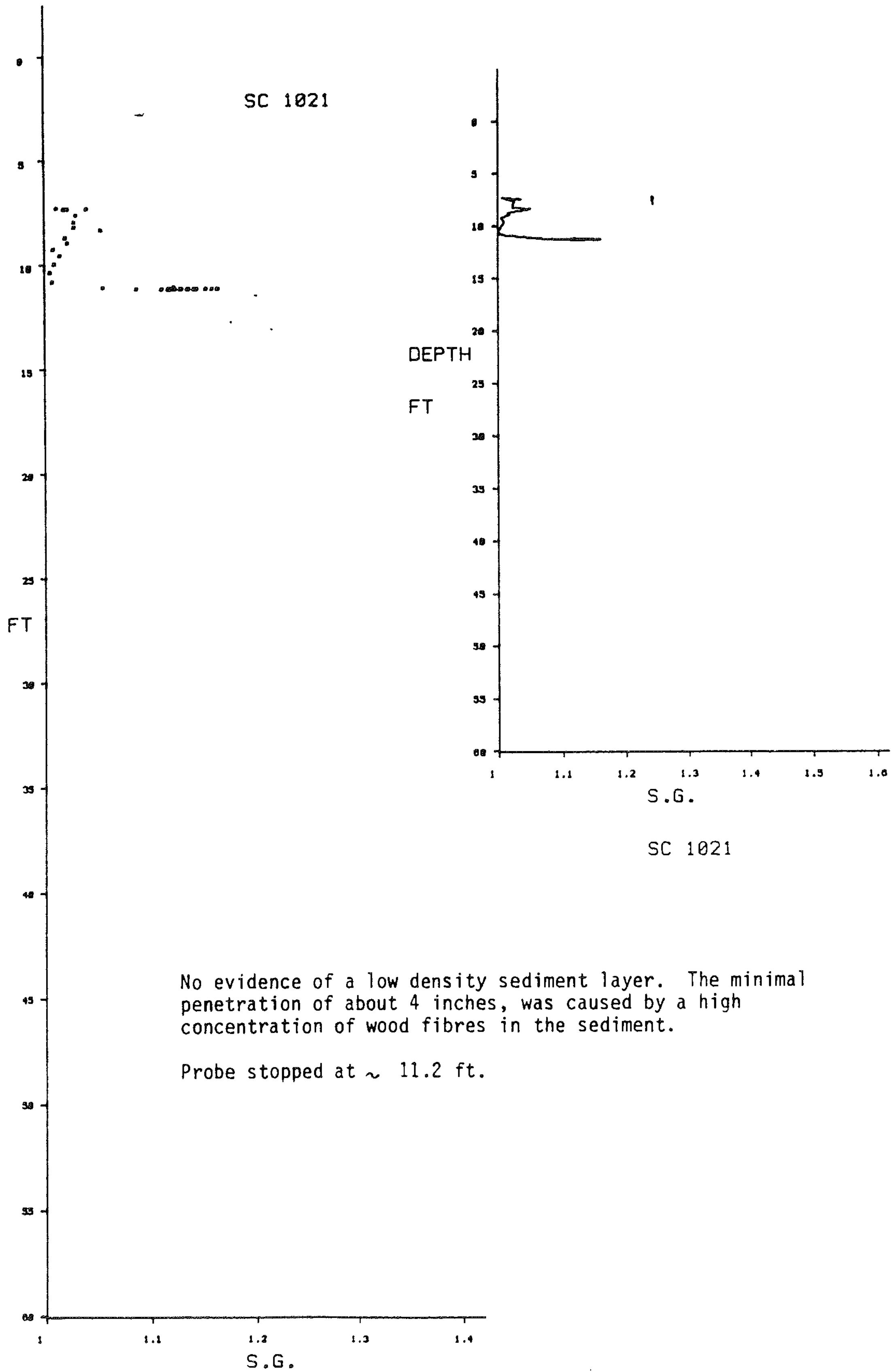




No evidence of a low density sediment layer. Probe did not penetrate into substrate more than one or two inches. This indicates a hard (sand or consolidated mud) bottom.

Probe stopped at ~ 10.5 ft.

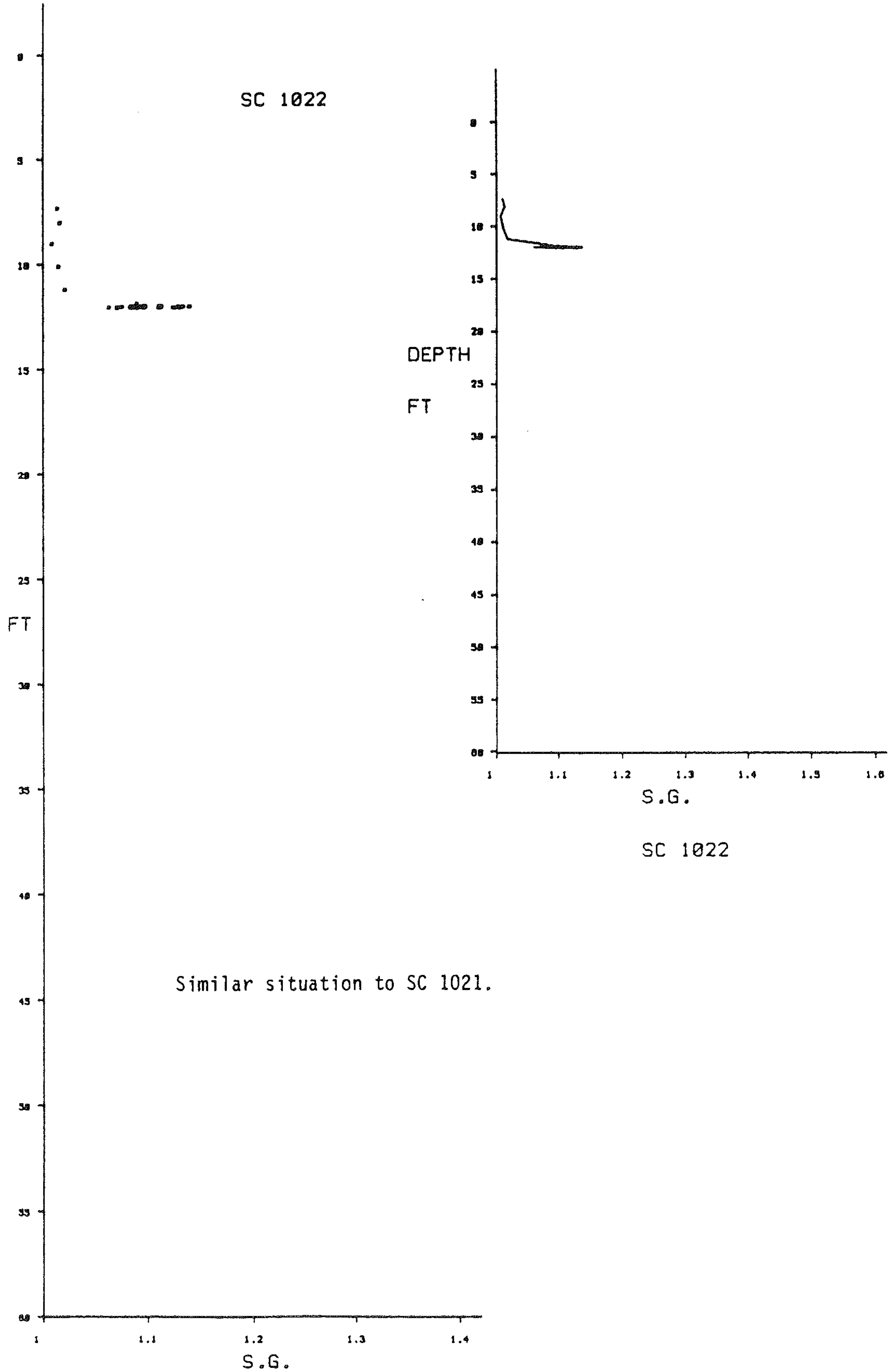
Figure A15. Near Station 6, free fall



No evidence of a low density sediment layer. The minimal penetration of about 4 inches, was caused by a high concentration of wood fibres in the sediment.

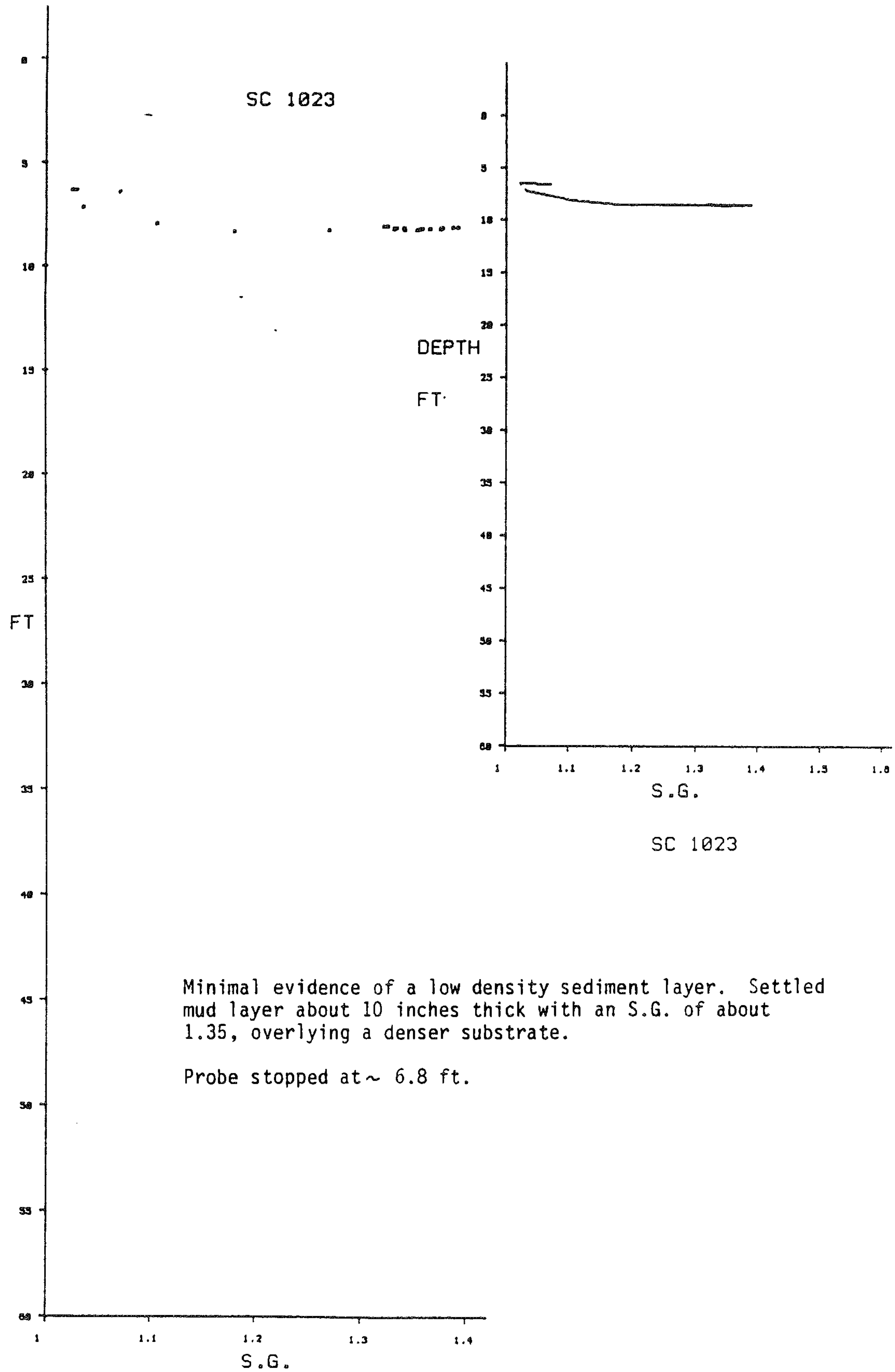
Probe stopped at ~ 11.2 ft.

Figure A16. Station 15, slow fall



Similar situation to SC 1021.

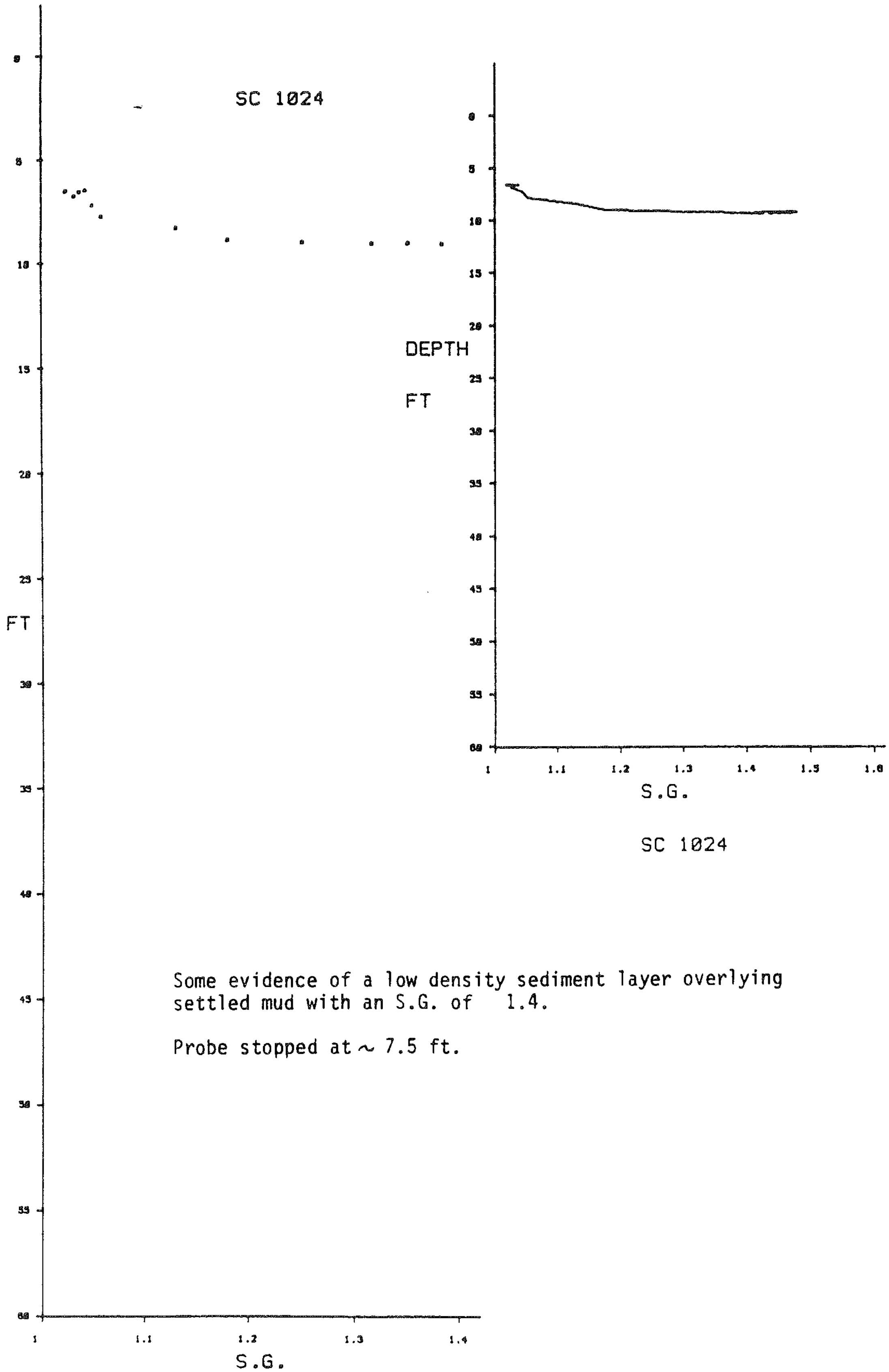
Figure A17. Station 15, free fall



Minimal evidence of a low density sediment layer. Settled mud layer about 10 inches thick with an S.G. of about 1.35, overlying a denser substrate.

Probe stopped at ~ 6.8 ft.

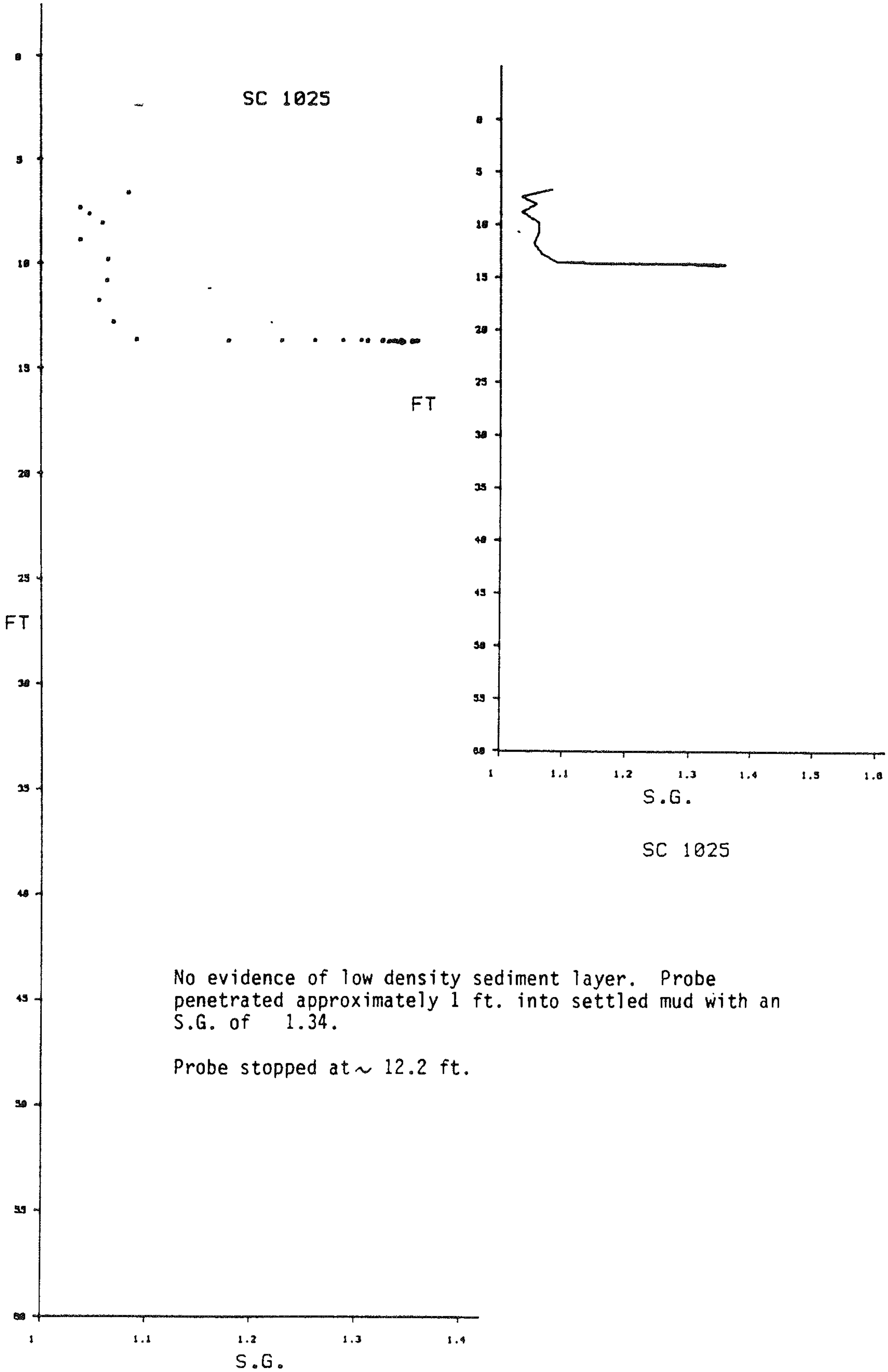
Figure A18. Station 16, slow fall



Some evidence of a low density sediment layer overlying settled mud with an S.G. of 1.4.

Probe stopped at ~ 7.5 ft.

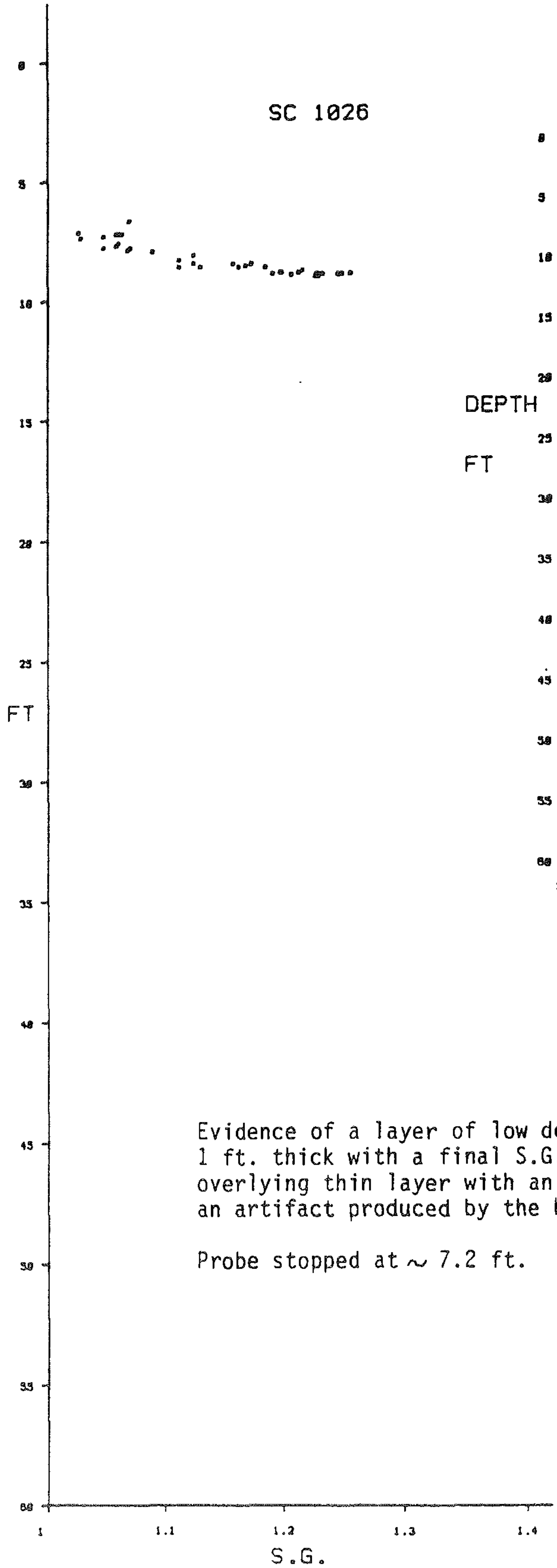
Figure A19. Station 16, slow fall

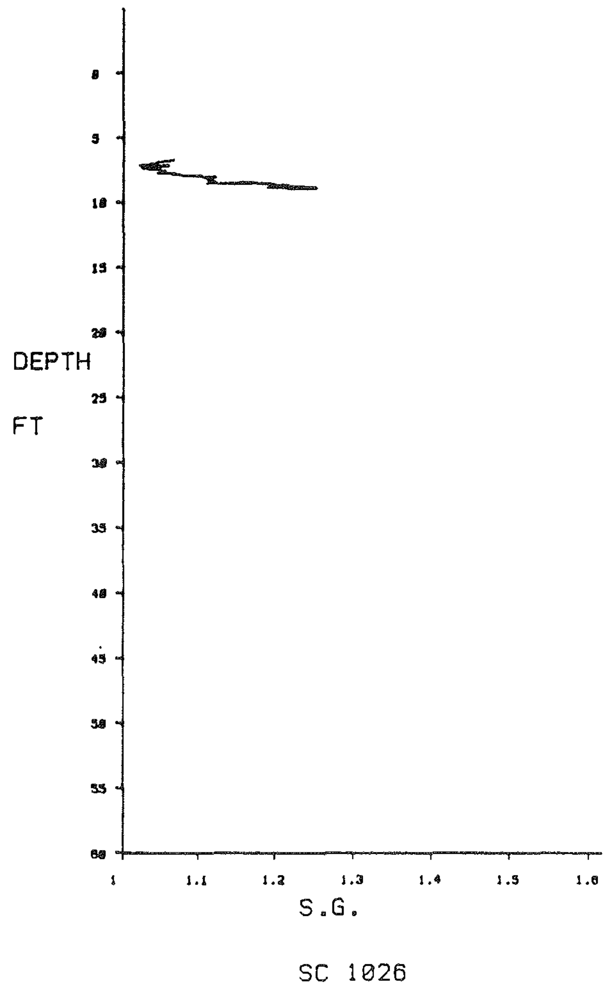


No evidence of low density sediment layer. Probe penetrated approximately 1 ft. into settled mud with an S.G. of 1.34.

Probe stopped at ~ 12.2 ft.

Figure A20. Station 17, free fall

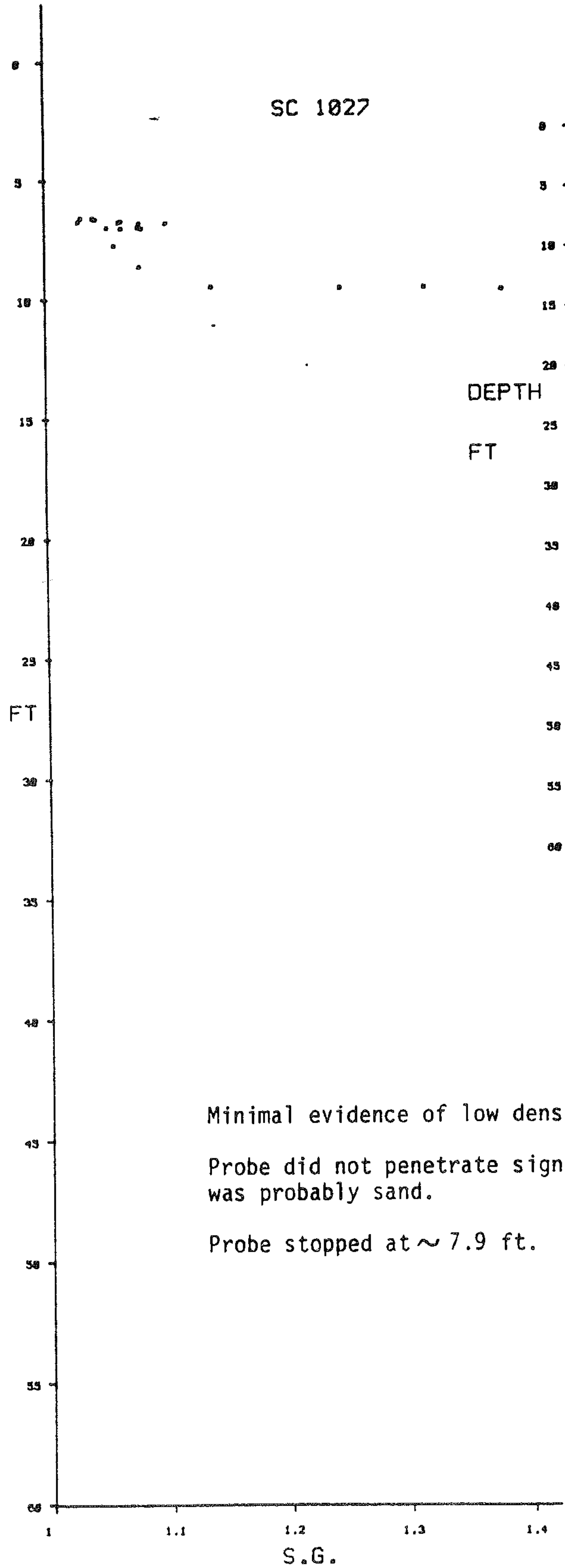


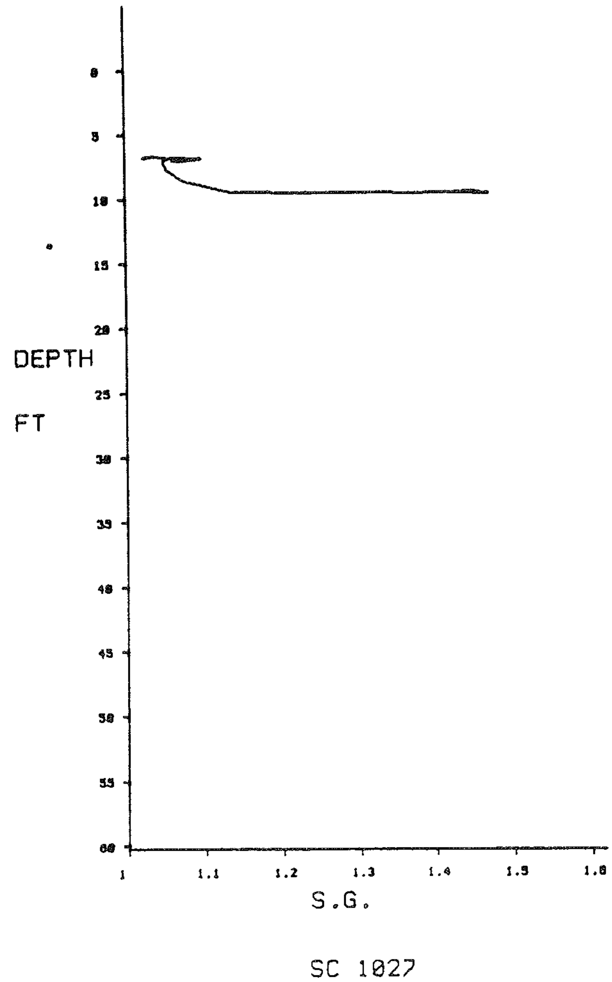


Evidence of a layer of low density sediment approximately 1 ft. thick with a final S.G. of about 1.25. The apparent overlying thin layer with an S.G. of approximately 1.17 is an artifact produced by the backscatter gauge geometry.

Probe stopped at ~ 7.2 ft.

Figure A21. Station 17, slow fall





Minimal evidence of low density sediment.

Probe did not penetrate significantly into substrate which was probably sand.

Probe stopped at ~ 7.9 ft.

Figure A22. Station 17, free fall